University of Reading

Open Science & Open Innovation. A new paradigm to achieve STE(A)M competences

PhD by published works

The Institute of Education

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Open Science & Open Innovation
A new paradigm to achieve STE(A)M competences

A critical review of a sample of publications submitted for the award of PhD by published works

By

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To all the dear friends that will be missed after this time of crisis.

To all the new dear colleagues who I work with, right because of it

Only a life lived for others is a life worthwhile

Albert Einstein (1879-1955)

Acknowledgements

This thesis talks about openness: Open Education, Open Science, Open Innovation, Open access, licensing, data, research, accreditation and so many topics more. All of them are related, all of the have their own meaning, and all of the them are required to understand a movement that started not so long ago, and that became more vivid just recently. There are many ways to define, approach and implement openness; all of the them are valid and they express the nuances that fight against a binary view, right or wrong, which is always simplistic and mostly misleading. This work is part of that movement. It drinks from many discussions, conferences, courses, publications and informal chats with so many respected colleagues in this field. No doubt that a large part of this thesis is possible thanks to them.

I also thank all the colleagues who were I wrote these selected publications with. Many of them are included in the previous paragraph. They have improved and broaden my view about the topic, and we have nurtured the concept of openness together.

Thanks to my supervisors, Prof. Floyd and Dr. Trakulphadetkrai. Both have provided me with a clear guideline, an effective support and a close mentoring relation. Their faith in this project made it easier.

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Abstract

A global challenge is how to help learners achieve relevant competences in educational contexts, such as higher education, in the fields of science, technology, engineering, the arts and maths—or STE(A)M. A *competence* is an efficient combination of *knowledge*, *skills*, and *attitudes* that meet specific requirements in diverse contexts while keeping their meaning.

Competences are used to build academic programmes that align with the needs of the labour market, enabling graduates to gain required knowledge and skills in a proper context. However, there is a perceived gap between achieving competences and applying them in the market. Further, when competences are transferred from the academy to the workplace, the academic and professional competences do not seem to match. Although these competences are key for students to successfully transition into the labour market, **research shows that they are not properly assessed or implemented, whether it is their definition, acquisition or transfer to the market. Further, it seems to be no clear, normalised framework to check whether a student has achieved these competences.**

On the other hand, STE(A)M competences combine technical skills, problem-solving techniques, applied creativity, and creative thinking (from the arts) and they demand hours of training and assimilation before being integrated into the learner's embedded behaviour. The challenge is twofold: The learning curve and the resources spent to master specific competences. But these two challenges do not address how to relate competences to the labour market and how to include the creativity component from the arts. Most **research highlights the lack of an appropriate, effective and normalised way to integrate creativity into the technical components when achieving competences**.

This thesis helps solve both research gaps: (1) Lack of a normalised framework; and (2) lack of an effective way to combine creative and technical competences, by using Open Science, Open Innovation and an Open Competence Framework

The publications propose that **Open Science and Open Innovation are key elements to design, implement, achieve and validate STE(A)M competences in an effective way out of a normalised, open and structured framework**.

This thesis is developed based on three research questions: 1) **How can Open Science contribute to complement official, accredited competences in STE(A)M in an effective way?**; 2) **How can Open Innovation support the design, implementation and validation of formal, non-formal and informal learning settings?**; and 3) **How can an Open Competence Framework become a key contribution to develop a new paradigm in achieving competences in educational settings?**

Table of contents

List of tables

List of published works

ID*	TH*	Publication
01	Open Science	**Burgos**, D., & Corbi, A. (2018). Transgenic learning for STEAM subjects and virtual containers for OER. Distance Education, 39:1, 4-18. (Q1, SSCI). DOI: https://doi.org/10.1080/01587919.2018.1429894
02	Open Science	**Burgos**, D., & Corbi, A. (2017) STEAM subjects enhanced through virtual containers for OER. Proceedings of the Innovation Arabia Conference (p.2). March, 6-8, 2017. Dubai, UAE. ISSN# 2414-6099 (peer-reviewed paper)
03	Open Science	Corbi, A, & **Burgos**, D. (2017). OERaaS: Open Distribution of Virtual Containers as a Key Framework for Open Educational Resources and STEAM Subjects. The Electronic Journal of e-Learning, 15(2), 126-136, available online at https://eric.ed.gov/?id=EJ1142209.
04	Open Science	Corbi, A, & **Burgos**, D. (2015). Semi-automated correction tools for mathematics-based exercises in MOOC environments. IJIMAI, 3(3), 89-95. DOI: https://doi.org/10.9781/ijimai.2015.3312
05	Open Science	Nascimbeni, F., **Burgos**, D., Campbell, L. & Tabacco, A. (2018) Institutional mapping of open educational practices beyond use of Open Educational Resources. Distance Education, 39:4, 511-527 (Q1, SSCI) DOI: https://doi.org/10.1080/01587919.2018.1520040
06	Open Innovation	**Burgos**, D. (2015) A critical view of IMS Learning Design: recommendations for a revised version. In Maina, M., Brock, C., & Yishay, M. (Eds.) The art & science of learning design (pp. 137-153). SensePublishers, Rotterdam. DOI: https://doi.org/10.1007/978-94-6300-103-8_10
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08	Open Innovation	**Burgos**, D. (2020). A Predictive System Informed by Students' Similar Behaviour. Sustainability, 12 (2), 706. DOI: https://doi.org/10.3390/su12020706
09	Open Innovation	Nascimbeni, F., & **Burgos**, D. (2019). Unveiling the Relationship between the Use of Open Educational Resources and the Adoption of Open Teaching Practices in Higher Education. Sustainability, 11(20), 5637. DOI: https://doi.org/10.3390/su11205637
10	Open Innovation	Nascimbeni, F., **Burgos**, D., Aceto, S., & Kamtsiou, V. (2017). Supporting innovation in technology-enhanced learning: a stakeholder-based open approach. International Journal of Innovation and Learning. Vol. 22, No. 2, pp.233–253. DOI: https://doi.org/10.1504/IJIL.2017.085922
11	Open Innovation	**Burgos** D. (2019) The Innovation Cycle for Sustainable ICT Education. In: Tatnall A., Mavengere N. (eds) Sustainable ICT, Education and Learning. SUZA 2019. IFIP Advances in Information and Communication Technology, vol 564. Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-28764-1_24
12	Open Competence Framework	**Burgos**, D. (Ed.)(2017) Open Education Policy. UNIR: Logroño, La Rioja (Spain). Open Access from http://bit.ly/unir-openpolicy (English) and http://bit.ly/unir-educacionabierta (español) (peer-reviewed)
13	Open Competence Framework	Bacsich, P., Nascimbeni, F., Atenas, J., Aceto, S. & **Burgos**, D. (2017) Member States case studies: Policies for Opening Up Education in Europe. Seville, Spain: Joint Research Centre. European Commission (peer-reviewed technical report by the European Commission experts)
14	Open Competence Framework	Nascimbeni, F., & **Burgos**, D. (2016). In Search for the Open Educator: Proposal of a Definition and a Framework to Increase Openness Adoption Among University Educators. The International Review of Research in Open and Distributed Learning, 17(6). (Q1, SSCI). DOI: http://dx.doi.org/10.19173/irrodl.v17i6.2736
15	Open Competence Framework	Nascimbeni, F., Alonso, J., Sanz, O., & **Burgos**, D. (2019). Read, Watch, Do: Developing Digital Competence for University Educators. In International Workshop on Higher Education Learning Methodologies and Technologies Online (pp. 80-93). Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-31284-8_7

**ID: Publication ID, for internal classification; TH: Thematic cluster, for grouping the publications*

Declaration of authorship

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Section 1. Introduction

This section presents the research problem and research questions and explains why the published works were chosen and how they connect to the research questions. It explains why the methodology was chosen and how the collected publications contribute to knowledge. Finally, it introduces the candidate and his motivation for this thesis.

1.1. Research problem and focus of collected publications

Students in higher education and other educational contexts need a radical step forward in achieving competences in science, technology, engineering, arts and maths (Stracke et al., 2019a, 2019b). The definition of *competence* is always contested, but in this research, *competence* is defined as an efficient combination of knowledge, skills, and attitudes that fulfil specific requirements in diverse contexts, while keeping the same meaning (Alles, 2006; Ossandón & Castillo, 2006; Tardif, 2006).

The *knowledge* component stresses learning about the human condition and systems thinking (e.g. *The learner understands the roles individual components play when connected together and combines those components to produce a functioning system*); the *skills* component stresses communication, data analysis and problem solving (e.g. *The learner identifies challenges, brainstorms solutions, and applies specific methods and knowledge from multiple disciplines to efficiently solve problems depending on the context*); and the *attitudes* component stresses collaboration, critique and an open mind-set (e.g. *The learner is open to constructive criticism, unexpected ideas, new ways of thinking, and growth. The learner is willing to re-evaluate personal ideas and opinions when faced with new information*). Further, competences are usually divided into core/key and specific/functional. The later are needed for a professional exploitation of training. A core competence represents a transferable, multifunctional package (system) of knowledge, skills, and values, attitudes, beliefs, and personal attributes that all individuals need to acquire for their personal fulfilment and development, inclusion and employment (e.g. *The learner identifies challenges, brainstorms solutions, and applies specific methods and knowledge from multiple disciplines to efficiently solve problems depending on the context*) (Halász & Michel, 2011). Additionally, a specific/functional competence is a specific knowledge or skill area that relates to successful performance in a job (e.g. *The learner drives the simulation game for experiments in physics efficiently and safely*).

There is an apparent mismatch between the competences students achieve at school anduniversity and the competences required by workplaces (Teijeiro et al., 2013; Winterton & Turner, 2019). Furthermore, a breakthrough is needed to hasten progress and adapt skills to specific, practical objectives so as to achieve related competences more effectively. Indeed, there is an identified gap between competence acquisition during training programmes and their implementation in the labour market (Khampirat & Pop, 2017; McGinness & Sloane, 2011).

The acronym STEM (for science, technology, engineering and maths) was first used by the U.S. National Science Foundation (NSF) in 2001 (Hallinen, 2015) and by the George W. Bush administration with the No Child Left Behind Act of 2001 (Wong & Sunderman, 2007). However, the acronym SMET had the same meaning and was already used a decade earlier by the NSF, the National Research Council, and many researchers (Cooper & Robinson, 1997, 1998; Mahoney, 1996; Springer et al., 1999). At the Americans for the National Arts Policy Roundtable discussion in 2007, the arts were added to STEM, creating STE(A)M, to encourage students' engagement, innovation, creativity and problem-solving skills (Perignat & Katz-Buonincontro, 2019; Warne et al., 2019). The arts bring balance to the computational and process thinking of STEM and encourage outside-the-box solutions and innovative approaches to problem solving (Liao, 2016; Perignat & Katz-Buonincontro, 2019; Root-Bernstein, 2015).

However, researchers have discovered that many educators resist learning how to teach STE(A)M subjects so as to achieve the related competences (Hong & Im, 2012, 2019). Consequently, **the competences (a) are not properly implemented, (b) are not thoroughly evaluated, and (c) do not follow a normalised framework to check their proper achievement** (Chung et al., 2012; Margot & Kettler, 2019; Pears et al., 2019).

Classroom instruction once focused on STEM subjects and technologies but has evolved to include the arts—becoming STE(A)M—and to stress creativity and open thinking (Clarke, 2019). However, **creativity is not systematically integrated into STEM subjects and does not follow a normalised framework** (Conradty & Bogner, 2019), and competences associated with the arts are neglected (Daugherty, 2013; Perignat & Katz-Buonincontro, 2019). But the arts bring creative thinking and open-mindedness to problem solving in science, technology and maths, and a structured competence framework would cross-integrate disciplines and competences instead of working on isolated fields. Thus, STE(A)M subjects and associate competences would not be isolated but interwoven.

In this thesis, I argue that a paradigm shift based on Open Science and Open Innovation can help solve both research gaps with the support of an Open Competence Framework. They provide a structured, normalised, timely and resourceful way to achieve STE(A)M competences. This thesis uses Open Science, Open Innovation and an Open Competence Framework to close the following gaps: **(1) lack of a normalised competence framework; and (2) lack of an effective way to combine creativity and technical competences** by using Open Science, Open Innovation and an Open Competence Framework.

The current paradigm of developing university-level competences concentrates on specific classroom tools with narrow application and minimal integration into full academic programmes or methodologies (Ferrell & Ferrell, 2002; Li et al., 2019; Ng et al., 2019). A significant breakthrough is needed to design a new paradigm adapted to current and future educational contexts (Lopez et al., 2020); to complement existing contexts; to evolve with actual users of the educational system, both institutions (companies, universities, user associations, unions, governments) and individuals (researchers, politicians, students, teachers, professors, tutors, parents); and to keep pace with them (Barrera et al., 2019; Koutsopoulos, 2019). At present, numerous resources complement and promote openness in science, education and innovation: Open Science (**Burgos**, 2020a; Allen & Mehler, 2019), Open Educational Resources (Nascimbeni & **Burgos**, 2019), Massive Open Online Courses (MOOCs) (Stracke et al., 2019a), virtual reality (Crofton et al., 2019), augmented reality (Shyshkina & Marienko, 2020), emotional intelligence (Kaplan, 2019), personalized learning (**Burgos**, 2020b), serious games (Tlili et al., 2020), analytics (Moreno-Ger & **Burgos**, 2020), and Blockchain (Paniagua et al., 2019). The educational community needs to use these.

The impact on research, policy and practice is vast, at many levels (global, regional and national). There is a historical momentum about STE(A)M and Open Science, and about their application into innovative Education. Many major members of the educational community worldwide push for a transparent implementation process of an educational paradigm from the inception of an idea to the final release of a product or service translated into specific actions (Ruan et al., 2019). The European Commission; the United Nations Educational, Scientific and Cultural Organization (UNESCO); the International Council of Open and Distance Education (ICDE); and the Commonwealth of Learning (COL), usually organizers, representatives and participants in these discussions, require pushing a step towards actual implementation of an action plan, with specific steps that implement a theoretical framework (Espino et al., 2019).

For instance, globally speaking, UNESCO develops a very active policy to encourage a gender-balanced participation into STEM topics, worldwide, and with a special focus on developing countries (UNESCO, 2017). Further, UNICEF pro-actively encourages the redefinition of girls' education thanks to the integration of STEM courses in their curricula with the support from Equals Global Partnership and the International Telecommunication Union (UNICEF, 2020). United Nations also develops a specific action called "Design Thinking in STEM" supported by private funding (Siemens Stiftung), which combines STEM and the Sustainable Development Goals by UN as a "global prerequisite for individual development and participation in a technology-driven world" (United Nations, 2019).

Based on Europe, the Horizon 2020 work programme supported a complete strand on Science Education from 2014 to 2020 (European Commission, 2014), which is expected to be extended in the coming period (Horizon Europe, 2021-2027) (European Commission, 2014; Giones, 2019). To this extent, European SchoolNet (funded by Texas Instruments and the European Commission's Horizon 2020 work programme), develops the Scientix initiative, the Community for Science Education in Europe, in which the state that "unmet labour-market needs in STEM-related sectors that are expected to grow in the future" (European Schoolnet, 2018: 3); the STEM Alliance (also supported by the European Commission), to strengthen links between STEM education and careers in schools across Europe (European Schoolnet, 2016); and Inspiring Science Education (ISE, 2018), a European-funded project under the Competitiveness and Innovation Framework Programme that developed over 140.000 resources on STEM for schools.

Furthermore, national bodies and institutions in United Kingdom, Singapore, Finland, Europe, USA, South-Africa, Australia and across the world, support the *openness movement* into Open Science & Open Education, to achieve STE(A)M competences as a means to boost progress and equity (Colucci-Gray et al., 2019; He & Li, 2019; Kuehn & Porter, 2019; MacDonald et al., 2019; Peña & Rodríguez, 2019). For instance, in United Kingdom, the Institute for Innovation and Public Purpose at the University College London (IIPP-UCL) supports a systematic support in the development of science, technology and the arts, and it states that "Innovation is not only about Science Technology Engineering and Maths (STEM) but also the Arts: STEAM. We recommend that the social sciences, humanities and creative arts are not only supported but central to ensuring that missions are framed as creatively and inspirationally as possible, helping citizens unleash their imagination of the future" (IIPP, 2019: pp 17, 27). This view is also supported by The Royal Academy of Engineering (supported by Lloyd's Register Foundation), which identified 600 organisations in UK that encourage engineering education and STEM, being "critically important to the UK's economic success" (Morgan & Kirby, 2016: 10).

In addition, many of the presented cases, there is a required cross-support between academia and business market, with many large enterprises that work along with the public funding bodies: Pharmaceuticals (Bayer), Agriculture (Syngenta), Telecomm (Telefónica), IT (IBM), private foundations (Melinda & Bill Gates, George Soros), and others, support public policies on the topic, and publish a large part of their experiments, research data and research results openly and for free (Bahlai, 2019; Gold et al., 2019; Kock, 2019).

The greatest difficulty, I believe, is finding the right integration (a) between traditional knowledge flow (e.g. content and memory based) and new ways of learning (Corbi & **Burgos**, 2020), and (b) between the traditional sequential production chain and new ways of progress. These two approaches to learning and progress (a and b) support a new paradigm for achieving STE(A)M competences that comprises three strands: (1) integrating informal ways of learning, teaching and using daily services with formal courses and academic degrees (**Burgos** et al., 2016); (2) combining resources intelligently from inside to outside the university; and (3) updating accredited content and data with enriched open information from outside to outside (**Burgos**, 2020c). This paradigm is a disruptive approach to innovation in education and science.

However, *open* also means *controversy*. Nobody denies the benefits of the nine pillars of Open Science: **access, content, data, research results, licensing, accreditation, policy, inter-operability** and **technology** (**Burgos**, 2020d; Weller, 2020). However, controversy arises from the lack of a clear, unified definition for *open* in the educational context. For instance, **Burgos** (2017) compiles 12 definitions of *open* from experts and institutions in the *openness movement*—all different and all valid. In addition to *open*, the terms *universal* and *free* also support openness (**Burgos**, 2020d). For some authors, an open approach is valid only if it is simultaneously universal and free. For others, these three features combined will allow for a grading of openness, all valid, depending on the context and stakeholders (Weller, 2020). The educational and scientific community must be sure that data, content, access, technology and the other pillars provide users with the best services and a minimum threshold for quality (Stracke et al., 2019c).

This approach requires every Open Science activity to satisfy a list of requirements and metrics to meet that threshold, based on an agreement amongst stakeholders. The approach must be normalised to become sensible, reachable and useful. Furthermore, the community needs an agreement so users have confidence in a quality framework whenever they follow an Open Science paradigm (Sullivan et al., 2019).

1.2. Research questions

This research states that **Open Science and Open Innovation are key elements to design, implement and validate STE(A)M competences and are key facilitators to achieve competences in a normalised framework**. I argue that these key elements can be modelled as frameworks to cross-connect and normalise the subjects and competences alongside the traditional components of an educational methodology (i.e. objectives, samples, target users). In doing so, I posit that the open approach will boost and drive the development of STE(A)M competences and close the gap between theoretical knowledge and practical solutions.

The research questions (RQ) are as follows:

- RQ-01. How can Open Science contribute to complement official, accredited competences in STE(A)M in an effective way?

- RQ-02. How can Open Innovation support the design, implementation and validation of formal, non-formal and informal learning settings?
- RQ-03. How can an Open Competence Framework become a key contribution to develop a new paradigm in achieving competences in educational settings?

These research questions will illuminate how openness and competences can fill the international gap between training productive professionals and fully integrating them into the labour market (Lukács, 2016; Tomlinson, 2018).

1.3. Rationale for selected publications their link to the research questions and contribution to the field

In the last seven years, I have authored and co-authored many studies on Open Science and Open Innovation and the achievement of STE(A)M competences; the publications submitted for this PhD proposal are listed in *Table 1*.

Further, for the final binding, selected publications followed a set of criteria: 1) Every publication must focus on one of the three strands in the thesis (Open Science, Open Innovation, Open Competence Framework); 2) they are peer-reviewed and follow a strict quality control process by third parties; 3) they provide an open and broad set of co-authors and reviewers, from various cultures and scientific approaches, so that the thesis main bottom-line is widely contrasted and contested; 4) they are authorised by the co-authors to be selected to the purpose of this thesis, including an acknowledgment of the contribution from the researcher; 5) they provide a unique view into the matter, with a significant contribution to the current state and future steps; 6) they lean on one or many pillars of Open Science (as described earlier in this text); 7) they show a practical implementation and-or exploitation approach. Samples were selected based on a) cultural diversity (27 European member states, United Kingdom, Latin America, Emirates, Africa); b) diversity of sample profile, always within Higher Education (massive courses, restricted OER, mentoring); c) topic of the course addressed in the pilot or experiment, always focused on STE(A)M and-or competences; d) interconnection between academia and market environments; and e) a practical approach or solution provided to every problem presented, always focused on openness, in one of the three strands presented in the thesis (Science, Innovation, Competence Framework)

Electronic copies of these publications are included in the annexes. For each paper, I include a full reference, state my involvement, and describe that paper’s contribution to the field. The selected publications are all peer reviewed, and none have been submitted for consideration of other academic awards:

- Ten scientific papers (#01, #03, #04, #05, #07, #08, #09, #10, #14, #15) published in indexed journals through a double-blind, peer-review process, following the standards of Web of Science (WoS-JCR) and Scopus indexes

- One scientific paper in conference proceedings (#02), following a strict double-blind, peer-review process by an international programme committee

- Two book chapters (#06, #11), published by Sense Publishers and Springer, under open calls for chapters and which followed a double-blind, peer-review process

- One open education policy (#12) led by the candidate and produced by the 10-person academic board at Universidad Internacional de La Rioja (UNIR) and peer-reviewed by 25 high-level experts from UNESCO, the European Commission, Commonwealth of Learning, International Council for Open and Distance Education, the Open Education Consortium, Horizon Report and other key stakeholders in Open Education[1] . This open policy is the first one published worldwide in Spanish, and the first one by an online university, adopted unanimously by the board.

- One technical report (#13) reviewed and sanctioned by experts from the Joint Research Centre of the European Commission. This report is the key resource for the European Commission's position on open education across Europe.

The publications are grouped into three thematic clusters that sustain the research: Open Science, Open Innovation, and Open Competence Framework.

[1] Full list at http://research.unir.net/ited/credits/?lang=en

Table 1. Publications to be considered for this PhD thesis

ID	Thematic Cluster (TH)	Year	Role of candidate	% Contri-bution	Publication	Contribution to the field and impact. Focus on the nine pillars of Open Science
01	Open Science	2018	Co-author	80%	**Burgos**, D., & Corbí, A. (2018). Transgenic learning for STEAM subjects and virtual containers for OER. Distance Education, 39:1, 4-18. (Q1, SSCI). DOI: https://doi.org/10.1080/01587919.2018.1429894	Scientific paper published in the dean journal on distance education that shows how STEM subjects & Arts (= STEAM) can be portable to create autonomous units of knowledge, to replicate science experiments. **It is focused on Technology, Data and Research results. It supports STEAM (Science, Technology, Engineering, Arts, Maths)** Peer-reviewed and indexed by Web of Science (JCR)
02	Open Science	2017	Co-author	50%	**Burgos**, D., & Corbí, A. (2017) STEAM subjects enhanced through virtual containers for OER. Proceedings of the Innovation Arabia Conference (p.2). March, 6-8, 2017. Dubai, UAE. ISSN# 2414-6099 (peer-reviewed paper). Retrieved April, the 29th, 2020 from http://www.innovationarabia.ae/wp-content/uploads/2017/05/HBMSU-Smart-Learning-Conference-2017.pdf#page=6	Scientific paper that presents a practical implementation of the virtual containers instrument to replicate experiments in Science, Technology, Engineering, Arts and Maths. **It is focused on Data, Access, Content and Technology. It supports STEAM (Science, Technology, Engineering, Arts, Maths)** Peer-reviewed by international Programme Committee
03	Open Science	2017	Co-author	50%	Corbí, A, & **Burgos**, D. (2017). OERaaS: Open Distribution of Virtual Containers as a Key Framework for Open Educational Resources and STEAM Subjects. The Electronic Journal of e-Learning, 15(2), 126-136, available online at https://eric.ed.gov/?id=EJ1142209.	Scientific paper that shows the use of a technical tool (virtual containers) to pack STEAM experiments, content and data into a meaningful unit of learning. **It is focused on Data, Access, Content and Technology. It supports STEAM (Science, Technology, Engineering, Arts, Maths)** Peer-reviewed and indexed by Web of Science (JCR) (ESCI) and Scopus
04	Open Science	2015	Co-author	50%	Corbí, A, & **Burgos**, D. (2015). Semi-automated correction tools for mathematics-based exercises in MOOC environments. IJIMAI, 3(3), 89-95. DOI: https://doi.org/10.9781/ijimai.2015.3312	Scientific paper that presents a tool to support grading of Maths' activities, taking users' massive enrolment, thanks to semi-automatic processes. **It is focused on Data, Access, Content and Technology. It supports Maths, as in STE(A)M** Peer-reviewed and indexed by Web of Science (JCR)
05	Open Science	2018	Co-author	60%	Nascimbeni, F., **Burgos**, D., Campbell, L. & Tabacco, A. (2018) Institutional mapping of open educational practices beyond use of Open Educational Resources. Distance Education, 39:4, 511-527 (Q1, SSCI) DOI: https://doi.org/10.1080/01587919.2018.1520040	Scientific paper focused on the vision and overall approach to **Open Science through Education**. It shows a framework to measure and assess the level of adoption in university professors into the topic. **It is focused on Policy, Access, Research Results and Data. It supports Education, as in STE(A)M** Peer-reviewed and indexed by Web of Science (JCR)

06	Open Science	2015	Author	100%	**Burgos**, D. (2015) A critical view of IMS Learning Design: recommendations for a revised version. In Maina, M., Brock, C., & Yishay, M. (Eds.) The art & science of learning design (pp. 137-153). SensePublishers, Rotterdam. DOI: https://doi.org/10.1007/978-94-6300-103-8_10	This book chapter is focused on the inter-operability aspect of learning objects (LO), which are the base for **packed Open Educational Resources**. The book chapter makes an analysis of one of the most implemented **eLearning specifications** (IMS Learning Design) and provides a set of recommendations to improve it**. It supports Technology, as in STE(A)M** Peer-reviewed by international Editorial Committee and sanctioned by Springer
07	Open Innovation	2013	Author	100%	**Burgos**, D. (2013). L.I.M.E. A recommendation model for informal and formal learning, engaged. International Journal of Interactive Multimedia and Artificial Intelligence, 2 (2), 79-86: DOI: https://doi.org/10.9781/ijimai.2013.2211	Scientific paper that explores a **theoretical model to integrate Open Science into regular academic programmes**. The paper also presents a software tool that implements the model in practice**. It supports Technology and Engineering, as in STE(A)M** Peer-reviewed and indexed by Web of Science (JCR)
08	Open Innovation	2020	Author	100%	**Burgos**, D. (2020). A Predictive System Informed by Students' Similar Behaviour. Sustainability, 12 (2), 706. DOI: https://doi.org/10.3390/su12020706	Scientific paper about Innovation of basic competences and informal evaluation into official academic programmes. **It works with Education, Content, Technology** Peer-reviewed and indexed by Web of Science (JCR)
09	Open Innovation	2019	Co-author	50%	Nascimbeni, F., & **Burgos**, D. (2019). Unveiling the Relationship between the Use of Open Educational Resources and the Adoption of Open Teaching Practices in Higher Education. Sustainability, 11(20), 5637. DOI: https://doi.org/10.3390/su11205637	Scientific paper about the adoption of open education (resources, practices) in HE. **It works on Education, Content, Policy** Peer-reviewed and indexed by Web of Science (JCR)
10	Open Innovation	2017	Co-author	40%	Nascimbeni, F., **Burgos**, D., Aceto, S., & Kamtsiou, V. (2017). Supporting innovation in technology-enhanced learning: a stakeholder-based open approach. International Journal of Innovation and Learning. Vol. 22, No. 2, pp.233–253. DOI: https://doi.org/10.1504/IJIL.2017.085922	Scientific paper focused on open innovation for companies and stakeholders working on the educational sector. It shows a process and the innovation cycle to boost that very process based on empirical data. **It is focused on Data and Research results. It supports Technology, as in STE(A)M** Peer-reviewed and indexed by Web of Science (JCR)
11	Open Innovation	2019	Author	100%	**Burgos** D. (2019) The Innovation Cycle for Sustainable ICT Education. In: Tatnall A., Mavengere N. (eds) Sustainable ICT, Education and Learning. SUZA 2019. IFIP Advances in Information and Communication Technology, vol 564. Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-28764-1_24	Scientific book chapter focused on the use of innovation to support a sustainable education on ICT. **It works with Technology and Access** Peer-reviewed and indexed by Scopus

12	Open Competence Framework	2017	Editor and main author	90% (author)	**Burgos**, D. (Ed.)(2017) Open Education Policy. UNIR: Logroño, La Rioja (Spain). Open Access from http://bit.ly/unir-openpolicy (English) and http://bit.ly/unir-educacionabierta (español)	This Open Education Policy works on the nine pillars of Open Science and it is the first one Worldwide designed and published by a private university. It means a breakthrough in actual implementation of open policies, and mostly cited by experts across the World. **It is focused on Policy and Licensing** Peer-reviewed by 25 external high-level experts, worldwide
13	Open Competence Framework	2017	Co-author and co-main researcher	40%	Bacsich, P., Nascimbeni, F., Atenas, J., Aceto, S. & **Burgos**, D. (2017) Member States case studies: Policies for Opening Up Education in Europe. Seville, Spain: Joint Research Centre. European Commission	Technical report published by the European Commission that shows the current state of the National policies across the 28 countries of the European Union. It means a breakthrough in analysis of open policies, and mostly cited by experts across the World. **It is focused on Policy, Data, Research results and Licensing, along with Competence Frameworks** Peer-reviewed and sanctioned by international experts at the Joint Research Centre at the European Commission
14	Open Competence Framework	2016	Co-author	75%	Nascimbeni, F., & **Burgos**, D. (2016). In Search for the Open Educator: Proposal of a Definition and a Framework to Increase Openness Adoption Among University Educators. The International Review of Research in Open and Distributed Learning, 17(6). (Q1, SSCI). DOI: http://dx.doi.org/10.19173/irrodl.v17i6.2736	Scientific paper focused on the vision and overall approach to Open Science through Education. It shows a framework to measure and assess the level of adoption in university professors into the topic. **It is focused on Policy, Access, Research Results and Data. It supports Education, as in STE(A)M** Peer-reviewed and indexed by Web of Science (JCR)
15	Open Competence Framework	2019	Co-author	40%	Nascimbeni, F., Alonso, J., Sanz, O., & **Burgos**, D. (2019). Read, Watch, Do: Developing Digital Competence for University Educators. In International Workshop on Higher Education Learning Methodologies and Technologies Online (pp. 80-93). Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-31284-8_7	Scientific paper that presents a case study on how to work with digital competences with HE lecturers. **It works on Access, Data, Education, Competence Framework** Peer-reviewed and indexed by Scopus

1.4. Original contribution to knowledge

This thesis addresses two research gaps within STE(A)M competences: (1) the lack of a normalised STE(A)M framework for assessing achievement of competences; and (2) the lack of an effective way to integrate creativity (from the arts) into the technical components (from science, technology, engineering and maths).

The selected publications are all linked to the thesis and lean on an interdisciplinary approach: A paradigm shift is supported by Open Science and Open Innovation, which are key elements to design, implement and validate STE(A)M competences based on an Open Competence Framework. This paradigm shift takes the nine pillars of Open Science (**access, content, data, research results, licensing, accreditation, certification, policy** and **technology**) as the basis for categorizing the publications, as they are related to at least one STE(A)M subject. I chose the selected publications based on their relevance to the thesis and the following criteria:

- They address challenges about **access** to resources and **technology** in developing countries, in rural areas in every country, and in leading countries with access to abundant information and technology, but with little time to assimilate these into established frameworks.
- They address the benefits of using **open content, open data** and **open research results**, where anyone can learn from the experience of others and build on previous deliveries for free.
- They highlight the role of **innovation** in the use, re-use, creation and sharing of content, resources and other elements of Open Science, allowing end users and stakeholders in the education chain to contribute to and benefit from a collaborative, iterative environment.
- They design and contribute to **open policies** and **an accreditation framework** that supports the achievement of competences through openness and that integrates competences into official educational and professional environments.
- They balance open and proprietary resources through a sensible **licensing agreement**.

The selected publications all clearly support the design and application of the proposed paradigm shift based on Open Science, Open Innovation and Open Competence Framework for effectively achieving and assessing STE(A)M competences.

1.5. About me and my motivation for this thesis

I have worked in Open Education, Open Science, Open Innovation and competences for the last 15 years. I started as an assistant professor at the Open University of the

Netherlands, with a special focus on eLearning standards facilitating the open and free sharing of units of learning, educational resources (e.g. learning objects), innovation practices, academic information in learning management systems, and online competence assessment. I then joined Atos Origin, where I developed numerous research, development and innovation projects (R&D&i) under the open paradigm to support teachers, train surgeons and grade online students; to assess the competence achievement of company employees; and to foster open practices and innovation in research networks of excellence across Europe. In this company, I led an academic chair on technological innovation.

I later moved to Universidad Internacional de La Rioja (UNIR), a 100% online open university with locations in seven countries and over 40,000 students worldwide. As an academic and management board member (technology, eLearning, research and innovation, knowledge transfer), I designed and implemented the first Open Educational Policy for an online university and for any university in Spanish, worldwide. This policy provides open and free access to 25% of the university's educational resources and datasets and is committed to reaching 40% by 2022. I also developed many competence frameworks for competence achievement based on STE(A)M, validated by the National Accreditation Agency(ANECA). Through the Research Institute for Innovation & Technology in Education (UNIR iTED), I also lead research, development and innovation projects (R&D&i) focused on a) competence frameworks; b) MOOCs and Open Educational Practices; c) use of STE(A)M as a resource to model online teaching competences, innovation frameworks; and d) policy design to improve online learning and teaching.

In addition, I work with UNESCO, the International Council for Open and Distance Education (ICDE) (leading two chairs on eLearning and Open Education), and with the Commonwealth of Learning, the United Nations European Committee for Education in Sustainable Development (UNECE), the European Commission and the European Parliament, as an advisor on these topics.

This background has allowed me to work in multiple areas of the educational system: in design, development, implementation, assessment and dissemination; on layers of the educational community, from teaching at school, to research at university, to drafting international policies; and in diverse countries and cultures on five continents, with a special focus on Europe, China, Arab countries and Latin America. This multi-faceted approach allows me to deeply understand and aim to balance the community's needs with governmental requirements and to directly link education with society.

I have also performed a number of R&D&i projects, experiments and pilots focused on Open Science, Open Innovation and Competence Frameworks. In addition to authoring selected papers and publications (*see Table 1*), I was a designer, lead researcher and-or scientific coordinator for European-funded projects focused on the research fields (*see Table 2*).

Table 2. Research and innovation projects, experiments and pilots on openness

Years	Role of candidate	Full description, contribution to the field and impact
2019-2022	Main researcher at Universidad Internacional de la Rioja. Design of competence framework for soft skills, & instructional design	Compete! (COMPetences for Effective labour markeT Entry!). Erasmus+ KA203: Strategic Partnerships for higher education. Project number: pending. Project reference: 2019-1-IT02-KA203-062350
2019-2021	Main researcher & Project Coordinator. Lead on instructional design of educational game and gamification, and scientific publication	OpenGame (Promoting Open Education Through Gamification). Erasmus+ KA203: Strategic Partnerships for higher education. Project reference: 2019-1-ES01-KA203-065815. https://opengame-project.eu/
2017-2020	Main researcher at Universidad Internacional de la Rioja. Design and assessment of educational platform and educational content	Edu-Hack (Hacking Education through eLearning and Open Education). Erasmus+. KA2 - Cooperation for Innovation and the Exchange of Good Practices. Strategic Partnerships for higher education. Project number: 2017-1-IT02-KA203-036854. https://eduhack.eu/
2016-2017	Main researcher & Project Coordinator. Lead on Quality Assurance and Evaluation	IPTS-JRC-Open Policies. A Member States Case Studies on Policies for Opening up Education. Contract number: 930419-2016 A08-ES. http://research.unir.net/blog/openedu-study/
2015-2018	Main researcher at Universidad Internacional de la Rioja. Lead on WPs on LMS portal development, content course design. Contribution to sustainability	OpenMed (A bottom-up approach for opening up education in South-Mediterranean countries). Erasmus+. Contract: 2015-3166/001-001. http://openmedproject.eu/home/
2014-2017	Main researcher & Project Coordinator. Educational model and ICT design	AppMOOC (Support to semi-automatic grading in MOOCs). Regional Development Agency of La Rioja (ADER). Project number: 2014-I-IDD-00030. http://research.unir.net/blog/project-appmooc/
2013-2015	Main researcher at Universidad Internacional de la Rioja. Lead of WP on Clearing House for university ECTS based on Open Educational Resources	eMundus. Fostering international Higher Education collaboration though ICT and open education (LLP-Erasmus Mundus, Grant Agreement: 2013-2508/001-001. Project number: 545766). http://research.unir.net/blog/emundus-2/
2012-2015	Main researcher, Universidad Internacional de la Rioja. Responsible for the Spanish pilot (500 K-12 schools)	Inspiring Science Education (http://www.inspiringscience.eu), Large Scale Experimentation Scenarios to Mainstream eLearning in Science, Mathematics and Technology in Primary and Secondary Schools (ICT PSP sixth call for proposals 2012, Grant Agreement: 325123)

As author of over 150 indexed scientific papers and 14 books, as editor of 20 books and special issues in scientific journals, and as author of over 1,000 dissemination pieces, I explore the relation between students, teachers, university lecturers, academic managers, content providers, researchers, policy makers and other stakeholders. Through my extensive research, I have found a need to normalise and streamline competence achievement and to foster open practices in science, education and innovation. I believe that STE(A)M subjects and technologies are key for significant progress. This thesis comes from the understanding that a paradigm shift to Open Science and Open Innovation will help students improve STE(A)M competences and successfully deploy them in the labour market.

Section 2. Literature review of Open Science, Open Innovation and Open Competence Frameworks

In this section, I review the literature on the thematic clusters of Open Science, Open Innovation and Open Competence Frameworks, and cross-reference these clusters with the research questions. I then connect my research to the literature according to the three thematic clusters and highlight the original contributions of the outputs to the *openness* movement.

2.1. Open Science

Open Science represents a new approach to the scientific process based on cooperative work and new ways of diffusing knowledge by using digital technologies and new collaborative tools (European Commission, 2016). Further, there is an evolution in the *openness* movement. Until 2015-2016, content and Open Educational Resources where the key element (and usually the only one) in the *openness* movement, as I defend in Stracke et al. (2019a). However, many other pillars were added along the way, as presented before in this thesis: access, technology, data, etc. (Foster, 2017). This combination of pillars was modelled into what is now called Open Science, which mainly works with STE(A)M subjects (Kelley & Knowles, 2016). In **Burgos,** (2020c) I also argue this idea by a set of contributions focused on the implementation of Open Science, starting with the integration of all the basic pillars in the process. Further, the main question to address is how Open Science can contribute to complement official, accredited competences in STE(A)M in an effective way (Zakharov et al., 2017).

STE(A)M subjects in European academic programmes are structured in academic credits and competences, which are the building blocks of accredited programmes. Other countries in Africa (i.e. Morocco, Tunisia, South-Africa, etc.) follow the same pattern, like I claim in Idrissi et al. (2020). In other regions, like Latin America, USA, Australia or Canada, the basic unit is the academic hour and the learning outcome (Jie & Harms, 2017). In China and India, there is a co-habitation of academic credits and Grade Point Average (GPA) (Jain, & Bakshi, 2014; Wang, 2017). Lately, a combination of these units is understood, translated or even applied, in spite of the own regulated unit; it is becoming usual to find the regional accreditation scheme along with a translation into other foreign schemes. For instance, I introduce in Nascimbeni et al. (2020) a usual academic setting that depicts an academic course in European Credit Transfer System (ECTS) consistently used across Europe and the Bologna agreement, but that is introduced with the equivalent learning hours, so that Latin American students can find a match to their educational systems (Ryan, 2018). With the definition of competences happens very much the same. this research takes a competence as the building block of the whole accreditation scheme, since it is widely used in Europe and commonly accepted and translated, worldwide (Costa & Santos, 2017). In the context of this thesis and Higher Education, accreditation is defined as "a particular form of quality assurance, with, as the distinctive characteristic, that it leads to the formal approval of an institution or programme that has been found by a legitimate body to meet predetermined and agreed upon standards, eventually resulting in an accredited status granted to that provider or programme by responsible authorities" (Van Damme, 2004). Also, accreditation scheme is defined as "all institutionalised and systematically implemented evaluation schemes of higher education institutions, degree types and programmes that end in a formal summary judgement that leads to formal approval processes regarding the respective institution, degree type and/or programme" (Schwarz & Westerheijden, 2004).

Further, in this context, a competence is defined as "the ability to meet individual or social demands successfully, or to carry out an activity or task" (OECD, 2002: pp. 8-9). Further, I believe that a competence is achieved based on individual work, group work, nurtured knowledge, personalised mentoring, exploring, practice and many other ways (**Burgos** et al., 2006; Jeffrey, 2018; Schneider, 2019). The systems to measure the progress and achievement of a competence are diverse, but they always imply a series of metrics, with a possible combination of quantitative and qualitative control milestones, like I maintain in Nascimbeni et al. (2018). Further, these means and this tracking can take place in the academic, official environment, in a class, lecture, lab test, field work or through a number of assorted resources and channels. However, that tracking can also happen off-classroom. Learning happens anytime, anywhere, any-how (Green & Donovan, 2018; Matterson, 2014). I defend in **Burgos** (2015) that the instructional design has taken since 2003 key elements of inside and outside the classroom, to create the most personalised learning setting for the best learner performance (Dalziel et al., 2016). In that paper, I introduce the key role of an instructional designer through the definition of basic features of learning design, which include use, sharing and inter-operability of learning objects. For the last ten years a myriad of communication channels, repositories, clustered groups by interest or age, software applications, devices and a large etcetera of stakeholders have populated and diversified the way that people interact, work and learn. There are informal and non-formal ways to contribute to the achievement of those competences, in a complementary way to the official channels. This combination of roads to achievement is the common ground to excel personal and group performances (Czerkawski, 2016; Greenhow & Lewin, 2016).

Open Science makes use of that rich environment, it models the popular eagerness for openness, and it creates an extended learning and teaching setting to pursuit the academic objectives and achieve the related competences. In Stracke et al. (2019a) I support the view that Open Science is based on access, technology, content and other already cited pillars. Further, I also present in **Burgos** (2020d) the OUF coding to name Open, Universal and Free resources, so they can be properly labelled and used in the context of Open Science and Open Education. They all might work together in spite of a) the official accreditation of the programmes, b) the basic building block (e.g. ECTS or hour) and c) the way to interpret the competence transfer from the academic world to the labour market (Eremeeva, 2017; Eremmeva & Baranova, 2016). Further, Open Science can be built on many subjects such as Literature, Music and Sociology. However, I argue in **Burgos** and Corbi (2018) that, it is with Science subjects where Open Science shines brighter: Science, Technology, Engineering and Maths (STEM), sometimes with Arts included –STE(A)M- are the most common topics while using Open Science projects and channels. Mainly, they are used to teach STE(A)M content with STE(A)M resources, which makes any lesson a demonstrative example of knowledge application (Kersey, 2018). It makes STE(A)M easier to teach and to learn, as I assert in **Burgos** and Corbi (2017). Further, I support that STE(A)M resources are also used to teach and learn Arts (STEAM) and other disciplines, for instance Music composition, Theatre scenography and Graphical Design, providing creativity and open thinking to the process, like I argue in Corbi and **Burgos** (2015).

This first cluster of selected papers supports my vision to use STE(A)M tools to teach and learn STE(A)M subjects, in a combined educational setting, where official accredited programmes integrate open resources, access, content, technology and many other elements of the openness paradigm, to make a better, richer and faster environment to achieve the related competences, as I defend in Corbi and **Burgos** (2017).

2.2. Open Innovation

Students spend most of their time off the classroom (Putkin et al, 2016; Sarkam et al., 2019). With the explosion of social networks and smart phones, the online services cope with the types of relations amongst users. This immediate, universal and diverse way of communication also allows for other types or resources and access, rather than the text books (Curran, 2019). In **Burgos** (2020e) I attest how to use online technology to facilitate innovation and knowledge transfer. Further, in **Burgos** (2013) I support the view that the innovative integration of the out-of-classroom environment with the formal, official setting is a reality. Social networks, in the form of communities, immediate communication channels, *fora*, conference systems, recreational games universes, wikis and a long list of services and resources, create a vast umbrella for interaction, as I defend in Hummel et al. (2005), where I put forward the arguments that how *reward*, *altruism* and *privileged information* are the main drivers to incentive an active contribution in a community. It also happens to Learning Management Systems, repositories, archives for lesson plans and other pure educational means (Almarashdeh, 2016; Park & Jo, 2017). Further, it happens as well to open-licensed services and products like, i.e. MOOCs, video repositories or streaming channels (Kravčík, 2016), as I argue in Stracke et al. (2019a). In this paper, I challenge the idea of MOOCs, between the traditional approach of sharing just content, and the innovative approach of nurturing the community through sharing, and the personalised experience, through tailor-made experiences. The library and the connected knowledge source to a specific topic, subject or course in an official, accredited academic programme has no limits. In this context, the combination of formal, non-formal and informal learning is happening and there is a need to find an effective way to exploit that contract, for the end-users' sake (Peters & Romero, 2019). Further, in (**Burgos,** 2013) I introduce the model called L.I.M.E. (standing for Learning, Interaction, Mentoring, Evaluation) to integrate formal and informal learning through a personalised learning experience. Further, there is a need to transition from a university-only, closed approach to a university-also approach, which brings an innovative combination of formal and informal ways of learning, teaching and using support services (Ang et al., 2018). The main research question to answer is how Open Innovation can support the design, implementation and validation of formal, non-formal and informal learning settings. In **Burgos** (2019) I address that very question presenting an innovation cycle that engages formal and informal learning in university settings, with an agile production of early implemented outcomes, meaning the re-use and adaptation of outcomes re-introduced in the same process where they were taken from.

In doing so, there is also a shift from an academy-based main resource to an integrated stakeholder-based approach, which is multi-purpose (addressed to various user types), multi-channel (addressed through multiples ways of communication) and multi-source (retrieved from many information sources, simultaneously). Innovative education happens all the way along the educational chain, inclusive support services: Content providers, access services, ICT services, publishing houses, licensing agreements, academic managers, instructional designers and, of course, students and educators. Every stakeholder is capable to produce, apply, re-use and share innovation, in their context (Goodman et al., 2017) like in Nascimbeni et al. (2017), where I support the view that an implemented model to boost innovation outside learning environments. This is a first key for a successful implementation of innovation in an educational context that provides competences with a significant impact into the market (Small, 2018): The multi-connectivity of characters, roles, resources and services. Every progress on innovation must be owned by multiple issues and individuals, making unviable an isolated action. Innovation requires synergy and connectivity, group effort and implementation (Tantalo & Priem, 2016).

A second key is that innovation is made of layers or loops, where every cycle goes deeper, becoming a continuous and never-ending process. This cyclical approach allows for step-

by-step improvements or adjustments that make an implemented solution fit better (Mills, 2018; Strothman & Sonnemann, 2017). When making a number of rounds into the same problem, learning from the previous lap and running a new one with the lesson learned and applied, there is an improvement of the performance ratio, the matching degree or any other metric or key indicator in the model (Franceschini, 2019). It also allows for making projections and predictions thanks to the analysis of background data and data evolution. Innovation also means forecasting, in this case, and trying to apply the most refined data to the current framework of model to make a better future version (Fred-Ojala et al., 2018; Mwalumbwe & Mtebe, 2017). In this line, in **Burgos** (2020) I claim an innovative system to predict the user's behaviour based on historical records from students in other cohorts. This approach provides the lecturer with a powerful tool for anticipation.
I believe that Open Science makes innovation easier, since it can retrieve, compare and share source data, research-processed data and results data in a more informed way, as I assert in **Burgos** (2020): There might be more information available and use-able, from more diverse sources, with the possibility to discuss with more colleagues (even unknown ones) and analyse together; with the potential of building shared datasets that can be used for training, refining, debugging, dissemination, distribution and many other actions (Brunswicker et al., 2018; Eckartz et al., 2016). These open research practices support and relate to one another and reflect on open learning and teaching practices. Open Educational Practices are outstanding case studies that reflect on practical experience and provide insights about rights and wrongs, and recommendations into the future, all of them based on the use of Open Education (Czerniewicz et al., 2017). Further, in Nascimbeni and **Burgos** (2019) I argue that open educational resources should support open educational practices so as to innovate and create policy, not just content.

2.3. Open Competence Framework

Competences are defined in many ways. As per Ossandón and Castillo (2006), competence comes from moving from knowledge to action. Competence is the performance of activities within a given context. Per Tardif (2006), a competence is an efficient combination of internal resources and complex knowledge. Alles (2010) defines a competence like the combination of skills, knowledge and general motivations that are defined to meet some requirements in diverse contexts, so that they all keep the same meaning across those contexts. Further, competences are categorised into basic, generic, strategic and specific, usually (Sanghu, 2016; Van Der Aa et al., 2020). Basic competences are those necessary to live and to get by in society and are usually linked to issues relating to living with others, communication, and information processing. Generic competences are those common to several professions, such as resource management, teamwork, information management, critical thinking, creative thinking, problem solving, or planning. Specific competences are those of a certain profession, such as those related to programming skills or resolution of mathematical problems. They provide compulsory, unavoidable skills needed in order to get a qualification (Baczyńska et al., 2016).

In academia and learning environments, generic and specific get more attention and allows for a more personalised way to develop the student or professional expertise (Park & Luo, 2017). Recently, for the last three or four years, all these competences are seriously designed, developed and assessed as a framework, instead of as isolated links to a concrete subject. In Lopez et al. (2020) I support the combination of inputs to build a strong competence framework. These definitions are combined with some features to produce an Open Competence Framework based on STE(A)M subjects. There is a concern about how to migrate from subject-bounded competences to an integrated, open framework. In Europe, the Bologna process gathers 28 countries and tries to normalise a number of indicators and requirements for performance and success (Vögtle, 2019; Zahavi & Friedman, 2019;). One of the key elements of the process is the use of competences to build academic programme. In an academic programme under Bologna the main elements are: competences, learning results, credits and subjects. Structured in European credits (ECTS) an academic degree is given when the student is proved to have achieved the related competences for a specific area of knowledge (Davies, 2017; Souto-Iglesias & Baeza_Romero, 2018). Further, the competences are the actual building blocks of the academic degree, since they become the outcome of performing a learning process. They are interactions between activities and contexts, including "knowhow", "knowledge", and "knowing how to behave "and "knowing who you are".

A competence framework bridges academic environments and labour markets, in many ways: The basic competences are cross-topic; the generic competences are useful to perform better as a worker and to integrate better in any professional community; the strategic competences are linked to a broader vision into a certain field; and the specific competences provide the student with clustered knowledge in a certain area of that very field (Carretero et al., 2017). An academic programme must be necessarily linked to the market, so that the student does not achieve competences for nothing, but with a further purpose. These frameworks are the backbone that connects learning results with required skills and knowledge in the market. Without the competences, both sides of the same coin are unconnected, which might lead to unemployed graduates or to qualified workers without an academic degree (Norlander et al., 2020).

Further, these frameworks help normalising the requirements, the achievements and the expectations, from every party. A specific competence in a certain field (e.g. STEAM) should be standardised for the same field, in a concrete market (e.g. a country) (Shahali et al., 2016). In Nascimbeni and **Burgos** (2019) I take open education in higher education as a specific context to develop and assess competences. Every professional field, scientific area, regional government or transnational institution can create a framework. However, only the proper understanding about the thresholds, assessments, metrics and other indicators amongst the various stakeholders involved will facilitate a successful implementation of a framework (Espino et al., 2019). Further, I run a full analysis of policies and stakeholders across Europe to build a competence framework on openness, introduced by Bacsich et al. (2017). In doing so, all the graduates that achieve those competences are guaranteed to have the requirements to apply that competence in the market, no matter the institution, region, language or any other demographic factor that might cluster them. This means that a framework is valid as long as it is properly integrated into the contexts where it should play (e.g. university and labour market) (Redecker, 2017).

In addition, in the academic side, these frameworks must be integrated with the pedagogical model and the educational policy. These three instruments allow an institution for a structured and thorough approach to every educational level, role and activity in the educational system (Kelley & Knowles, 2016). For instance, in **Burgos** (2017) I argue a common effort through every stakeholder in a Higher Education institution to build a policy, validated by 25 external experts, that interweaves every layer, work group and competence. In doing so, everyone is committed and accountable, and every competence becomes a part of the full structure. Further, a competence is a building block, as mentioned before, however is not an isolated one. In Stracke et al. (2019b) I contend that every block requires others (e.g. competences) and other elements (i.e. metrics, educational resources, assessment protocols, quality controls, etc.) in order to create, support and improve the educational system in which they live in.

An open competence framework facilitates the communication and *de facto* normalisation of different frameworks on the same field (e.g. STEAM) (Voß et al., 2018; Rochman et al., 2019). Thanks to the open and free sharing, discussion, contribution, re-use and distribution of organised systems of competences a community can make them inter-operable, with more resources and channels to assess, refine and match the competences with the actual market needs, as I attest in Nascimbeni and **Burgos** (2016).

The key research questions are how an Open Competence Framework can become a key contribution to develop new paradigm in achieving STE(A)M competences in educational settings; and, as a combination of the last three sections, another key research question is addressed: Whether Open Science and Open Innovation are a key facilitator to achieve STE(A)M competences out of a normalised, structured framework.

Section 3. Critical review of research methodology, methods and paradigms

In this section, the research methodology applied across the selected papers is analysed to determine whether it was appropriate for the three research questions. This section also introduces and cross-relates the research methods to show that the research was ordered, rigorous, ethical and cohesive, and that it met the requirements for peer-reviewed publication.

3.1. Research paradigm and methodologies

A paradigm is a theoretical framework that influences how research is performed (Bogdan & Biklen, 1998; Mertens, 2005). Notwithstanding the range of paradigms within social science research, there are two main opposing paradigms (Candy, 1989)—**objectivist** and **constructivist**—which are both connected to philosophical points of view. On the one hand, **objectivism** (linked to science and quantitative research) prioritises standardised research instruments and positivist epistemology (based on facts and scientific methods), so that objective findings can be generalised (Creswell, 2003; Grix, 2002). On the other hand, **constructivism** (linked to interpretivist epistemology by the research subject and to qualitative research) prioritises the subject's interpretation of facts, so that every finding is relative to the observer (Mertens, 2005).

In recent years, a third paradigm has emerged to understand complex problems: **pragmatism**, which is linked to a dialectical position and mixed-methods research and is not committed to a single reality or philosophy; instead it prioritises research problems and applies every method required to solve them (Somekh & Lewin, 2005). This paradigm leans on pluralism and integrated methodologies (Goles & Hirschheim, 2000) and is philosophically supported by verification, as stated by Peirce in the late 20th century (Chiasson, 2001; Peirce, 1997).

Because many of the paradigms are applicable and complementary, the papers presented in this thesis reflect a mixed-methods approach, situated within the **pragmatic paradigm**.

Many disciplines prefer hybrid scientific research based on mixed methods (Abeza et al., 2015; Creswell & Clark, 2017; Johnson & Onwuegbuzie, 2004; Leavy, 2017). Pragmatism combines knowledge-processing methods based on the research needs, the resource provision and the researcher's view (Wille, 1999, 2006). Pragmatism is widely used in social science research (Punch, 1998; Tashakkori & Teddlie, 2010) and combines qualitative and quantitative methodologies (Bazeley, 2004). The objectivist paradigm gives a thorough analysis from data series and user-tracking services, but it lacks the personal context to learn the unique reasons behind a decision or behaviour. In contrast, the constructivist paradigm offers a comprehensive picture of the subject's environment, but it lacks the large objective datasets to escalate and find user patterns. Pragmatism, however, uses both approaches, so objective data complements subjective interpretation within context. The collected publications employ multiple complementary methods, such as semi-structured interviews, focus groups or software development, as shown by publication #ID in Section 3.2.

Some critics contest pragmatism for the following reasons: (a) It requires expertise in many skills. The researcher must employ multiple methods and interpret the crossed data coherently. This multi-faceted approach is not meant for everyone and takes longer to master. (b) Pragmatism extends the data collection phase because it uses semi-structured interviews, analysis of numerical data series, and other methods; these methods are complementary but require different settings for data gathering. (c) Methods might be labelled as pragmatism without proper justification; thus, pragmatism might become a catch-all category when no clear paradigm or methodological approach is identified (McMillan & Schumacher, 2006). However, despite these criticisms, it is argued that pragmatism is the best approach for this thesis because it takes multiple sources to provide the best solution to the problem without complying with a strict structure.

3.2. Methodologies and mixed-methods approach in selected publications

The collected publications span 15 years and are presented thematically rather than chronologically. The research followed the pragmatic paradigm and a mixed-methods approach, combining **action research with qualitative, experimental and practical approaches** (Kothari, 2004; Kumar, 2019; Kumar & Phrommathed, 2005; Rodríguez et al., 1999). The **experimental methodology** generated many case studies based on instructional designs in education (publications #03, #06, #07, #08, #11, #14, #15). I describe the best learning scenario to prove the original proposal, run the experiments in a controlled situation and interpret the qualitative and quantitative results to corroborate, refute or shape the premise. The **practical methodology** produced several software prototypes, including integration with eLearning specifications, in the search for interoperability and replication (publications #01, #02, #03, #04, #08). This hands-on approach focused on the experiences of real users, who provided feedback on instructional design, interface design and educational paradigm. In doing so, it applied a hermeneutic, interpretative perspective to research, data and people, so researchers could observe and interpret the users' behaviour and interaction and contribute to an integrated analysis of the findings (Arriazu, 2018; Diekelmann, 2001; Koch, 1999). The **qualitative methodology** yielded focus groups and semi-structured interviews and offered insights on the use of STE(A)M for competence achievement in open contexts (King et al., 2018;

Silverman, 2018) (publications #05, #07, #09, #10, #12, #13, #14). The **action research methodology** was used for cross-publications, which implement authoring, modification, use, re-use, innovation and learning, for institutions and experts.

This combined approach is required because the research leans on diverse yet complementary academic fields, such as psychology, sociology, anthropology, game theory, education, and technology. With it, I have produced a comprehensive analysis based on a hybrid, flexible, adaptive methodology, supported by pragmatism, which is indispensable to fully addressing the research focus with a mixed-methods approach (Khaldi, 2017).

From this methodological approach, a number of research methods were chosen, decided on, utilized, executed and validated, depending on the phase of the research, the pursued goals, the target users and other features. The publications use a mixed-methods approach, including desk/literature review (MT-01), case study (MT-02), software prototype (MT-03), learning design (MT-04), semi-structured interview (MT-05), and focus group (MT-06), as following described:

MT-01. Desk/literature review: This method provides a justified review and a comprehensive understanding of the state-of-the-art of every step of this research, delivered through periodic publications (Dunne, 2011; Thornberg & Dunne, 2019; Torraco, 2005;). Thanks to a thorough desk and literature review, the researcher puts the research in context, and shapes the novelty of the hypothesis, the outcomes, and the conclusions. The literature review will be thorough and include a number of high-class databases like, i.e. Web of Knowledge (renamed as Clarivate-Web of Science), Scopus, IEEE, ACM, Inspec, In-Recs, and others. It continues throughout the research as an iterative process enabling us to put the research in context, and helps shaping the novelty of the hypothesis, findings, and conclusions (Callahan, 2010; Lichtman, 2017; Webster, & Watson, 2002).

MT-02. Case study: For Gerring (2006) case study approaches are useful for both defined and experimental multi-disciplinary studies where methodological models are rare, and are applicable to both qualitative and quantitative research. Case studies can also be effectively scaled to include greater or lesser numbers. In this research, the candidate used a case study as a practical, empirical approach, which was implemented with a select group of real users and which tested a tool in the context of a learning process and/or a technical deployment (Harrison et al., 2017). This method provided a controlled, experimental context to match the research hypothesis with actual users. The candidate used it in combination with game design and learning design methods in order to work with experimental and controlled groups that were tracked; it provided first-hand information about the individual user and the group's behaviour, and the interaction amongst them. The case studies were designed as a key part of the full research process, from the literature review to hands-on user experience. The candidate used them to apply theoretical principles, and learning design, to a contextual story with which the user could identify and interact freely.

MT-03. Software prototype development and implementation: In this research, a number of prototypes were developed based on virtual containers for Open Educational Resources and prediction models in order to test the individual user and group's behaviour, interaction, performance and other features, leading towards effective learning through pattern recognition, awareness and effective implementation of open policies, innovation and competences frameworks (Ali, 2017; Lilley et al., 2004). This method provided a hands-on, practical setting, so that the individual users and the group could play, interact and test the game design and learning design in practice. In the context of this research, the software prototype development complements the theoretical research, providing insights into user behaviour (with or without their explicit awareness) while using a tracking approach.

MT-04. Learning design: Any learning scenario requires a design in order to elicit the best possible outcome (**Burgos**, 2015; Conole et al., 2004). The design will describe users, learning goals, social goals, various types of interaction, the expected outcomes, criteria of success and other features (Koper, 2005). Usually, a learning design approach can overlap with and is similar to a pedagogic lesson or assignment design, in both their components and outcome-based approaches (Merlot, 2015). In this research, instructional and learning design were combined, since both are the key for a successful applied methodology (Parchoma et al., 2019). In addition, in most of the publications, the learning design becomes the actual rationale flowing across the prototype and/or the case study, which become mere tools that support the ultimate goals described in that learning design (Law, 2017). This method described the learning setting in which the user explores, experiments with and achieves certain competences and skills, in addition to group interaction. The instructional design behind the case study becomes the backbone of every practical experience. It was mainly used with case study and software prototype methods, since it connects the hypothesis with the users' and the group's behaviour, giving an ultimate set of goals to the practical approach. The learning design facilitates the learning processes, itinerary, variables and outcomes used throughout the research, from the game design through to the prototype and the case study. Learning design was also used to give an educational background and implementation to the research environment as a whole.

MT-05. Semi-structured interview: A set of pre-defined questions that can be adapted to the conversation flow in real time (Blee & Taylor, 2002; Hammer & Wildavsky, 2018; Taylor, 2005). This type of interview allows for in-depth information retrieval from an expert or user, so that the user him- or herself can provide us with their experience, knowledge, and advice. Thanks to a systematic application of the method the researcher can collect insights and first-hand experience from representatives of every age-cluster. It will complement the Literature Review so that the Case Study can be designed according to actual facts of real users (Drever, 1995; Fylan, 2005; Kallio et al., 2016). This requires ethical clearance formalities to be completed.

MT-06. Focus group: It was elicited an in-depth feedback from experts in the field about the designed model, taking every phase or piece into a thorough run-through, to provide a progress and a fine and improved new version of the model (Farnsworth & Boon, 2010; Graf, 2019; Plummer-D'Amato, 2008). The focus group is an in-depth method for moderated discussions and grounded conclusions. The group of experts is previously prepared with readings and seed questions, so that they can bring their own arguments and share with the others (Halkier, 2010; Woodyatt, 2016).

Further,diverse data analysis procedures were performed to support this approach, both qualitative and quantitative. Because pragmatism is the selected framework and is based on a mixed-methods approach, a sensible combination of analytic techniques was implemented, including descriptive (DA-01), diagnostic (DA-02), language processing (DA-03), factor (DA-04), data modelling (DA-05), discriminant (DA-06), predictive (DA-07), and narrative (DA-08) (De Block & Vis, 2019; Fauzi & Pradipta, 2018; Harding, 2018; Kalpokaite & Radivojevic, 2018; Mertens et al., 2017; Mihas, 2019).

Connections are required between the outputs, methods, questions, data analytics and thematic clusters. In *Table 3*, publications are clustered thematically (TH), and the applied method (MT), research questions (RQ), and data analytics techniques (DA) used by each paper are cited to support the commentary[2] (*see Table 3. Thematic clusters, publications, methods, research questions and techniques on data analysis*):

[2] A one-page summary of this table is provided at the end of this document as Annex I.

Table 3. Thematic clusters, publications, methods, research questions and techniques on data analysis

Theme (TH)	Thematic focus	
TH-01 Open Science	This set of papers concentrates on two major issues. First, they show how open resources are used to provide STE(A)M competences to end users. Second, they show how to use Open Science as a resource to learn STE(A)M subject. In doing so, these papers use Open Science (e.g. containers, correction tools) to facilitate the achievement of competences on Science. So, they use Science to learn Science, from a practical, hand-on perspective. In addition, these papers show the relation between openness, university policy (Open Educational Practices) and inter-operability, which are two keys for a successful implementation of Open Science in Higher Education. They all address research questions RQ-01 and RQ-03	
01	**Burgos**, D., & Corbí, A. (2018). Transgenic learning for STEAM subjects and virtual containers for OER. Distance Education, 39:1, 4-18. (Q1, SSCI). DOI: https://doi.org/10.1080/01587919.2018.1429894	Methods (MT): MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype Data Analysis (DA): DA-01. Descriptive DA-02. Diagnostic
02	**Burgos**, D., & Corbí, A. (2017) STEAM subjects enhanced through virtual containers for OER. Proceedings of the Innovation Arabia Conference (p.2). March, 6-8, 2017. Dubai, UAE. ISSN# 2414-6099 (peer-reviewed paper)	MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype DA-01. Descriptive DA-02. Diagnostic
03	Corbí, A, & **Burgos**, D. (2017). OERaaS: Open Distribution of Virtual Containers as a Key Framework for Open Educational Resources and STEAM Subjects. The Electronic Journal of e-Learning, 15(2), 126-136, available online at https://eric.ed.gov/?id=EJ1142209.	MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype MT-04. Learning design DA-01. Descriptive DA-02. Diagnostic
04	Corbí, A, & **Burgos**, D. (2015). Semi-automated correction tools for mathematics-based exercises in MOOC environments. IJIMAI, 3(3), 89-95. DOI: https://doi.org/10.9781/ijimai.2015.3312	MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype DA-03. Language processing DA-04. Factor analysis DA-05. Data modelling
05	Nascimbeni, F., **Burgos**, D., Campbell, L. & Tabacco, A. (2018) Institutional mapping of open educational practices beyond use of Open Educational Resources. Distance Education, 39:4, 511-527 (Q1, SSCI) DOI: https://doi.org/10.1080/01587919.2018.1520040	MT-01. Desk/literature review MT-02. Case study MT-05. Semi-structured interview DA-01. Descriptive DA-06. Discriminant
06	**Burgos**, D. (2015) A critical view of IMS Learning Design: recommendations for a revised version. In Maina, M., Brock, C., & Yishay, M. (Eds.) The art & science of learning design (pp. 137-153). SensePublishers, Rotterdam. DOI: https://doi.org/10.1007/978-94-6300-103-8_10	MT-01. Desk/literature review MT-04. Learning design DA-05. Data modelling

Theme (TH)	Thematic focus	
TH-02 Open Innovation	This thematic cluster shows how Open Innovation becomes a driver to integrate formal, non-formal and informal learning into combined environment that allows for achieving professional competences. In this context, integration of various learning settings not only facilitates but boosts knowledge and the related competences. In addition, the papers in this cluster presents how Open Science broadens the scope of accredited Higher Education while adopting other off-classroom approaches. They all address research questions RQ-02 and RQ-01	
07	**Burgos**, D. (2013). L.I.M.E. A recommendation model for informal and formal learning, engaged. International Journal of Interactive Multimedia and Artificial Intelligence, 2 (2), 79-86: DOI: https://doi.org/10.9781/ijimai.2013.2211	Methods (MT): MT-01. Desk/literature review MT-04. Learning design MT-06. Focus group Data Analytics (DA): DA-05. Data modelling DA-07. Predictive
08	**Burgos**, D. (2020). A Predictive System Informed by Students' Similar Behaviour. Sustainability, 12 (2), 706. DOI: https://doi.org/10.3390/su12020706	MT-01. Desk/literature review MT-03. Software prototype MT-04. Learning design DA-05. Data modelling DA-07. Predictive
09	Nascimbeni, F., & **Burgos**, D. (2019). Unveiling the Relationship between the Use of Open Educational Resources and the Adoption of Open Teaching Practices in Higher Education. Sustainability, 11(20), 5637. DOI: https://doi.org/10.3390/su11205637	MT-01. Desk/literature review MT-05. Semi-structured interview MT-06. Focus group DA-08. Narrative DA-06. Discriminant
10	Nascimbeni, F., **Burgos**, D., Aceto, S., & Kamtsiou, V. (2017). Supporting innovation in technology-enhanced learning: a stakeholder-based open approach. International Journal of Innovation and Learning. Vol. 22, No. 2, pp.233–253. DOI: https://doi.org/10.1504/IJIL.2017.085922	MT-01. Desk/literature review MT-05. Semi-structured interview MT-06. Focus group DA-08. Narrative DA-06. Discriminant
11	**Burgos** D. (2019) The Innovation Cycle for Sustainable ICT Education. In: Tatnall A., Mavengere N. (eds) Sustainable ICT, Education and Learning. SUZA 2019. IFIP Advances in Information and Communication Technology, vol 564. Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-28764-1_24	MT-01. Desk/literature review DA-01. Descriptive

Theme (TH)	Thematic focus	
TH-03 Open Competence Framework	The papers in this thematic cluster argue for a normalised and structured design of a set of interlaced competences in the form of an open framework, as a means to improve the achievement of those very competences. An Open Competence Framework allows for an organised integration of competences achieved in non-formal and informal settings into accredited academic programmes, so that the actual learning phase is complemented and strengthen. These papers show a thorough analysis throughout a number of educational policies, along with some proposals for open frameworks. They all address research questions RQ-03 and RQ-02	
12	**Burgos**, D. (Ed.)(2017) Open Education Policy. UNIR: Logroño, La Rioja (Spain). Open Access from http://bit.ly/unir-openpolicy (English) and http://bit.ly/unir-educacionabierta (español)	Methods (MT): MT-05. Semi-structured interview MT-06. Focus group Data Analytics (DA): DA-08. Narrative
13	Bacsich, P., Nascimbeni, F., Atenas, J., Aceto, S. & **Burgos**, D. (2017) Member States case studies: Policies for Opening Up Education in Europe. Seville, Spain: Joint Research Centre. European Commission	MT-02. Case study MT-05. Semi-structured interview MT-06. Focus group DA-06. Discriminant DA-08. Narrative
14	Nascimbeni, F., & **Burgos**, D. (2016). In Search for the Open Educator: Proposal of a Definition and a Framework to Increase Openness Adoption Among University Educators. The International Review of Research in Open and Distributed Learning, 17(6). (Q1, SSCI). DOI: http://dx.doi.org/10.19173/irrodl.v17i6.2736	MT-01. Desk/literature review MT-04. Learning design MT-05. Semi-structured interview DA-06. Discriminant DA-08. Narrative
15	Nascimbeni, F., Alonso, J., Sanz, O., & **Burgos**, D. (2019). Read, Watch, Do: Developing Digital Competence for University Educators. In International Workshop on Higher Education Learning Methodologies and Technologies Online (pp. 80-93). Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-31284-8_7	MT-01. Desk/literature review MT-04. Learning design DA-05. Data modelling

3.3. Quality criteria for research

The 15 selected publications followed rigorous quality criteria to design, implement, test and analyse their methods. Several criteria ensure quality desk research: (1) Credibility of the source; (2) authenticity of the source; (3) proper representation of the context, and (4) understanding of the meaning (Mogalakwe, 2006, 2009). Further, the following quality criteria are applied to qualitative research: (1) the subject should be informed of the method prior to implementation (e.g. before the semi-structured interview); (2) research must be clearly related to the specific questions; (3) the method thoroughly documents the process and cases; and (4) the method allows group discussions to be interpreted based on inter-subjectivity and comprehensibility (Flick et al., 2004). Quality criteria for quantitative research also includes (1) validity, or how the researched concept is accurately measured; (2) reliability, or how the measure is consistent throughout a series; (3) homogeneity, or how data avoids a steep standard deviation so readings can be harmonised; and (4) stability, or how the method provides a similar performance in different measures (Heale & Twycross, 2015). The quality criteria for software, prototype and learning design is usually aggregated and include the following indicators: it matches the instrument with the test subject and is understandable, necessary, modifiable, non-redundant, terse, testable, traceable, and within scope (Cancian et al., 2010; Gravemeijer & Cobb, 2006; Koper & Manderveld, 2004; Lewis, 2017; Seto et al., 2017).

Mixed methods must incorporate quality criteria from all sides so that some criteria are unfulfilled, and those taken as a reference must be consistent with the research (Bryman et al., 2008; Liutenko et al., 2019). In *Table 3*, the publications are linked with the methods presented in *sub-section 3.2 Methodologies and mixed-methods approach in selected publications*. All methods applied to the collected publications follow these quality criteria and emphasise their aggregation, since every publication used mixed methods supported by multiple methodologies under the pragmatism paradigm (*see sub-section 3.2*).

3.4. Ethical considerations

Moore (1903) explained ethics as the general inquiry into what is good. Wittgenstein (1965) expanded the inquiry into what is valuable or important in life. Raskin and Debany (2018) stated that people are active meaning-makers who construct ethics on a personal basis, so every person has a different interpretation of ethics. Ryen (2016) argued that ethics in research is applied to (a) codes and consent; (b) confidentiality; and (c) trust; for Gravetter and Forzano (2018), ethics in research is applied to the outputs and the sample.

Regardless of the accepted meaning of ethics, this thesis is committed to the following ethical considerations. To uphold their ethical responsibility, the researchers ensured the accuracy and honesty of every publication in this collection. The collection is also guaranteed by the cohorts of reviewers, editing teams and editorials that have revised, commented on and approved the publications.

For the sample, all data followed strict rules for privacy and data collection, according to national and international regulations at the time of publication. These publications were all written before the enactment of the General Data Protection Regulation, part of the Data Protection Act of 2018, which tightened the rules on the possession of personal data by organisations. Participants in surveys, focus groups and semi-structured interviews were all informed of their right to access, modify and remove their collected data at any time and without further explanation, and provided explicit permission to record their contact information and opinions for ongoing research. The researcher, in turn, observed strict ethical principles motivated only by scholarly research. The collected publications adopted the APA *Ethical Guidelines Concerning Human Participants in Research* (APA, 2010), which protects research participants with such principles as doing no harm and maintaining privacy, confidentiality, anonymity, and informed consent.

When the research required a larger sample and wider data collection between faculty members and PhD researchers (publications #05, #08, #09, #14, #15), user identities were anonymised following a double-blind process that deposits the ID-key with a third party to hide subjects' contact information from researchers.

All results were presented in academic conferences and open classes with free access, and most results were published in open-access journals (publications #01, #02, #03, #04, #05, #07, #08, #09, #11, #12, #13, #14). This extended practice meant the research results were openly shared with the academic community and society at large, allowing a permanent contrast of ethical practices and facts robustness. Finally, all research presented in these publications was approved by the ethics committees of their respective institutions.

Section 4. Overall findings, original contribution and significance of the collected publications

This section presents the original findings and contributions of the selected papers. They are grouped by the main thematic cluster elaborated by the findings, and taking into account that no finding is isolated and be assigned to one strand only. Further, the topics of each paper are extracted and addressed transversally, because one paper might present numerous significant findings, or a finding might be elaborated across many papers. The selected publications that support the findings and original contributions of this thesis are numbered in parentheses as (publication #n). The relation between every thematic cluster and the research questions can be found in *Table 3. Thematic clusters, publications, methods, research questions and techniques on data analysis*.

4.1. Thematic cluster TH-01: Open Science

4.1.1. Simplified settings for teaching and learning STE(A)M subjects

The educational settings used to teach Open Science and STE(A)M subjects need to be simplified (**Burgos** & Corbi, 2017, 2018; Corbi & **Burgos**, 2015, 2017) (publications #01, #02, #03, #04). This finding concentrates on educational settings that allows for leacher and teaching subjects focused on STE(A) subjects. These settings include educational methodology, resources and ICT services, and they are usually complex to understand and use. Indeed, many school teachers and university professors of STE(A)M have not mastered the resources to properly lecture on these subjects beyond the traditional teaching style of knowledge transfer. However, virtual containers enable teaching with pre-set settings and foster innovation based on open content and open technology. They lean on the principles of transgenic learning and disruption to extract key parts of a learning path and to improve and reinsert them without drastically modifying the structure, instead making a major breakthrough on the learning process and performance. Virtual containers, like Docker and Jupyter notebooks, facilitate the design of a unit of learning that present theoretical concepts alongside simulations or practical applications. The teacher and student can dynamically modify this simulation and share involvement: Instead of passively receiving the teachers' knowledge transfer, the student actively drives their own learning and works with the teacher to solve problems and understand the internal mechanics of the environment. Teachers can easily configure this setting so that students learn by doing in a safe yet effective environment. In doing so, the complex setting is transformed into something more straightforward and simplified to use.

4.1.2. STE(A)M tools are powerful resources for teaching STE(A)M subjects

A difficulty of teaching STE(A)M subjects is designing and using effective tools that provide a clear solution to a specific problem or that allow for a concrete explanation to a complex term (**Burgos** & Corbi, 2017, 2018; Corbi & **Burgos**, 2015, 2017) (publications #01, #02, #03, #04). If a student works in physics, telecommunications or data mining labs, they can set up an experiment, run it and get the results physically. This implies a number of lab hours, spent resources, technical supervision, academic support, and numerous other factors that make repeating the experiment difficult. Digital simulations are improved through trial and error, thus saving resources, simplifying logistics, and minimising the impacts of failure. However, simulators are difficult to configure according to the needs of teachers or the syllabus. STE(A)M tools, like virtual containers, close the gap between a good tool and the required pre-configuration. A virtual notebook can adapt to and personalise the student's experience. These containers are software designed as Open Educational resources to create, use, re-use and freely share content and to operate on multiple devices and operating systems and in different technical settings. In short, STE(A)M tools are a solution for learning and teaching STE(A)M subjects.

4.1.3. Virtual containers are key to learning and distributing complex STE(A)M topics as Open Science

Complex STE(A)M topics like maths are taught using computer simulations, semi-automated grading or technical frameworks installed on computers (Corbi & **Burgos**, 2015) (publication #04). On the server side, these provide the right service or port; on the client side, they show the results data or tracking under a usable and understandable skin; and on the same computer, they prepare the operating system, kernel, language libraries, development frameworks, drivers, software tools, and other elements (**Burgos** & Corbi, 2017, 2018; Corbi & **Burgos**, 2017) (publications #01, #02, #03).

This complex, time-consuming configuration is required to execute correctly and gain results from the practice or experiment. However, Open Educational Resources as a service (OERaaS) combines these technical parameters and variables into a single object (or unit of learning) that is distributed as a single file, installed, and executed directly by students and teachers without further pre-configuration: A single container file holds all the requirements. This virtual container becomes a key framework to design and share Open Science resources (i.e. contents, simulations, practices, examples, case studies, and links) focused on complex STE(A)M subjects in a simple way. Thus, although the container usually requires an instructional designer, topic expert, and programmer, the science teacher or student does not need additional knowledge to use, re-use, and distribute the container.

4.1.4. Using structured Open Educational Practice frameworks to map Open Science

Open Education and Open Science are usually unconnected to the wider world. Invisible colleges and personal networks link specific people and sometimes institutions, but there is no systematic or structured interaction channel (Nascimbeni & **Burgos**, 2019; Nascimbeni et al., 2016, 2018, 2019) (publications #09, #05, #14, #15). Activities happen because of the good will and determination of participating individuals who build and maintain the open ecosystem. Using Open Educational Resources becomes a personal choice, not an institutional directive, and even less a national policy: every teacher or professor decides what to use, when to use it, and why. However, the resources and experiences are not connected and lack open assessment or accountability. These experiences need to be modelled into Open Educational Practices as case studies with real-life inputs, so they can be categorised and shared with the Open Science community. In this context, an Open Educational Practice is "a practice that can be implemented using Open Educational Resources for education" (Huang et al., 2020; Zhang et al., 2020). An articulated, validated open competence framework can assess the awareness, skills, knowledge and abilities of every educator, and it can foster innovation with an indicators dashboard that tracks users' information, activity, behaviour and interaction and provides personalised counselling about competence achievement.

4.2. Thematic strand TH-02: Open Innovation

4.2.1. Learning standards and specifications as effective, inter-operable tools for open re-use and sharing

The lack of a common language hinders instructional design and open approaches. Every content provider, service provider, learning management system, publisher or accreditor provides their unique seal and branding. Moodle, Sakai, Canvas, Claroline, Blackboard, WebCT, EdX, FutureLearn, Edraak, and others use their own user models, educational methodology and ICT infrastructure to provide the best support to students, educators and institutions. However, few outcomes (e.g. courses) are normalised or follow a specific notation system (**Burgos**, 2013) (publication #07). All systems may be good in reality, but they cannot communicate because their basic formats are incompatible. This means that they cannot understand each other or become inter-operable, which is the main objective of every standard (**Burgos** & Griffiths, 2005; Wiley, 2000).

Learning standards and specifications attempt to bridge miscommunication: IMS Learning Design, IMS Content Packaging and SCORM, for instance, provide instructional designers with a normalised structure and key elements (**Burgos**, 2015) (publication #06). Any content creator or accreditation service can use the final learning package (e.g. Unit of Learning) in any learning management or authoring system. This inter-operability is key to supporting Open Science because it facilitates open sharing, re-use and execution of the learning packages, irrespective of their owner (**Burgos** & Corbi, 2017, 2018; Corbi & **Burgos**, 2015, 2017) (publications #01, #02, #03, #04). Without standards and a common language, Open Educational Resources and other elements of Open Science will remain incompatible and will be presented to the educational community without full inter-operability.

4.2.2. Combined formal and informal learning to innovate in education

Academic programmes and formal learning in general follow strict accreditation rules and specific methodologies for patterned lecturing, tracking, assessment and grading (**Burgos**, 2013) (publication #07). In contrast, informal learning has high engagement and facilitates user involvement anytime, anywhere (**Burgos** & Corbi, 2017, 2018) (publications #01, #02). Informal learning and educational resources are gaining popularity, but their adoption into everyday classroom practice is still slow. A possible explanation is communication difficulties among open innovation stakeholders (Nascimbeni et al., 2017) (publication #10). Because usability and perceived usefulness also impede adoption of technological innovations, these topics should be evaluated in learning analytics systems. In this context, a learning scenario is useful if it provides the adequate means to reach learning objectives and achieve the related competences; as well as it is usable if it provides the student and the teacher with a friendly and personalised experience, adapted to everyone (Singla & Aggarwal, 2020; Tractinsky, 2018). In addition, online learning—sometimes formal but mostly informal—stores, categorises and processes big data coming from user behaviour and tracking. This information can help tailor the learning experience to personal expectations and group objectives (**Burgos**, 2020) (publication #08). With current and historic data, the system makes individualised recommendations to improve indicators such as interaction, early production, assistance, and content production. A combined model that works with formal and informal learning allows for integrated techniques to engage learners and teachers in interconnected settings and produce adaptive and personalised open educational practices.

4.2.3. Predicting student performance through learning analytics

Tailoring online instruction to students' needs is difficult because communication is often disrupted in this setting (Nascimbeni et al., 2017; **Burgos**, 2020) (publications #08, #10). Decision support systems help by automatically collecting and presenting students' data to the teacher (Corbi & **Burgos**, 2015) (publication #04).

In education, data analysis can be considered from the perspective of educational data mining and learning analytics. The former focuses on improving techniques and algorithms;

the latter focuses on how these techniques can improve education. In essence, learning analytics analyses data from educational scenarios and derives information that enriches education (Nascimbeni & Burgos, 2016, 2019) (publications #09, #14). Distance learning is particularly relevant to learning analytics: First, in online learning, teachers and students interact only through the virtual learning environment, making it easier than in classrooms or blended settings to capture the participants' activity in the course. Second, online education often suffers from miscommunications, and so informative methods must be established to understand what is happening and how learners are progressing. This interplay between learning analytics and learning design is gaining interest within the educational community, since learning analytics is a powerful tool for informing data-driven design decisions.

4.2.4. Designing an innovation cycle to implement STE(A)M education through open resources and practices

Innovation must be systematic: Isolated bursts of innovation do not make an educational process or setting innovative (**Burgos**, 2019) (publication #11). Innovation must be also continuous so the results of today feed the ideas of tomorrow. This cycle of design-apply-learn facilitates a never-ending adaptation to the needs of users and society. It also encourages early adoption of innovation and can re-route implementations for a better fit. When properly adopted in education, the innovation cycle keeps the content, methodology and educational framework (including competences) up to date and permanently links academic requirements with market expectations. This is especially true when working with innovation-inclined ICT or STE(A)M subjects.

Further, innovation must be interconnected. If every stakeholder in the educational environment and labour market is related, the work of students and teachers can have a real impact (**Burgos**, 2017; Nascimbeni et al., 2017) (publications #10, #12). Incubators and accelerators become foundations for building innovative practices, services and tools, supported by stakeholders in the academic community and labour market. Combining continuous open innovation with contributions from every stakeholder can achieve a comprehensive approach that turns every participant into an innovator and every contribution into an open contribution.

4.3. Thematic strand TH-03: Open Competence Framework

4.3.1. Open education as a competence framework integrated into educational institutions

Open Educational Resources or Practices normally rely on the good will and commitment of teachers, parents, and others. The educational community understands that Open Science and Open Education can be useful and encourage others to use, re-use, create and share in an open environment. However, commitment to openness often fades with the individual’s waning interest and time. Sometimes, teachers will collaborate and create a working group or association to model and implement an open approach, but they too lose interest or cannot maintain commitment.

Effective, long-lasting integration of open innovative into education must be a choral effort, fully engaged in the community and fully supported by stakeholders (Nascimbeni et al., 2016, 2018) (publications #05, #14). The bottom-line is that every actor in the field helps design and approve the framework deployed in the institution, based on the community’s needs (**Burgos**, 2017) (publication #12). In doing so, that community can thoroughly implement their approved recommendations, reflections and regulations, becoming a policy (Colebatch, 2018) When adopted by only a single member, a policy offers only personal, limited rewards and does not make a permanent impact on the community. But policies define frameworks, and institutional policies with unanimous contributions from the community facilitate an effective implementation.

4.3.2. Open policies as international cross-competence frameworks to support and boost open educational practices in Europe

Every policy requires an institution to design and approve its definitions, regulations and recommendations. This framework allows other institutions to assess and implement the policy, which must be drafted by stakeholder consensus (**Burgos**, 2017) (publication #12). Sometimes, one party designs the framework but another party must adopt it, creating poor dialogue, if any. Educational frameworks follow the same pattern. From standards to specifications to competence frameworks, these normalisation tools are lifeless if miscommunication prevents end users from using or testing them.

In addition, frameworks and policies in the same field are usually blind to case studies in neighbouring fields, even within common economic or cultural contexts, like the European Union, where 28 countries can apply 28 different regulations (Bacsich et al., 2017) (publication #13). This cross-referenced study of national policies on open educational practices and frameworks in the EU member states facilitates global understanding of design, deployment or success. Each country can learn from its neighbours and modify lessons learnt to apply them in context. The transversal study of national policies also fosters awareness in other countries and their educational institutions and disseminates the need for a comprehensive roadmap, beyond individual efforts, integrated into every national educational system.

4.3.3. Open Educational Frameworks help the adoption of competences in open innovation and STE(A)M inside educational settings

The education community of educators usually faces a lack of structured approach to achieving STE(A)M competences and digital skills, leaving teachers to self-learn the requirements to develop their job. When teachers must migrate from face-to-face lessons to fully online settings, as it is happening during the COVID-19 pandemic, they feel helpless because many do not have a technological or STE(A)M background (Nascimbeni et al., 2019) (publication #15). These teachers also need to learn in parallel to their regular activities, creating a stressful work and personal environment that harms their physical or mental health.

Within the teaching community, awareness of open education and science is uneven. Teachers' knowledge mostly ends with learning management systems (e.g. Moodle), free email services (e.g. Google), free content (e.g. MOOCs) or tools for a specific need (i.e. a calendar, appointment, or group decision) (Nascimbeni & **Burgos**, 2016, 2019) (publications #09, #14). They do not know about open access, technology, licensing or data. This limitation stops innovation and further adoption of openness in the classroom (**Burgos**, 2019) (publication #11). However, Open Educational Frameworks are a consistent approach to achieve competences in STE(A)M and open innovation. Further, defining and implementing a policy or framework for open innovation and competences facilitates real impacts on teachers, encourages others to join and share, and provides the institution with a powerful resource for strengthening the combined formal and informal educational settings, which brings a more comprehensive approach to real education processes.

Section 5. Conclusions and future research

5.1. Main conclusions out of this research

The collected publications demonstrate how Open Science and Open Innovation improve the design, implementation, achievement and validation of STE(A)M competences within a structured, open framework. This work presents evidence supported by crossed data, mixed methodologies and combined methods to prove the connections amongst three thematic clusters: Open Science, Open Innovation and Open Competence Framework. Together they provide the target individual (a student, school teacher, university lecturer, tutor, mentor, or academic manager) with a new paradigm that strengthens and streamlines the educational setting.

Open Science becomes a powerful partner to create, use, re-use and share educational resources focused on STE(A)M using STE(A)M technology (linked to research question RQ-01). These resources are integrated into official programmes to complement and improve the accredited academic pathway. In doing so, every individual can simultaneously become a producer, consumer and distributor, multiplying the educational capacity of a networked community. Open Science provides units of learning for STE(A)M, but also simulation labs, virtual spaces, augmented reality, serious games, unlimited exercises and tests, trial-and-error activities, support groups, and live lectures with live programming and calculations.

Open Innovation facilitates the testing of new learning spaces and instruments, focusing on integrating formal, non-formal and informal settings (linked to research question RQ-02). Social networks, digital repositories, face-to-face lectures, experiment re-creation, controlled online sites, and other resources from non-formal and informal sources are combined with formal sources. Open Innovation also provides a methodology based on iteration and continuous progress that delivers early prototypes and pilots, which, in turn, feed the next round of improvement. This innovation cycle out of agile approaches optimises the learning curve and teamwork to achieve competences.

An Open Competence Framework structures all the above into a normalised, multi-layer, inter-connected model that fosters the design, implementation, achievement and evaluation of practical competences into the labour market (linked to research question RQ-03). It is only when all stakeholders in the educational process are committed and interwoven that the miracle happens. From the student to the principal, everyone plays an active role in the paradigm and becomes a key contributor to the policy. They all define relations, objectives and the of reaching them. Competences are the building blocks of education, since they describe the ultimate goal for learners, which is to achieve and implement competences into real practice (e.g. the labour market).

To this extent, a few challenges are also presented. First, from the practitioners, namely teachers and professors. They show some resistance to change based on a number of reasons, from developing new ICT skills, to the lack of time or overburden with new tasks to migrate from face-to-face to online and blended settings, through the integration of Open Science, Open Educational Practices (OEP) and Open Educational Resources (OER) into official academic programmes. Teachers and professors are mostly committed and good performers. However, the need for adaptation to openness makes them put all things on a scale, which leads to not easy implementation strategy. Even when they decide to use, re-use, created, and share Open Science, OEP and OER, they need to find time and support to make it happen.

Second, academic managers (such as school principals or rectors) who need to implement structural changes and policies across their institutions, so that they become effective. If they decide to support any of the findings reported in this thesis, a consensus and group work that involve every stakeholder in their educational environment is required. Only with group effort those changes are viable and long-lasting.

Third, the students, since they become the primary force for adaptation. The full integration of formal and informal settings, the implementation of technology-based resources to develop STE(A)M competences and perform better, and the approach to use open solutions and services to complement and enhance those traditionally used, need the pro-active energy from the main end-users, namely the students. Since in this new paradigm they become consumers and producers, combined, that very paradigm requires synergy with them, in order to achieve a full and successful adoption.

Fourth, the policy makers, who need to authorise and implement the Open Competence Framework across official academic programmes, so that they support better the competence achievement and the combination of Arts into STEM subjects. Without an official recognition of the open approach to better achieve competences in these fields, the required structure will not support the paradigm shift and it will leave the institutions and the practitioners alone.

Fifth and last, the market. Companies and public institutions should adopt the competence-based approach in STE(A)M subjects from academic programmes, to seamlessly integrate training and practice. Without that complicity between schools, universities and enterprises, the potentially implementable findings in educational levels would miss the practical exploitation into the market, and fail.

This research shows how the thematic clusters Open Science, Open Innovation, and Open Competence Framework are combined to support STE(A)M competences. They all are required and cross-supported to provide learners with an optimum setting for self and group development.

5.2. Future research based on findings

A possible fourth thematic cluster —accreditation —is the object of the next short-term and medium-term research.. From academic schemes (e.g. programmes) to competences, accreditation is fundamental to the educational system. In academic accreditation, the basic unit is the credit (e.g. in Europe) or the hour (e.g. in Latin America) that leads to an academic degree (e.g. a bachelor's). Europe provides a complete system called European Credit Transfer and Accumulation System (ECTS) under the Bologna process (Karran, 2004). Thus, every passed course is a link that strengthens the learning chain in the related academic scheme (Anugom, 2016). If the unit changes from credit/hour to a competence of achieved/developed, then the building block of academic programmes is what matters most: the achieved competence that grants a student the educational goal. This shift into the basic unit would lead a portability of academic records focused on the actual competences (knowledge, skills and attitudes) and not on the student performance (e.g. passed exams). To this extent, micro-accreditation and micro-credentialing could be supported by cutting-edge technology, such as blockchain, which might be embedded into the academic and professional curriculum of a person, with full guarantees of a universal certificate (Paniagua et al., 2019). Indeed, portability and micro-accreditation seem to be a key challenge in the mid-term educational panorama. At present, and growing, there are a number of facts that lean on the individual mobility: International academic programmes, migration flows, tele-working and displaced premises in companies and universities are a clear tendency (Zaccagni et al., 2019). In this context, the capacity of proving the achieved competences thanks to a guaranteed system based on segmented accreditation that allows the holder move from country to country without being re-accredited or contested for their achievements in a different educational system, becomes a key for a global market and a real multi-national, educational context (Badr et al., 2019; Resei et al., 2019).

Further, accreditation should engage with a competence framework, like the Open Competence Framework, to provide another step to competence provision (Grand et al., 2010), and not just isolated efforts to collect individual competence, outside a comprehensive and structured system. A normalised, mutually accepted accreditation framework means the educational institution could guarantee competence achievement and the labour market could rely on that guarantee (Bowers, 2019). I believe that the presented research combined with the development of an accreditation system engaged with Open Science, Open Innovation and Open Competence Framework is worth exploring because it will improve the educational system.

An additional focus for future research could explore the migration of these findings into other educational levels, such as Vocational Education and Training (VET), or High School, for instance. Although the basic focus of this research concentrates on Higher Education many findings seem easily transferrable to other contexts. Out of the two identified main gaps -competences in STE(A)M subjects are not properly achieved and transferred to the market; creativity is not properly integrated into STE(A)M subjects-, future research could elaborate further in many ways: Further on VET, since the connection between academic training and professional markets is even more immediate than at university level (Aarkrog & Wahlgren, 2017; Buiskool et al., 2010; Volmari, 2009). Also in High School and Secondary Education, since the combination of STEM subjects, critical thinking and creativity becomes a top priority in modern educational policies and frameworks (Clarke, 2019; De Meester et al., 2020; Harris & de Bruin, 2017).

More specifically, the use of virtual containers and eLearning standards should be welcome anywhere to address STE(A)M subjects with an Open Science approach, since they improve the user experience and performance, and they also facilitate the teaching methodology. Also, Open Innovation that works with learning analytics of students' data focused on performance and interaction might become a useful service to support better learning and teaching processes in every level, with emphasis on predictions and specific actions to re-route learning paths. Further, the integration of formal and informal learning, as well as open educational practices that include Open Educational Resources widens the scope and diversity of sources and user networks considerably and might be a breakthrough in any educational level. Last, all of the above might be integrated in an Open Educational Framework and institutional open policy in order to provide an orchestrated effort and plan across the various stakeholders involved, which might common or similar in VET and School Education. The transferability and further exploitation of the findings presented in this thesis seem appropriate and worth exploring.

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Zhang, X., Tlili, A., Huang, R., Chang, T., **Burgos**, D., Yang, J., & Zhang, J. (2020). A Case Study of Applying Open Educational Practices in Higher Education during COVID-19: Impacts on Learning Motivation and Perceptions. Sustainability, 12(21), 9129. DOI: https://doi.org/10.3390/su12219129

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Annex I: List of thematic clusters, publications, methods and research questions

Thematic cluster (TH)	Thematic focus	
TH-01 Open Science	This set of papers concentrates on two major issues. First, they show how open resources are used to provide STE(A)M competences to end users. Second, they show how to use Open Science as a resource to learn STE(A)M subject. In doing so, these papers use Open Science (e.g. containers, correction tools) to facilitate the achievement of competences on Science. So, they use Science to learn Science, from a practical, hand-on perspective. In addition, these papers show the relation between openness, university policy (Open Educational Practices) and inter-operability, which are two keys for a successful implementation of Open Science in Higher Education. They all address research questions RQ-01 and RQ-03	
01	**Burgos**, D., & Corbi, A. (2018). Transgenic learning for STEAM subjects and virtual containers for OER. Distance Education, 39:1, 4-18. (Q1, SSCI). DOI: https://doi.org/10.1080/01587919.2018.1429894	Methods: MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype
02	**Burgos**, D., & Corbi, A. (2017) STEAM subjects enhanced through virtual containers for OER. Proceedings of the Innovation Arabia Conference (p.2). March, 6-8, 2017. Dubai, UAE. ISSN# 2414-6099	MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype
03	Corbi, A, & **Burgos**, D. (2017). OERaaS: Open Distribution of Virtual Containers as a Key Framework for Open Educational Resources and STEAM Subjects. The Electronic Journal of e-Learning, 15(2), 126-136, available online at https://eric.ed.gov/?id=EJ1142209.	MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype MT-04. Learning design
04	Corbi, A, & **Burgos**, D. (2015). Semi-automated correction tools for mathematics-based exercises in MOOC environments. IJIMAI, 3(3), 89-95. DOI: https://doi.org/10.9781/ijimai.2015.3312	MT-01. Desk/literature review MT-02. Case study MT-03. Software prototype
05	Nascimbeni, F., **Burgos**, D., Campbell, L. & Tabacco, A. (2018) Institutional mapping of open educational practices beyond use of Open Educational Resources. Distance Education, 39:4, 511-527 (Q1, SSCI) DOI: doi.org/10.1080/01587919.2018.1520040	MT-01. Desk/literature review MT-02. Case study MT-05. Semi-structured interview
06	**Burgos**, D. (2015) A critical view of IMS Learning Design: recommendations for a revised version. In Maina, M., Brock, C., & Yishay, M. (Eds.) The art & science of learning design (pp. 137-153). SensePublishers, Rotterdam. DOI: https://doi.org/10.1007/978-94-6300-103-8_10	MT-01. Desk/literature review MT-04. Learning design
TH-02 Open Innovation	This thematic cluster shows how Open Innovation becomes a driver to integrate formal, non-formal and informal learning into combined environment that allows for achieving professional competences. In this context, integration of various learning settings not only facilitates but boosts knowledge and the related competences. In addition, the papers in this cluster presents how Open Science broadens the scope of accredited Higher Education while adopting other off-classroom approaches. They all address research questions RQ-02 and RQ-01	
07	**Burgos**, D. (2013). L.I.M.E. A recommendation model for informal and formal learning, engaged. International Journal of Interactive Multimedia and Artificial Intelligence, 2 (2), 79-86: DOI: https://doi.org/10.9781/ijimai.2013.2211	Methods: MT-01. Desk/literature review MT-04. Learning design MT-06. Focus group
08	**Burgos**, D. (2020). A Predictive System Informed by Students' Similar Behaviour. Sustainability, 12 (2), 706. DOI: https://doi.org/10.3390/su12020706	MT-01. Desk/literature review MT-03. Software prototype MT-04. Learning design
09	Nascimbeni, F., & **Burgos**, D. (2019). Unveiling the Relationship between the Use of Open Educational Resources and the Adoption of Open Teaching Practices in Higher Education. Sustainability, 11(20), 5637. DOI: https://doi.org/10.3390/su11205637	MT-01. Desk/literature review MT-05. Semi-structured interview MT-06. Focus group
10	Nascimbeni, F., **Burgos**, D., Aceto, S., & Kamtsiou, V. (2017). Supporting innovation in technology-enhanced learning: a stakeholder-based open approach. International Journal of Innovation and Learning. Vol. 22, No. 2, pp.233–253. DOI: https://doi.org/10.1504/IJIL.2017.085922	MT-01. Desk/literature review MT-05. Semi-structured interview MT-06. Focus group
11	**Burgos** D. (2019) The Innovation Cycle for Sustainable ICT Education. In: Tatnall A., Mavengere N. (eds) Sustainable ICT, Education and Learning. SUZA 2019. IFIP Advances in Information and Communication Technology, vol 564. Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-28764-1_24	MT-01. Desk/literature review MT-04. Learning design
TH-03 Open Competence Framework	The papers in this thematic cluster argue for a normalised and structured design of a set of interlaced competences in the form of an open framework, as a means to improve the achievement of those very competences. An Open Competence Framework allows for an organised integration of competences achieved in non-formal and informal settings into accredited academic programmes, so that the actual learning phase is complemented and strengthen. These papers show a thorough analysis throughout a number of educational policies, along with some proposals for open frameworks. They all address research questions RQ-03 and RQ-02	
12	**Burgos**, D. (Ed.)(2017) Open Education Policy. UNIR: Logroño, La Rioja (Spain). Open Access from http://bit.ly/unir-openpolicy (English) and http://bit.ly/unir-educacionabierta (español)	Methods: MT-05. Semi-structured interview MT-06. Focus group
13	Bacsich, P., Nascimbeni, F., Atenas, J., Aceto, S. & **Burgos**, D. (2017) Member States case studies: Policies for Opening Up Education in Europe. Seville, Spain: Joint Research Centre. European Commission (peer-reviewed technical report)	MT-02. Case study MT-05. Semi-structured interview MT-06. Focus group
14	Nascimbeni, F., & **Burgos**, D. (2016). In Search for the Open Educator: Proposal of a Definition and a Framework to Increase Openness Adoption Among University Educators. The International Review of Research in Open and Distributed Learning, 17(6). (Q1, SSCI). DOI: http://dx.doi.org/10.19173/irrodl.v17i6.2736	MT-01. Desk/literature review MT-04. Learning design MT-05. Semi-structured interview
15	Nascimbeni, F., Alonso, J., Sanz, O., & **Burgos**, D. (2019). Read, Watch, Do: Developing Digital Competence for University Educators. In International Workshop on Higher Education Learning Methodologies and Technologies Online (pp. 80-93). Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-31284-8_7	MT-01. Desk/literature review MT-04. Learning design

Annex II: Papers considered for this PhD proposal

01 Burgos, D., & Corbí, A. (2018). Transgenic learning for STEAM subjects and virtual containers for OER. Distance Education, 39:1, 4-18. (Q1, SSCI). DOI: https://doi.org/10.1080/01587919.2018.1429894

DISTANCE EDUCATION, 2018
https://doi.org/10.1080/01587919.2018.1429894

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Transgenic learning for STEAM subjects and virtual containers for OER

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ABSTRACT

Transgenic learning is a disruptive approach in education. It encourages modification of moving parts of the educational chain. This article provides a view of transgenic learning focused on the delivery of enriched learning contents in STEAM areas. It discusses the mutagenic role that the virtual containers may play in current distance education. We focus on the containers' technology and how it can bridge students, computing resources, teachers and specific IT needs. We also present an experiment carried out at UNIR University where we describe the transition from using conventional software distribution methods to the use of containers. Thanks to this virtualization approach, it is possible to deliver the necessary software-based lab scenarios. The results show that the participation and satisfaction of the students increased over time. Our experience shows that the combination of open educational resources, containers, and modern distribution channels can play a significant role in STEAM education.

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Virtual containers; STEAM; open educational resources (OER); content distribution platforms

Disruptive learning, transgenic learning

Genetically modified organisms (GMO) is a controversial technique to produce new life or food based on the artificial modification of DNA (Apolinario, 2015; Burton, Rigby, Young, & James, 2001; Millis, 2006). Induced by an external disruption, a significant change happens, as if it might be part of the natural evolution of a species. In doing so, adaptation is forced into the natural course, so that an additional feature is provided to that species: from a stronger plant against stormy weather or a plague, to a vitamin embedded into a cereal that does not contain it by default, through the modification of a human protein. This external intervention is conflictive from a number of approaches: ethical, scientific, societal and economic, to name a few. However, the possibility exists; and if smartly applied, it provides the human being with a new resource for progress.

Education, as a whole, nowadays, requires a disruptive boost (Collins & Halverson, 2010; Wrigley, 2009). If we teach and learn in the same way that we did for the last 20 centuries; if we use the very same academic structures that we did 10 centuries ago; if we stress some methodologies from the early years of the last century; and if we use resources from before the rise of the Internet; if all this happens, we will miss every single possibility that the last

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20 years bring to the table. We will miss new, adapted, personalized ways to learn and to teach; to be more efficient, to get a better performance; to enjoy more the experience as a user; and to improve the competence and skill acquisition. Furthermore, we need to break this slow evolution in education. The young people, the technicians, the mass media, the entertainment industry, all of them are far advanced from any practical implementation in the classrooms, from kindergarten to the University.

There are open educational resources (OER), MOOCs, Virtual Reality, Augmented Reality, Emotional Intelligence, Personalized Learning, Analytics and so many resources, services and approaches to complement, enhance and evolve education, as it is now (McGreal, Kinuthia, Marshall, & McNamara, 2013; New Media Consortium, & EDUCAUSE Learning Initiative, 2015). We need a radical innovation, to design a new paradigm, to complement the existing ones, to evolve with the actual users of the system (students, teachers, professors, tutors, parents) and not always far behind from them. We need a GMO concept into learning and teaching, a transgenic approach to education. Something that makes things evolve quicker and more adapted into a very specific and practical objective.

And out of this challenge, the most difficult part is to find the right integration between informal ways of learning, teaching and using daily services, with formal courses and academic degrees; the smart combination of resources inside-outside the classroom; the update of accredited content with enriched, additional information outside the official syllabus that can fit into the same slot of educational competences (Dabbagh & Kitsantas, 2012; De-la-Fuente-Valentín, Carrasco, Konya, & Burgos, 2013).

In the context of our research, STEAM education and specifically in distant STEAM subjects and activities (such as remote labs), we need a novel GMO approach to fight against their limitations (discussed next). Our transgenic solution is based on modern and state-of-the-art virtualization technologies (i.e., virtual containers) and the possibility of freely and openly sharing virtual computing environments. In the work described in this text, we examine a gene (or *set of genes*) in the *educational gnome* that does not quite work (remote STEAM labs and their open delivery as educational resources) and we propose a new genetic variation that does the job.

Limits of OER in STEAM

As part of the transgenic approach, OER are becoming a trend in the academic field at the university level, as summarized by Zancanaro, Todesco, and Ramos (2015) and Hatzipanagos and Gregson (2015). Many renowned academic institutions are already distributing digital content for free, such as California State University (http://als.csuprojects.org), MIT OpenCourseWare (http://ocw.mit.edu), Washington State University (https://teach.wsu.edu/oer) and Tufts OpenCourseWare (http://ocw.tufts.edu)

In addition, non-profit institutions are also offering free OER materials, such as OpenStax (http://cnx.org) and The Open University (http://www.open.ac.uk)

Furthermore, there are associations whose objective is to collect OER with creators, collaborators, students and OER consumers, such as Open Education Consortium (https://oerconsortium.org), EDUCASE (https://library.educause.edu), OERu (https://oeru.org), OER Foundation (http://wikieducator.org/WikiEducator:OER_Foundation) and OERCommons (https://www.oercommons.org)

As stated by Albright (2005) and Pearce, Weller, Scanlon, and Kinsley (2012), OER have contributed to the democratization of education by allowing students and teachers to coexist in a context of mutual benefit. The non-hierarchical relations that arise between OER students, OER creators and teachers help to improve formal and informal learning contexts, interpersonal interactions and the educational process in general.

An OER generally comprises teaching, learning, research or even electronic/multimedia resources. These resources are available for free, for the most part, and with very unrestrictive licensing. Within the contents of an OER, the student can find any material designed for educational purposes (i.e., textbooks, lectures, interactive simulations, games, competitions, evaluation *software*, etc.).

In the context of computer science and engineering teaching, there are already many open source *software* initiatives. However, these cannot strictly be considered OER, since they usually do not come with instructions or teaching guides (i.e., proposed activities, starting tutorials, automatic self-correcting tools, etc.). For example, open *software* repositories like GitHub or SourceForge and their code, despite being de facto open resources, cannot be regarded as OER because they do not necessarily aspire to play an educational role.

In addition, the implementation of traditional educational *software* in institutions can be a tedious task, which is normally delegated to teachers, students or other members of staff who are not technicians. This difficulty arises because of the wide range of computer systems and architectures in such institutions. In the case of inter-institutional collaboration, the situation worsens, as discussed in detail by Nerantzi (2012). The lack of documentation on handling such content adds an additional challenge. OER, as with any type of learning material based on *software*, normally requires that the student not only be able to access these digital resources, but also deal with their installation, configuration and proper use.

In the face-to-face teaching context, the process just described can be carried out with the means and resources of the educational institution, and the student can ask for help when necessary. However, in distance learning, the student feels isolated and somehow alone in facing any type of technical or learning difficulties (Collins & Halverson, 2010). This isolation may be more intense in the specific case of OER, for which students have no institutional or official contact with the creator of the learning resource and, therefore, cannot request any type of support.

In some cases, the installation of the required tools is difficult. Other learning content also requires very sophisticated computing environments, such as:

- Specific operating system (OS) and versions
- Pre-installed libraries, frameworks and runtimes, such as Python, Java, .NET, etc.
- Specific user permits or administrator rights in order to install and run software
- Specific hardware: processors, amounts of memory, GPU resources, etc.
- In these situations, the only alternatives are:
- To require the student to acquire or replicate the software architectures and necessary conditions for the activities and contents provided.
- To allow remote access by the students to a controlled working environment, deployed by the institution or a third party (e.g., hostings based in the cloud, such as Microsoft Azure, Salesforce Heroku or Red Hat OpenShift).

- To limit the underlying technologies necessary for the learning resource to those that have a broad consensus and adoption (e.g., international standards, such as W3C and HTML5, ECMA and ISO, or C# and C++.
- To virtualize each of the work environments through so-called virtualization technologies, which are addressed in this article.

From our point of view, of all the options mentioned, the only one that can be successful in the vast majority of scenarios is, without doubt, virtualization, as justified below. It is currently generally considered that cloud solutions are the best response to the problems mentioned above (Sultan, 2010). However, in order to run some applications in a shared time/remote environment, significant computational resources are required and performance may decrease significantly in these cloud scenarios. In this article, we propose emerging virtual containers (which are discussed in detail in Section 'State of the art of virtualization of e-learning tools and OER') as a vehicle for the distribution of complex educational resources. We have studied a specific application of these containers called Docker.

A great part of Docker's attractiveness lies in the management of an openly accessible repository of virtualized environments or *images*. This repository behaves as an OER management tool and can be considered as an OER as a service (OERaaS) platform, prepared for use in distance learning scenarios. This interesting feature will be addressed in Section 'Virtual containers', but we will first discuss the contributions of classical virtualization technologies to e-learning.

State of the art of virtualization of e-learning tools and OER

Virtualization, in its traditional or classic conception, is the implementation of a partial or complete *hardware* element or system exclusively through *software*. These elements can be disks, processors, network infrastructure, desktop or peripheral computers (including graphics, multimedia and sound reproduction). The virtualized resources are controlled by a *hypervisor*, which adds a layer of abstraction between the real *hardware (host)* and the virtual scenario *(guest)*. The main companies involved in classical virtualization are Oracle, Parallels, VMware and Citrix. The major counterpart open source projects are the famous VirtualBox and QEMU.

Despite being virtualized environments, the efficiency and versatility of modern commercial and open/non-commercial solutions are virtually equal to those obtained through the *host* systems (Seo, Hwang, Moon, Kwon, & Kim, 2014).

This type of virtualization comes with a big disadvantage: each time a new activity or content is created (educational), a completely new virtual machine must be distributed. This usually implies the need for greater bandwidth for upload and download on the part of both the student and the institution. It may also imply decreased performance when running several exercises, and hence several virtual machines, simultaneously. This disadvantage can be overcome by way of virtual containers, which are discussed below in Section 'State of the art of virtualization of e-learning tools and OER'.

Each new virtual machine is distributed using the standards and specific formats (OVF, VDI, VDMK, etc.) agreed by renowned companies and projects that are part of the Open Grid Forum (OCCI-WG, 2010).

With regard to the application of virtual machines in education, we find interesting the study carried out by Bruce (2010), who discusses the barriers to virtualization's entry into schools. These barriers are mainly:

- Lack of skills and knowledge on the part of teachers and students
- Lack of resources on the part of educational centres and institutions
- Disagreements between actors in the educational system.

On the other hand, IBM (2007) predicts an unstoppable increase in virtualization technology in all areas and recommends that schools' IT services join this trend. Finally, other research groups focusing on education technologies, such as Nauczycielski (2011), have conducted comprehensive analyses of the existing virtualization technology and its application to the teaching of subjects related to the creation of networks. Also, various educational institutions, have described the successful development of remote courses thanks to the concept of virtualization. Bližňák, Vojtěšek, Matušů, and Dulík (2008), Cronin, Pauli, and Ham (2013), Li (2009) and Toderick, Peng, and Lunsford (2009) are just a few examples. Theses authors strongly agree on that virtualization frees students from the restraints of having to attend a physical place at a given time in order to attend a course or a lab. With some limitations, discussed below, *traditional virtualization* already represents a powerful *transgenic shift*. Traditional virtualization and virtual machines, including STEAM educational tools, have been used since their technological birth. Generally, these educational resources emulate complete desktop environments with everything necessary for the student to begin to solve tasks with the greatest possible ease of use. The choice of virtual machine has been primarily influenced by the degree of complexity of the resource with which the student will be working. If complex configuration is required in order to use a resource, a properly configured virtual machine seems the best option. This is so, for instance, in the case of the Geant4 application for tomographic emission (GATE). GATE offers the download of a traditional virtual machine based on the popular Ubuntu Linux system, including the *software* necessary to operate directly with this *framework*.

Likewise, Goodman et al. (2012) have developed a learning environment based on the virtual machine for astronomy (WWT). The CloVR project (Angiuoli et al., 2011) shares the same objectives, but focuses on the teaching of genetics. Kind, Leamy, Leary, and Fiehn (2009) have launched a VirtualBox virtual machine for the teaching of chemistry and Hamada (2009) has done something similar for mathematics. The BioImg project (Dahlö et al., 2015) aims to centralize a complete repository of existing virtual machines with learning resources on the teaching of biology. The websites of these projects can be found in Table 1. Likewise, Figure 1 shows some images of these learning environments.

Table 1. Some STEAM educational environments that use classic or traditional virtual machines.

Project	URL	Description
GATE	opengatecollaboration.org	Simulations in physics and medical radiation therapy
WWT	worldwidetelescope.org	Environment to work with a virtual telescope
CloVR	clovr.org	Genetic analysis
BioImg	bioimg.org	Bioinformatics exercises

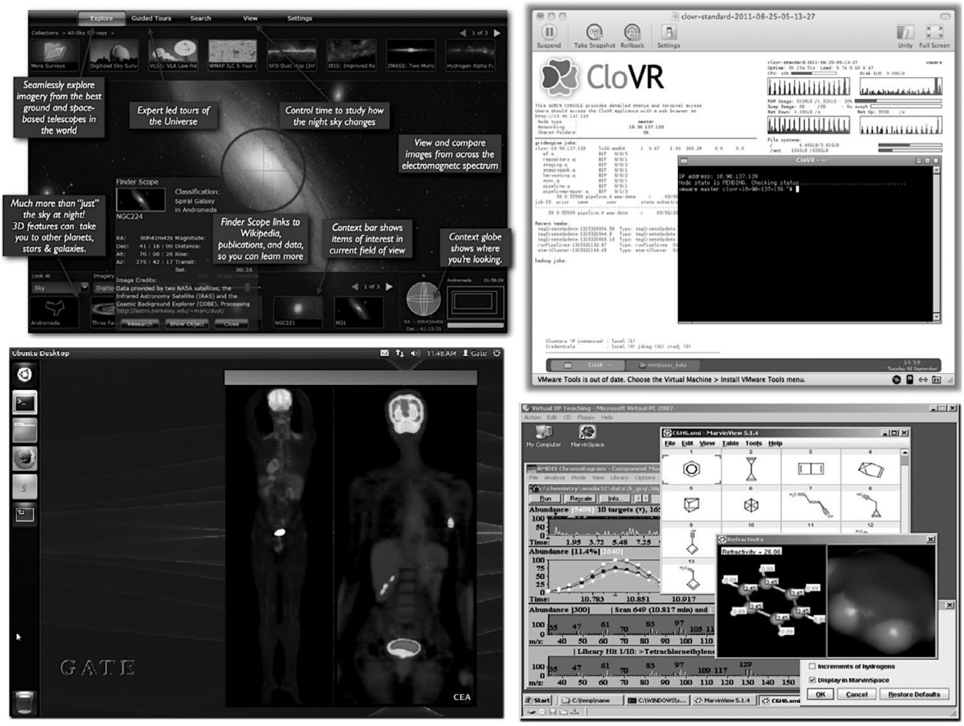

Figure 1. Some educational resources distributed as classic virtual machines (WWT, CloVR, vGATE and a VirtualBox image for chemistry teaching).

Virtual containers

Virtual containers (Rosen, 2014) may be considered light virtual machines, which are normally based on a GNU/Linux shared system. They are designed to run an instance of a specific application (and not a typical virtual scenario, complete with screen, desktop and varied applications). A container seeks, generally, to implement a web service: a Ruby on Rails, Node or PHP application that exposes a TCP/IP interactive port. This aim is achieved by running a *virtual machine* that implements all the necessary *software*.

Such containers are becoming major allies to programmers, systems administrators and *DevOps* (*development and operations*) professionals because they can be easily implemented in any IT infrastructure with minimum pre-installation support. Their main advantage is their lightness and their ability to work in both development and production scenarios. They differ from traditional virtual machines in that all *contained* (or *containerized*) applications share the same underlying *software* layer.

The main projects on virtual containers are Xen (Barham et al., 2003), LXC (Rosen, 2014), Docker (Liu & Zhao, 2014), KVM (Kivity, Kamay, Laor, Lublin, & Liguori, 2007), OpenVZ (Kolyshkin, 2006), VMware ESX (Muller & Wilson, 2005) and libvirt (Bolte, Sievers, Birkenheuer, Niehörster, & Brinkmann, 2010). Some interesting comparisons between these technologies have also been performed by Deshane et al. (2008), Che, Yu, Shi, and Lin (2010) and Fragni, Moreira, Mattos, Costa, and Duarte (2010).

Virtual containers have, in recent years, come to fill an important niche in the administration of systems (Rosen, 2014). Container technology is currently considered the best solution to the problem of how to ensure that *software* runs reliably when it is transferred from one computer environment to another. A container is a complete *runtime bundle* package, including the target application and all its units (i.e., linked or static libraries, help programs, public or configuration files, etc.). The *containerization* of the application and its units eliminates differences in the underlying infrastructure. In contrast to conventional virtualization technologies (like VMware Fusion, Parallels Desktop, Oracle VirtualBox, etc.), various container applications share a core individual OS. This means they are lighter and consume fewer resources than conventional virtual machines, and allows for the large-scale distribution of educational environments with a few dozen *megabytes,* or even less. As a result, a container can easily be run on the *hardware* of the local user/student's device, or on cheaper commercial cloud infrastructure (Joy, 2015).

Recently, many projects have emerged related to the core technologies of containers, in which numerous computer engineering companies, communities and associations are participating, from the largest to the smallest. KVM from Open Virtualization Alliance, ESX from VMware and Docker from dotCloud are only some examples (Che et al., 2010).

Just like others in this group, Docker implements a simple high-level interface in order to provide light virtual environments that run isolated processes. However, Docker has a key advantage over other options, called the Hub. The Docker Hub is an online service (registration is free) for the distribution of containers (Figure 2). It also provides search tools for the discovery and management of containers, and team collaboration (Hagstrom & Essary, 2009). As we suggest later in Section 'Virtual containers', the Docker Hub can implicitly behave as a service for the distribution of OER, and so can be considered an OERaaS platform.

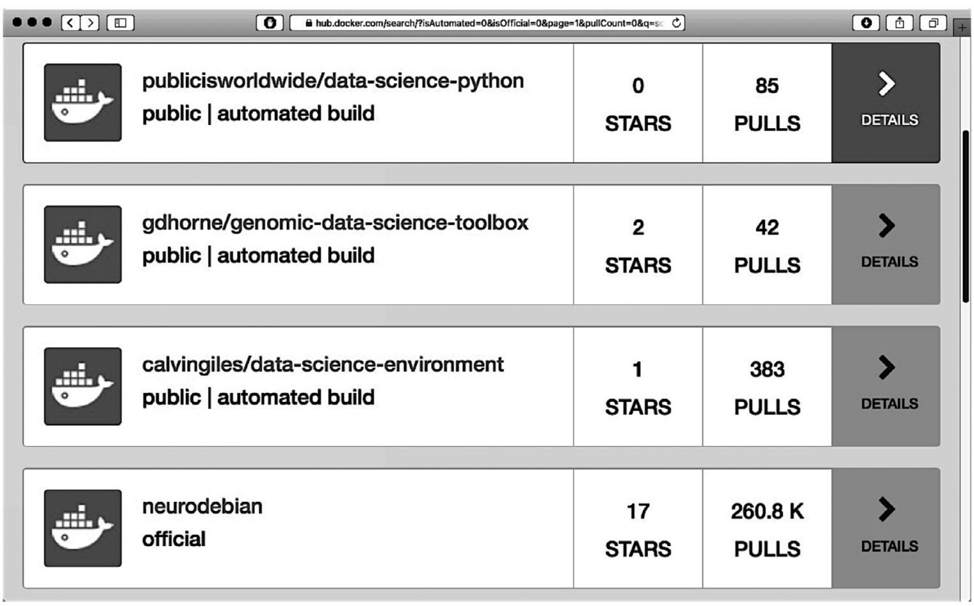

Figure 2. The website of Docker Hub.

Without doubt, the main application of virtual containers is the distribution of services and applications. However, these containers are also attracting the attention of science research groups who consider them as a means to ensure the reproducibility of experimental results. For example, Boettiger (2015) investigates this possibility in the case of Docker, and Clark et al. (2004) do the same with regard to Xen. However, their application has been neglected in academia, particularly as a resource for distance education. In this context, it is proposed that Docker containers are appropriate for ensuring the proper, simple, uniform and open distribution of educational content. In particular, Docker and its Hub are suggested for use in the distribution of open learning resources. In our opinion, these 2 features (light-weight virtual computing environments together with their open distribution) represent a needed *genetic mutation* in the context of the distribution and execution of remote STEAM labs. This transgenic improvement is even more significant and powerful than the one already characterized by the classic virtualization technologies and efforts tackled in Section 'State of the art of virtualization of e-learning tools and OER'.

The Docker Hub as distribution platform for OER

One of the most successful platforms in the virtual containers ecosystem is Docker (Tuomas, 2015). This virtual container works with the concept of interconnected and interdependent images, which endows it with great flexibility and explains the commercial success that it has already enjoyed in its short life thus far. These images are snapshots of containers, which fit together like pieces of a puzzle, forming a virtual operating environment. Each container incorporates only the *framework* (libraries, binaries, configuration files, support *scripts*, etc.), specific configuration files and *software* necessary to perform a task.

Docker has a public repository of open and free containers, which makes thousands of these snapshots available for download and implementation. This repository is called Docker Hub (Figure 4) or, simply, the Hub. Any registered user (registration is free and does not imply any royalties) can upload images to the Hub and share them with a vast and growing community of users. Some of these images have clearly academic goals, as they are designed to recreate specific educational environments for many STEAM subject knowledge areas. Therefore, the Hub behaves as a de facto OERaaS platform, from which hundreds of educational resources are distributed and delivered every day.

Docker and the Docker hub have already been hosting thousands of containers aimed at educational purposes. Recently, two programs have been announced to tighten the links with the educational community: the Docker Student Kit, the Docker Campus Ambassador Program and the Docker in Higher Education Community Directory.

Table 2 lists some Docker images related to science and education, along with the repository (within the Hub) in which they can be found. A repository name is usually presented

Table 2. Some container image repositories associated with education in Docker Hub.

Hub repository	Description
bwawrik/bioinformatics	Bioinformatics with the Python programming language
arkadi/mathics	Mathematics alternative to Wolfram Research
sagemath/sagemath	Environment of numerical and symbolic mathematics
official/scratch	MIT environment to teach programming to children
official/gazebo	Interactive robots simulation

in the author/image format, for which the first element refers to the author of the image and the second to the image itself.

The images that belong to the *official* repository are considered to be of great relevance in specific environments, and are generally developed, maintained and uploaded by institutions with a long tradition. This is the case for the famous Scratch *software* (Resnick et al., 2009) in the field of education, developed and maintained by MIT.

As stated above, this open distribution of containers in the Docker Hub is the second *genetic improvement* presented in this work. It solves one of the main difficulties in the realm of OER sharing: the free, bandwidth-efficient distribution of STEAM-related materials and activities.

A practical case study on transgenic learning and virtual containers

As a practical example, we propose the experiments carried out in the School of Engineering of the Universidad Internacional de La Rioja (UNIR). UNIR is a young 100% online university, with headquarters in Spain, and premises in five Latin-American countries and in USA. It counts 26.000 students, 1.000 faculty, and 500 support staff (including 200 coaches-tutors), with a strong research force focused on Educational Technology and Innovation. A regular student profile is between thirty-five and forty-five years old, has a family and works full time.

The example presented in this paper describes, in the context of the subject of physics for *software* engineers at UNIR, a transition from the use of conventional methods of *software* distribution to the use of Docker containers for the dissemination of *software* for each task. Each set of tasks was delivered to the students as a virtual container. These tasks ranged from simple physics problems that had to be solved with a set of Python scripts, to more complex simulation scenarios that require complex reality *software*. The latter was the case for an exercise related to the study of subatomic particles and photon collisions/circuits, calculated with the Geant4 package developed by CERN. All of the containers implemented the necessary *software* tools for each physics task, along with examples and complementary solutions manuals, freeing the students from royalties and allowing them to focus on how to solve the problem. All the containers (and all of the proposed activities) shared common resources, such as the kernel, core libraries and Python environment.

Our reason for choosing the container technology and the Docker Hub, was the low amount of student participation in remote labs that required complex computing environments for physics simulations. After betting on these two tools, the scenario changed completely (when compared against former semesters), as is shown in Section 'Results and discussion'.

The physics subject mentioned has an essentially applied focus. The implemented methodology consisted of the analysis of the main *software* tools in projects that currently are part of modern physics experiments, along with a replication of those experiments in a virtual form and a discussion phase to share and compare the experience, and assess the actual disruption along the learning flow. Participation in these activities was voluntary, since they generally call for more time and commitment from the student. For this reason, this block of exercises (Table 3) has been called *alternative activities* and, although they have a certain weight in the scoring of the course, their execution and resolution is not compulsory. In the first editions of the physics subject, each of these tools was distributed in a more

Table 3. Proposed activities performed with virtual containers.

Activity	Software	URL
Circuits analysis	Ngspice	http://ngspice.sf.net
Symbolic mathematics	Maxima	http://maxima.sf.net
Delineation and mapping functions	Gnuplot	http://gnuplot.info
Optics	GNU Octave	http://octave.sf.net
	OpenCV	http://opencv.org
	Python	http://python.org
Particle physics	Geant4	http://geant4.web.cern.ch
	Root	http://root.cern.ch
Quantum physics	Ruby	https://www.ruby-lang.org
	Java	http://java.com
Text processing of scientific documents	LaTeX	https://www.latex-project.org
	HTML5	https://www.w3.org
Medical physics	DCMTK	http://dicom.offis.de
	ITK	http://www.itk.org
	VTK	http://www.vtk.org
	C++	https://isocpp.org

traditional manner, i.e., through discrete packages of *software* for each OS that students had to install on their own computers. Despite the careful preparation of each tool, in some cases compatibility and configuration issues emerged. For this reason, in subsequent years, the use of classic virtual machines (full desktop scenarios) was preferred for certain activities. One of these activities was the particle physics laboratory. To minimize the complexity associated with the implementation and execution of this exercise, a *headless* virtual machine was created (lacking both a desktop system and graphical interface). The students downloaded the machine, which they could access through an SSH session. This session, in turn, allowed for the execution of the necessary calculations (Figure 3). The only drawback to this method of distribution – that when the particle physics task required some, even minor, change, a completely new virtual image had to be rebuilt from scratch – was addressed in Section 'Limits of open educational resources in STEAM'.

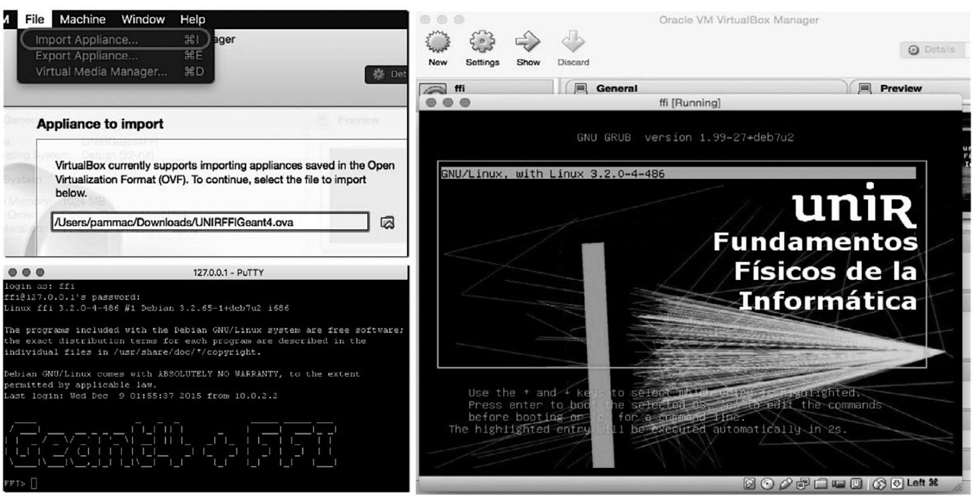

Figure 3. The classic virtual machine distributed to the students to carry out an experiment in particle physics. The students had to download a 2 GB OVF file and import it into their own Oracle VirtualBox.

Figure 4. Kitematic displays and allows for the free download of images of containers for the physics subject.

Just as with the simulation of the interaction of fundamental particles, the vast majority of these cutting-edge scientific projects (i.e., particle physics, accelerator physics, nuclear medicine, electromagnetism, optics, circuits' analysis, etc.) require very specific contexts and computer scenarios that are difficult to reproduce outside the academic/research field in which they were designed. This means that, when we must implement these tools in an external educational environment, technical difficulties often arise.

During the 2015–2016 academic year, the School of Engineering & Technology (ESIT, http://esit.unir.net) decided to move the application of some of these activities to virtual containers based on Docker. This led to a huge simplification of workflow and methodology for all students (twenty-one -21-in total), given that all they really needed to do was install the Docker chain of basic tools. Once installed, the students could download these resources from the Docker Hub or by means of a more modern tool called Kitematic (Figure 4), developed by the Docker team to handle virtual containers more comfortably.

These images were available in the Docker Hub and all students could download and use them, regardless of the institution to which the images belong. For this reason, these images can be considered OER and the Docker Hub behaved as an OERaaS platform.

The evolution in the number of students who presented did homework with the help of virtual containers was automatically measured thanks to assignments submission tool in our online campus. At the same time, the students' perceptions towards virtual containers were studied through a forum thread within the campus forums tool.

Results and discussion

With regard to the results, we see that the students' participation and satisfaction increased over time, in part due to the ease and speed of use of the containers technology and distribution of each of the physics classes mentioned above (Figure 5).

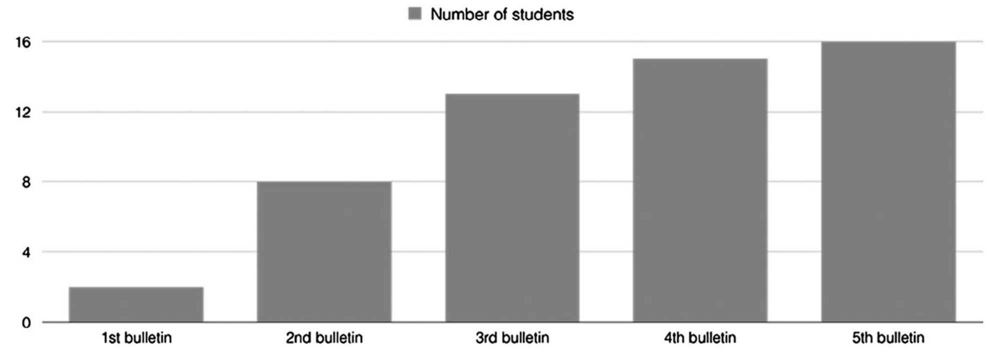

Figure 5. Evolution of the percentage of students committed to the execution of alternative activities based on virtual containers.

Over the course of a semester, these resources were openly available in the Docker Hub and the students could access, download and run them as if they were OER, with total independence and without worrying about the configuration of their personal *host* system. Our experience shows that the combination of educational resources in containers with free and open distribution channels can be one of the cornerstones of the OER approach in STEAM subjects.

Similarly, interest increased over this last year, with a particular increase in week six, where the fourth homework bulletin was presented. (Figure 5). During this week, students conducted the particle physics exercise described above. In this activity, the students simulated a particle beam and its possible interactions with matter and detectors. The ease of implementation of this task thanks to the use of a virtual container led a large number of students to continue solving the rest of the proposed activities, which were also distributed as independent light containers. Figure 6 represents de number of lab activities that were submitted across several semesters. In the first two, distant-learning students found awkward the submission of lab-related assignments, mostly due to the complex required computing setups. However, in the 2015–2016 edition of *physics for computer engineers*, lab-activities gained

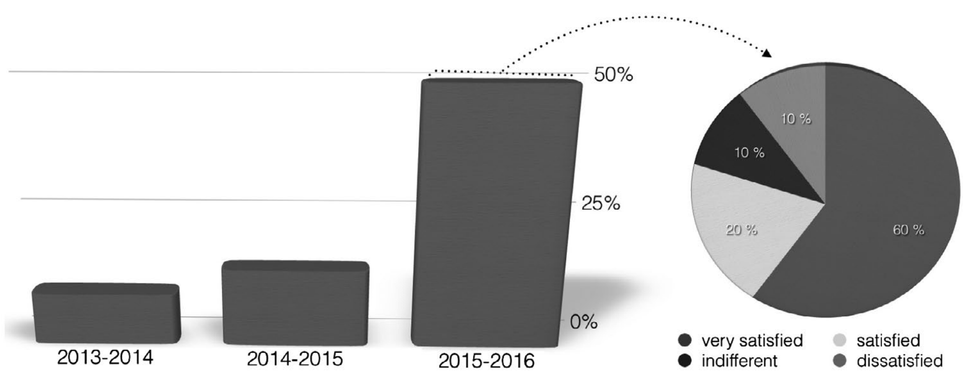

Figure 6. The left side of the figure shows the percentage of participation and dedication to alternative activities based on the use of scientific *software* tools. The right side shows the degree of satisfaction of students with the virtual containers technology (used in the 2015–2016 academic year).

remarkable acceptance when compared against the previous two academic years. The pie chart on the right represents the students' opinion regarding the use of virtual containers as a tool for their homework. Clearly, 80% of them claimed to be satisfied or very satisfied with the adoption of Docker, virtual containers and the way they are distributed.

Conclusions

The simplification of the distribution of computing scenarios in education is a key element in persuading students to use modern and highly complex STEAM learning tools. Transgenic learning is an approach to modify selected parts of the educational process and reinsert them towards an improved performance. Virtual containers mean a disruptive progress to learning and a powerful distribution tool for OER. In this article, we focused on the Docker project and its Hub platform for the easy and open distribution of virtual containers. We have shown, through a real case study, how this tool can work as an OERaaS platform. During the same case study, a progressive increase in the interest and participation of students in the use of the proposed educational tools was noted and measured, showing the progressive support from those students to the disruptive use of this tool. The use of a virtual container represents a disruptive approach for teaching and learning physics, and it follows the principle of transgenic learning: to select and extract a piece of the learning flow, to modify it and improve it, so that it is finally put it back to boost that very same process. Indeed, the students' interest, interaction and performance were better with the virtual container that without it.

Finally, although the focus of this paper has been on the scientific/technical teaching side of the Docker and Docker Hub tandem, we would like to stress that there is plenty of room for its use in other activities, such as digital arts. There also exist hundreds of containers devoted to image manipulation software, photo-editing tools, etc.

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Table of Contents

STEAM Subjects Enhanced through Virtual Containers for OER

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Abstract

This paper starts by summarizing the limits of the delivery of open and enriched learning content, along with their tasks, corresponding to university level students in science, technology, engineering, arts and mathematics (STEAM) areas. Additionally, it discusses the role that the virtual containers may play in current distance education, starting by analysing efforts related to education in the use of classic virtual machines. Subsequently, we focus on the containers' technology and how they can form an online bridge between students, modest computing resources, teachers and specific IT characteristics. ***Modern digital notebook methodologies are also introduced and linked to virtual containers.*** *We also present a practical example: an experiment carried out in the School of Engineering and Technology at Universidad Internacional de la Rioja (UNIR). We describe, within the context of a Computing Physics module for engineers, the successful transition from the use of conventional software distribution methods to the use of virtual containers. Thanks to this virtualization approach, it is possible to implement the activities of the students, easily distribute the necessary software tools and correctly submit the attached documentation. The results show that the participation and satisfaction of the students increased over time, in part due to the ease provided by the containers technology. Our experiment shows that the combination of educational resources in containers with free and open distribution channels can be one of the cornerstones of a new open educational resources (OERs) approach in STEAM subjects.*

Keywords: *Virtual Container, STEAM, Open Educational Resource*

STEAM and Open Educational Resources: Boundaries

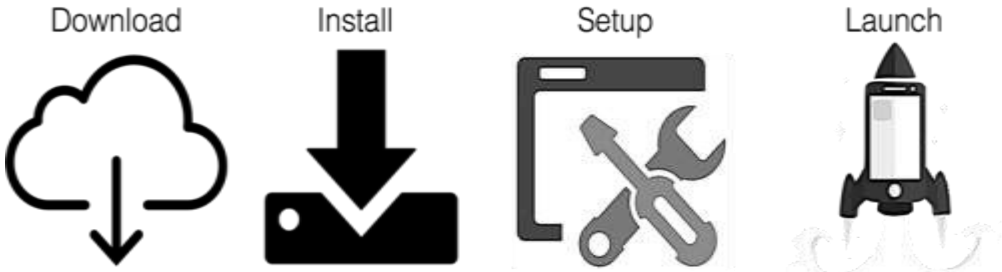
An open educational resource (OER) generally comprises teaching, learning, research and even electronic/multimedia resources. These resources are available for free, for the most part, and with very unrestrictive licensing. Within the contents of an OER, the student can find any material designed for educational purposes (i.e., textbooks, lectures, interactive simulations, games, competitions, evaluation *software*, etc.).

In the context of computer science and engineering teaching, there are already many open-source *software* initiatives. However, these cannot strictly be considered OER, since they usually do not come with instructions or teaching guides (i.e., proposed activities, starting tutorials, automatic self-correcting tools, etc.). For example, open *software* repositories like GitHub or SourceForge and their code, despite being *de facto* open resources, cannot be regarded as OER because they do not necessarily aspire to play an educational role.

Indeed, OERs are becoming a trend in the academic field at the university level, as summarized by Zancanaro et al. (2015) and Hatzipanagos and Gregson (2015). Many renowned academic institutions are already distributing digital content for free. As noted by Albright (2005) and Pearce et al. (2012), OERs have contributed to the democratization of education by allowing students and teachers to coexist in a context of mutual benefit.

In addition, the implementation of traditional educational *software* in institutions can be a tedious task, which is normally delegated to teachers, students or other members of staff who are not technicians. This difficulty arises because of the wide range of computer systems and architectures in such institutions. In the case of inter-institutional collaboration, the situation worsens, as discussed in detail by Nerantzi (2012). The lack of documentation on handling such content adds an additional challenge. OER, as with any type of learning material based on *software*, normally requires that the student not only be able to access these digital resources, but also deal with their installation, configuration and proper use, as summarized in Fig. 1.

Figure 1: Basic steps in educational *software* deployment.



In the face-to-face teaching context, the process just described can be carried out with the means and resources of the educational institution, and the student can ask for help when necessary. However, in distance learning, the student is alone in facing any type of technical or learning difficulties. This isolation may be more intense in the specific case of OER, for which students have no institutional or official contact with the creator of the learning resource and, therefore, cannot request any type of support. In this context, virtualization presents itself as a favourable and efficient solution for the isolated learner (and teacher). Although cloud solutions are the usual technology used in this type of scenario, they are sometimes inconvenient. For instance, to run some applications in a shared time/remote environment requires significant computational resources. In this paper, we propose emerging virtual containers as a vehicle for the distribution of complex educational resources. To allow for analysis of a practical, hands-on experience, we have studied a specific application of these containers called Docker.

In combination with Docker, we have also explored the use of new industry standards for content presentation and assignment execution. Specifically, we have used the Jupyter notebook technology, which will also be investigated below.

A great part of Docker's attractiveness lies in the management of an openly accessible repository of virtualized environments or *images*. This repository behaves as an OER management tool and can be considered as an OER as a service (OERaaS) platform, prepared for use in distance learning scenarios. The most frequently downloaded images in learning environments (and specifically in STEAM) have to do with Jupyter-based set-ups, hence the importance of studying this technology combination.

OER, Virtual Containers and e-Learning Tools: A Review

Virtualization, in its traditional or classic conception, is the implementation of a partial or complete *hardware* element or system exclusively through *software*. These elements can be disks, processors, network infrastructure, desktop or peripheral computers (including graphics, multimedia and sound reproduction). The virtualized resources are controlled by a *hypervisor*, which adds a layer of abstraction between the real *hardware (host)* and the virtual scenario *(guest)*. The main companies involved in classical virtualization are Oracle, Parallels, VMware and Citrix. The major counterpart open-source projects are the famous VirtualBox and QEMU.

Despite being virtualized environments, the efficiency and versatility of modern commercial and open/non-commercial solutions are virtually equal to those obtained through the *host* systems (Boaventura, 2014; Seo et al., 2014).

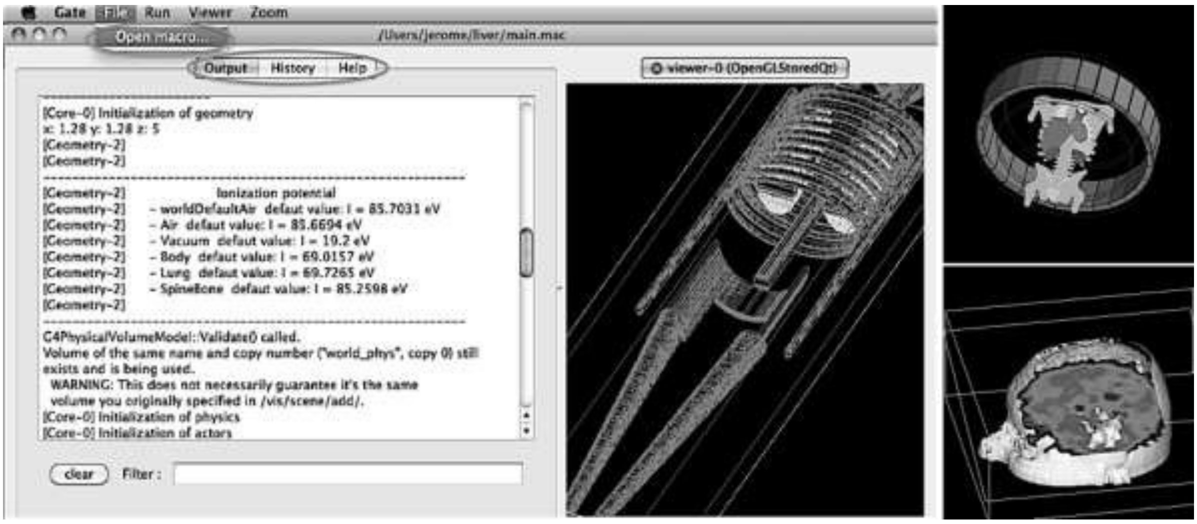
This type of virtualization comes with a big disadvantage: each time a new activity or content is created (educational), a completely new virtual machine must be distributed. This new machine usually implies the need for greater bandwidth for upload and download on the part of both the student and the institution. It may also imply decreased performance when running several exercises, and hence several virtual machines, simultaneously.

Each new virtual machine is distributed using the standards and specific formats (OVF, VDI, VDMK, etc.) agreed by renowned companies and projects that are part of the Open Grid Forum (OCCI-WG, 2010).

With regard to the application of virtual machines in education, we find interesting the study carried out by Bruce (2010), who discusses the barriers to virtualization's entry into schools. These barriers are mainly: 1) lack of skills and knowledge on the part of teachers and students; 2) lack of resources on the part of educational centres and institutions; and 3) disagreements between actors in the educational system.

Traditional or *classical* virtualization and virtual machines emulate complete desktop environments with everything necessary for the student to begin to solve tasks with the greatest possible ease of use. The choice of virtual machine has been primarily influenced by the degree of complexity of the resource with which the student will be working. If complex configuration is required in order to use a resource, a properly configured virtual machine seems the best option. This is so, for instance, in the case of the Geant4 Application for Tomographic Emission (GATE). GATE offers the download of a traditional virtual machine based on the popular Ubuntu Linux system, including the *software* necessary to operate directly with this *framework* (Fig. 2).

Figure 2: The GATE classical virtual machine (based on VirtualBox) for dose assessment calculation.

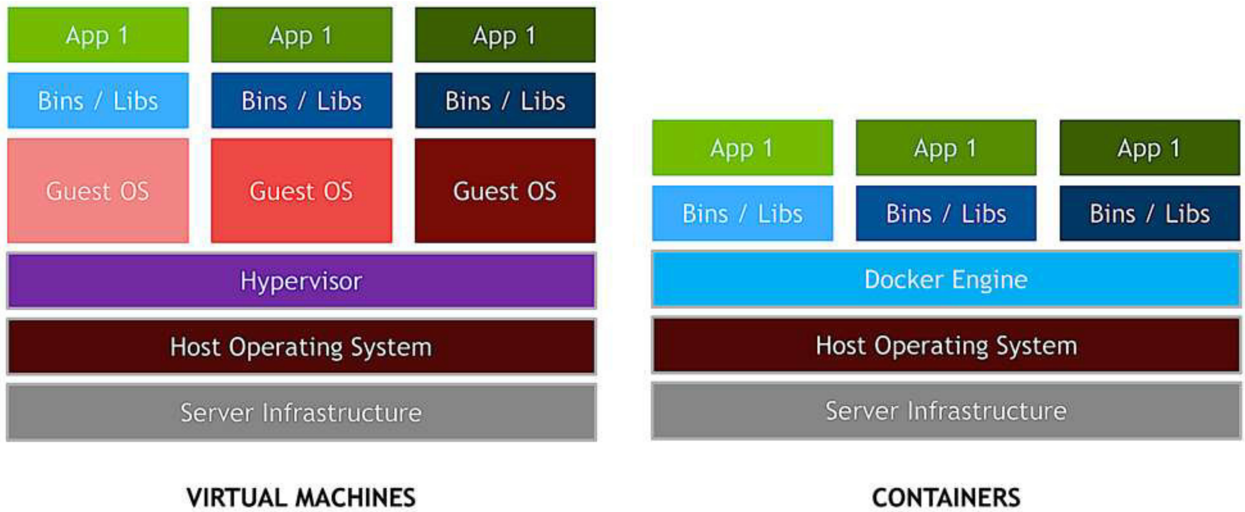


Likewise, Goodman et al. (2012) have developed a learning environment based on the virtual machine for astronomy (WWT). The CloVR project (Angiuoli et al., 2011) shares the same objectives, but focuses on the teaching of genetics. Kind et al. (2009) have launched a VirtualBox virtual machine for the teaching of chemistry and Hamada (2009) has done something similar for mathematics. The BioImg project (Dahlö et al., 2015) aims to centralize a complete repository of existing virtual machines with learning resources on the teaching of biology.

On the other hand, virtual containers (Rosen, 2014) may be considered light virtual machines, which are normally based on a GNU/Linux shared system. They are designed to run an instance of a specific application (and not a typical virtual scenario, complete with screen, desktop and varied applications). A container seeks, generally, to implement a web service: a Ruby on Rails, Node or PHP application that exposes a TCP/IP interactive port. This aim is achieved by running a *virtual machine* that implements all the necessary *software*.

Such containers are becoming major allies to programmers, systems administrators and *DevOps* (*development and operations*) professionals because they can be easily implemented in any IT infrastructure with minimum pre-installation support. Their main advantage is their lightness and their ability to work in both development and production scenarios. They differ from traditional virtual machines in that all *contained* (or *containerized*) applications share the same underlying *software* layer, as shown in Fig. 3.

Figure 3: Operational background of classical virtual machines vs containers.



The main projects on virtual containers are Xen (Barham et al., 2003), LXC (Rosen, 2014), Docker (Liu and Zhao, 2014), KVM (Kivity et al., 2007), OpenVZ (Kolyshkin, 2006), VMware ESX (Wilson and Muller, 2005) and libvirt (Bolte et al., 2010). Some interesting comparisons between these technologies have also been performed by Deshane et al. (2008), Che et al. (2010) and Fragni et al. (2010).

Virtual containers have, in recent years, come to fill an important niche in the administration of systems (Rosen, 2014). Container technology is currently considered the best solution to the problem of how to ensure that *software* runs reliably when it is transferred from one computer environment to another. A container is a complete *runtime bundle* package, including the target application and all its units (i.e., linked or static libraries, help programs, public or configuration files, etc.). The *containerization* of the application and its units eliminates differences in the underlying infrastructure. In contrast to conventional virtualization technologies (like VMware Fusion, Parallels Desktop, Oracle VirtualBox, etc.), various container applications share a core individual OS. This means they are lighter and consume fewer resources than conventional virtual machines, and allows for the large-scale distribution of educational environments with a few dozen *megabytes,* or even less. As a result, a container can easily be run on the *hardware* of the local user/student's device, or on cheaper commercial cloud infrastructure (Joy, 2015). In this research we pursuit an agile, efficient and re-usable way to cope with difficult settings while teaching technical subjects by non-ICT teachers. This approach will facilitate the fostering of a simple solution to be easily integrated into daily practice, no matter the level of complexity of the technical requirements of content in a subject. So the main research question to answer is how virtual containers help teachers to explain technical subjects in an affordable and replicable way. To tackle this question we will follow a hands-on strategy, trial-and-error based, with a direct use of related technology, to produce, implement and evaluate virtual containers with specific student groups, so that they work as an on-demand service to the teacher.

Docker as a Solution for Virtual Containers of OER

Recently, many projects have emerged related to the core technologies of containers, in which numerous computer engineering companies, communities and associations are participating, from the largest to the smallest. KVM from Open Virtualization Alliance, ESX from VMware and Docker from dotCloud are just some examples (Che et al., 2010).

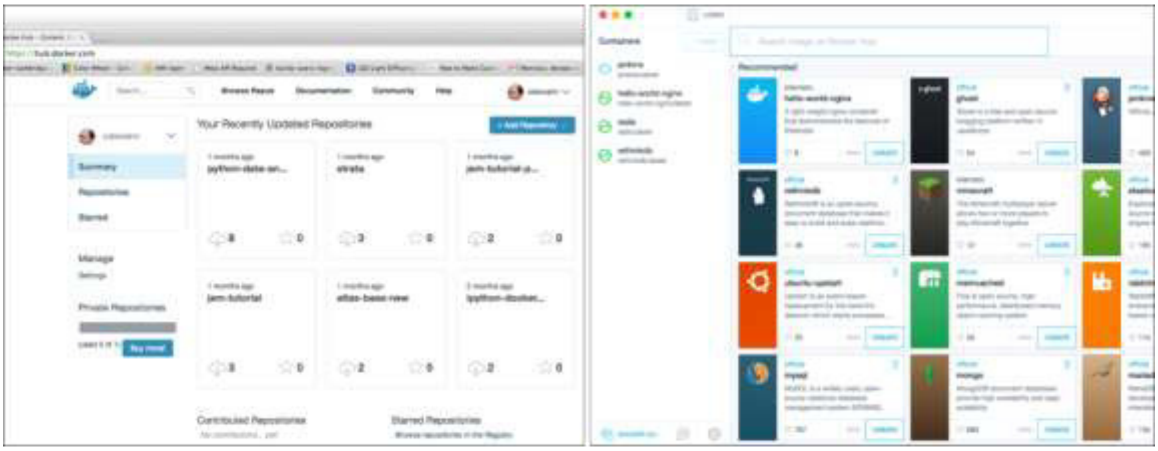
Just like others in this group, Docker implements a simple high-level interface in order to provide light virtual environments that run isolated processes. However, Docker has a key advantage over other options, called the Hub. The Docker Hub is an online service (registration is free) for the distribution of containers (Fig. 5). It also provides search tools for the discovery and management of containers, and team collaboration *(*Hagstrom and Essary, 2009). The Docker Hub can implicitly behave as a service for the distribution of OER, and so can be considered an OERaaS platform. Indeed, this virtual container works with the concept of interconnected and interdependent images, which endows it with great flexibility and explains the commercial success that it has already enjoyed in its short life thus far. These images are snapshots of containers, which fit together like pieces of a puzzle, forming a virtual operating environment. Each container incorporates only the *framework* (libraries, binaries, configuration files, support *scripts*, etc.), specific configuration files and *software* necessary to perform a task.

Without doubt, the main application of virtual containers is the distribution of services and applications. However, these containers are also attracting the attention of science research groups who consider them as a means to ensure the reproducibility of experimental results. For example, Boettiger (2015) investigates this possibility in the case of Docker, and Clark et al. (2004) do the same with regard to Xen. However, their application has been neglected in academia, particularly as a resource for distance education. In this context, it is proposed that Docker containers are appropriate for ensuring the proper, simple, uniform and open distribution of educational content. In particular, Docker and its Hub are suggested for use in the distribution of open learning resources.

Furthermore, Docker has a public repository of open and free containers, which makes thousands of these snapshots available for download and implementation. This repository is called Docker Hub (Fig. 4) or, simply, the Hub. Any registered user (registration is free and does not imply any royalties) can upload images to the Hub and share them with a vast and growing community of users. Some of these images have clearly academic goals, as they are designed to recreate specific educational environments for many STEAM subject knowledge areas. Therefore, the Hub behaves as a *de facto* OERaaS platform, from which hundreds of educational resources are distributed and delivered every day.

The Docker Hub has two main visible faces: a website and a dedicated multiplatform application called Kitematic, both shown in Fig. 4.

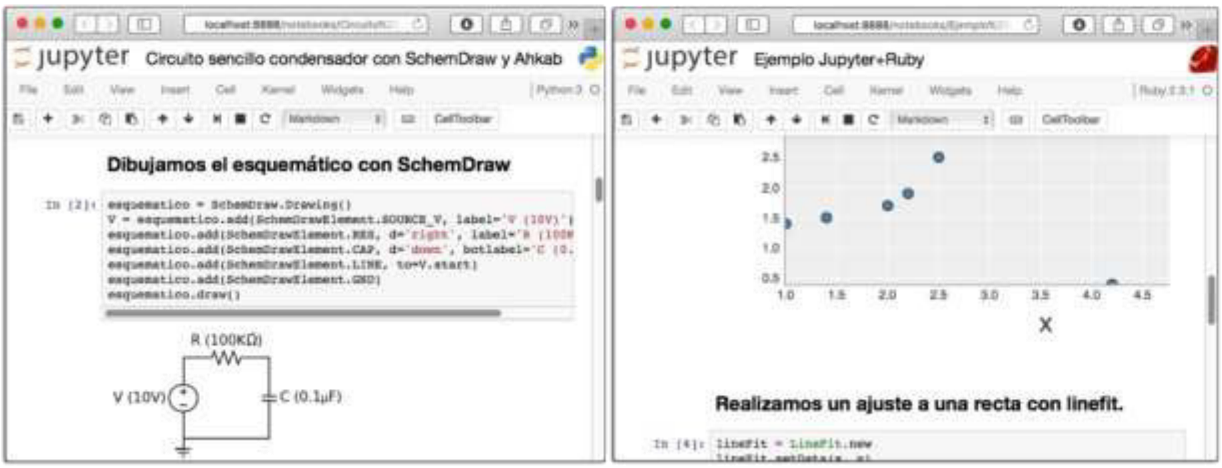
Figure 4: Screenshots of Docker Hub and Kitematic, tools used to manage Docker virtual containers.



Jupyter Notebooks as Containerizable Platforms for Content Delivery and Assignments Execution in STEAM Subjects

Jupyter is the recent evolution of the project formerly known as IPython (Ragan-Kelley, 2014). It was originally developed in and for the Python programming language, but it has evolved into an adaptable platform for almost any scripting language used in scientific fields. Jupyter is based on an architecture for parallel and distributed computing. The *notebook* version of Jupyter is a web-based interactive computational environment for creating and developing assignments. Internally, a notebook is a JSON document containing an ordered list of input/output cells. These cells can contain code, rich Markdown or rich media, such as HTML text, mathematics and plots, as shown in Fig. 5.

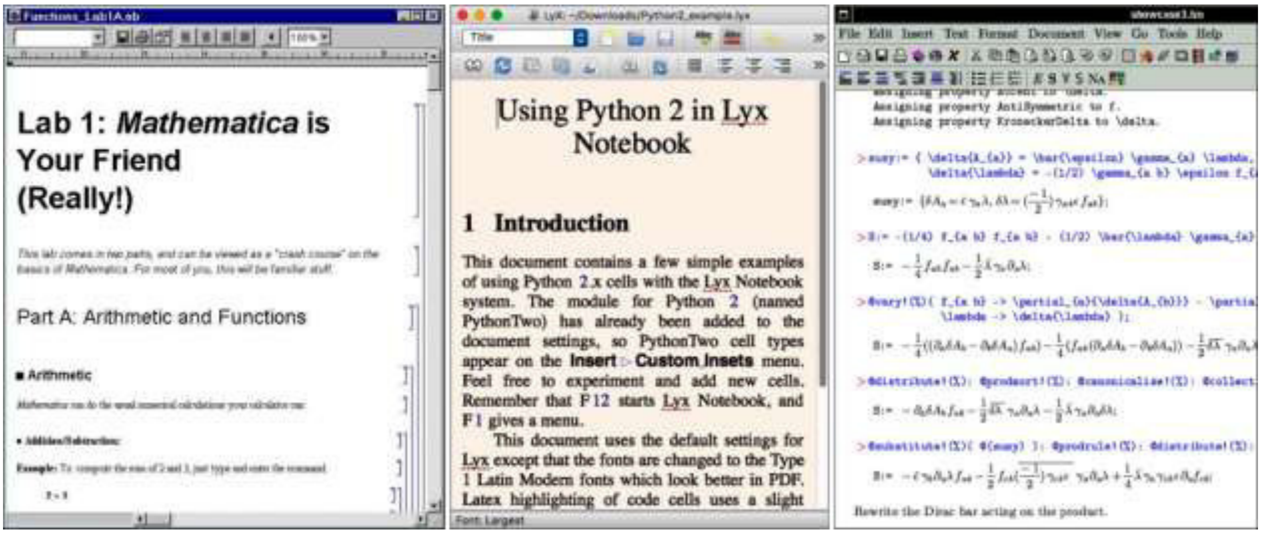
Figure 5: The Jupyter notebook technology with two different kernels: Python and Ruby.



A notebook thus represents a very appropriate means of OER delivery (Shen, 2014), as it can include rich content with explanations, methodology and contextual information, while simultaneously allowing the students to perform their exercises within the same notebook. All these actions can even take place over the network, through a simple web browser. Notebooks also facilitate the development of interactive scenarios through the implementation of HTML5-compliant widgets.

Notebook technologies for assignment and rich content transmission have existed for many years (Fig. 6). Perhaps the main example is the Wolfram Mathematica notebook format (Gray et al., 1991). There exist other open source-based projects, such as TeXmacs (Van Der Hoeven, 2001) and the well-known LyX editor (Kastrup, 2002), which was recently updated to incorporate notebook-like behaviour.

Figure 6: Some other notebook technologies used in STEAM areas. From left to right: Wolfram Mathematica, LyX text processor and TeXmacs.



As explained above, Jupyter notebooks facilitate the development of assignments in a cohesive, immersive, interactive and elegant way. However, they share the same difficulties as other OERs, as outlined in Section 1. A complete Jupyter environment, with the corresponding computing kernels, can be tedious to deploy. It usually entails installing a fully operational Python environment including the two main versions of this language (2.X and 3.X) and the same set of libraries for both.

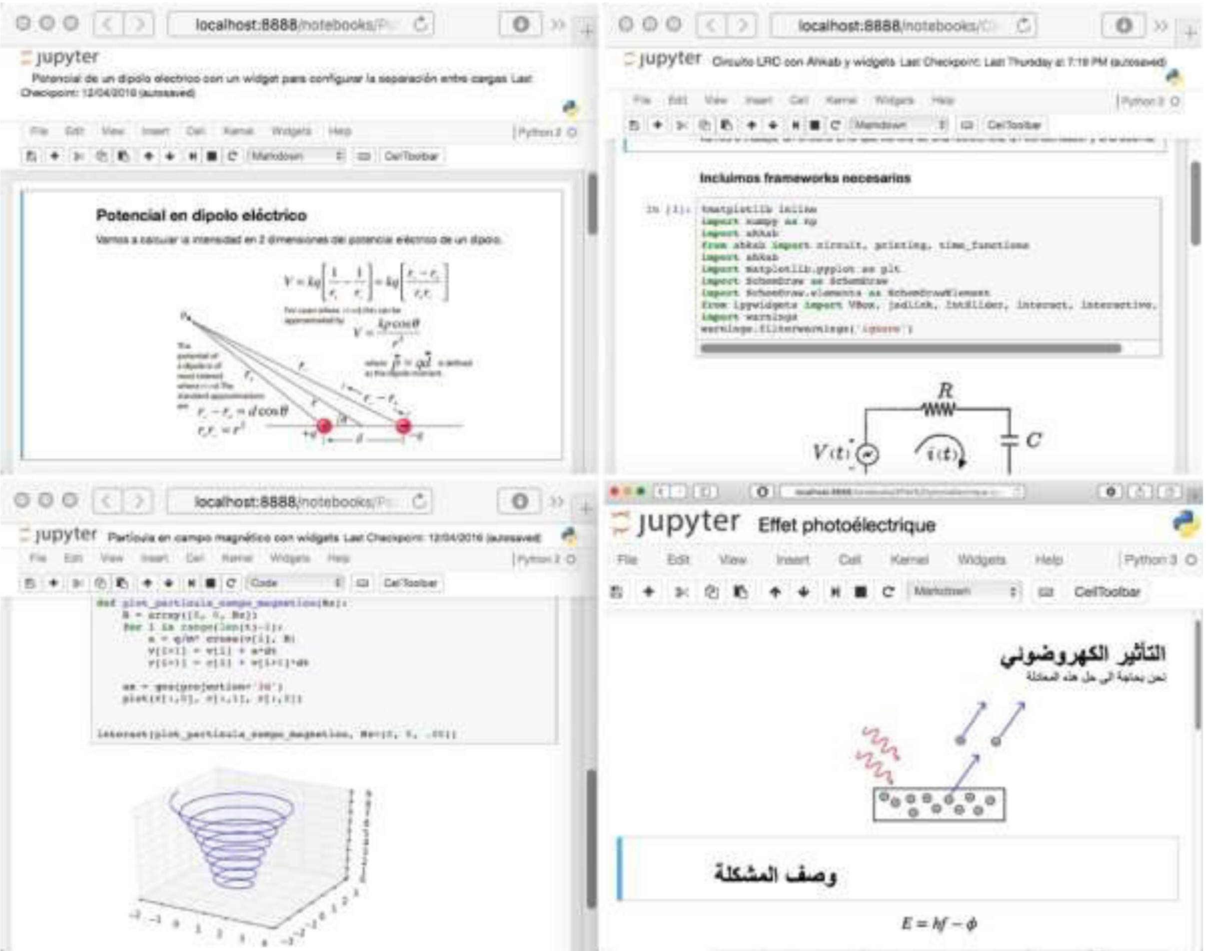
In this context, we have studied the interplay of this digital notebook environment with virtual containers as a means of distributing OERs to students. As mentioned in the introduction to this paper, there exist over 1000 Docker images for tasks related to Jupyter *notebooking*, which have been downloaded over a million times between 2015 and 2016. These range from basic Jupyter support with accompanying scientific standard libraries (i.e., SciPy, matplotlib, NumPy, SymPy, etc.) to very specific framework combinations (e.g., for particle physics simulations).

Research Carried out with a STEAM Subject

To demonstrate the advantages of the proposed tandem technologies (Docker and Jupyter) we carried out a practical experiment in the subject of *physics for software engineers* at the School of Engineering and Technology at Universidad Internacional de la Rioja (UNIR). In the context of this experiment, students were permitted to complete all assignments either using a Jupyter-ready virtual container or *legacy* methods. It was up to each student to select which method they preferred. All tasks could be submitted through a Sakai-based online campus. By *legacy* methods we mean: problem-solving on plain paper (handwritten and then scanned and submitted as a PDF) or with standard word processor *software* (primarily Microsoft Word or OpenOffice). The experiment took place in the winter semester of 2016 over the course of three months.

The proposed assignments comprised physics problems regarding electric force and electric fields, currents, photoelectric effect, circuit simulation, optics and particle physics. The students who chose the Jupyter and Docker version had the additional option of submitting their notebooks as URLs to their GitHub account. Currently, this private site devoted to open *software* collaboration can perfectly render Jupyter notebooks. In fact, GitHub is one of the main actors involved in the evolution of Jupyter.

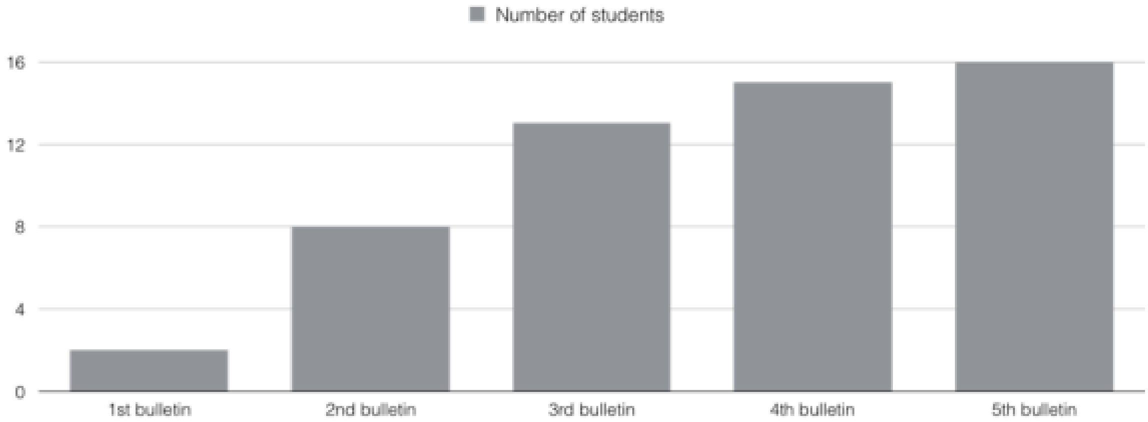
Figure 7: Some of the Jupyter notebooks that were used by our students. They were served through HTTP from Docker containers, which made them very easy to deploy and execute.



Results and Findings

At the beginning of the semester, students were reluctant to use the new proposed tools. However, as time progressed, the law of diffusion of innovation was steadily fulfilled, as Fig. 8 shows.

Figure 8: Growth of the number of students who embraced the proposed methodology regarding virtual containers and Jupyter notebooks (for each bulletin).



Simultaneously, the number of messages exchanged in the forum tool (within the online campus) also increased accordingly.

For their part, the teachers also highlighted the benefits of the ability to distribute homework through an open platform such as GitHub.

Conclusions

The simplification of the distribution of computing scenarios in education is a key element in persuading students to use modern and highly complex STEAM learning tools. Virtual containers are an important tool for the distribution of OERs, though students might need more help to fully deploy digital assignments. A further step to improve this simplification would be the use of web standards that permit the inclusion of introductory explanations and theoretical backgrounds, and allow students to use computing tools to perform calculations and record results and conclusions.

In this article, we focused on the Docker and Jupyter projects. We have shown, through a real case study, how these tools can steadily attract students to use modern problem-solving environments. During the same case study, a progressive increase in the interest and participation of students in the use of the proposed educational tools was noted and measured.

Acknowledgement

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Open Distribution of Virtual Containers as a Key Framework for Open Educational Resources and STEAM Subjects

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Abstract: This paper presents how virtual containers enhance the implementation of STEAM (science, technology, engineering, arts, and math) subjects as Open Educational Resources (OER). The publication initially summarizes the limitations of delivering open rich learning contents and corresponding assignments to students in college level STEAM areas. The role that virtual containers can play in current distant education is then discussed, starting by reviewing related teaching efforts around the use of legacy virtual machines. We then focus on the superseding container technology and how it can bridge the gap between online students, humble computing resources, teachers and IT specificities. As a practical example, we present an experience carried out at the online School of Engineering & Technology at Universidad Internacional de La Rioja (UNIR). Within the context of a subject about Physics for Computing Engineers, we describe the satisfactory evolution from using conventional software distribution methods towards the transition to virtual containers. Thanks to this virtualization approach, the necessary student activities can be implemented, the required software tools can be easily distributed, and the accompanying documentation can be seamlessly presented. The results show how student engagement and satisfaction increased over time, partly because of the easiness introduced by the container technology. Our experience proves that combining containerized educational resources and free and open distribution channels can be one of the cornerstones of a new OER approach in STEAM subjects.

Keywords: virtual containers, STEAM, Open Educational Resources, content distribution platforms

1. Limitations of open educational resources in STEAM

Open Educational Resources (OER) are reaching a relevant level of acceptance in the college-level academic sphere, as the authors in (Zancanaro et al., 2015), (Hatzipanagos and Gregson, 2015) and (Allen and Seaman, 2016) have summarized. Many reputed academic institutions are already distributing free digital content: California State University (http://als.csuprojects.org), MIT OpenCourseWare (http://ocw.mit.edu),Washington State University (https://teach.wsu.edu/oer) and the Tufts Open Courseware (http://ocw.tufts.edu), among others. In addition, non-profit institutions are offering free OER materials like OpenStax (http://cnx.org) and the Open University (http://www.open.ac.uk). Furthermore, there are associations whose goal is to bring together open educational resources and OER creators, contributors, students, and consumers, such as the Open Education Consortium (https://oerconsortium.org), EDUCASE (https://library.educause.edu), OERu (https://oeru.org), OER Foundation (http://wikieducator.org/WikiEducator:OER_Foundation), and OERCommons (https://www.oercommons.org).

As pointed out by (Albright, 2005; Pearce et al., 2012), open educational resources have contributed to the democratization of education by allowing students and teachers to live together in a framework of mutual benefit. Also, as (Burgos, 2006) highlights, the non-hierarchical relationships that emerge between OER learners, OER creators, and teachers contribute very positively to the improvement of formal and informal learning settings, inter-personal interaction, and the overall educational process. Finally, (Downes, 2007) has written a very thorough review regarding sustainable paradigms for open educational resources and discusses several distribution, technical, staffing and funding models.

An OER typically consists of an electronic/multimedia teaching, learning, or even research resource. These resources are mainly available at no cost and under license types that have very few restrictions. Within the contents of an OER, the student can find any material envisioned for educational purposes (i.e., textbooks, related readings, interactive simulations, games, quizzes, assessment software, etc.).

In computing and engineering education, there already exist plenty of open source software initiatives. However, they cannot strictly be considered as OER since usually no companion instructions or teaching guides (i.e., proposed activities, starting tutorials, auto-correction tools, etc.) can be found. For instance, even though they are *de facto* open resources, all open software repositories like Github or Sourceforge and the code hosted inside them, cannot be considered as OER given that they do not necessarily aspire to play an educational role.

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Besides, traditional educational software deployment in institutions can become a tedious task, which is usually delegated to teachers, students, and other *non-technical* staff. This difficulty arises from the huge variety of computer systems and architectures. In the case of cross-institutional collaboration, the situation worsens, as the authors in (Nerantzi, 2012) examine in detail. The lack of documentation when manipulating these contents also adds extra complexity. OER (and any kind of software-based learning material) not only require access to these digital resources by the student, but they also require knowledge for their installation, configuration and proper use, as summarized in Fig. 1.

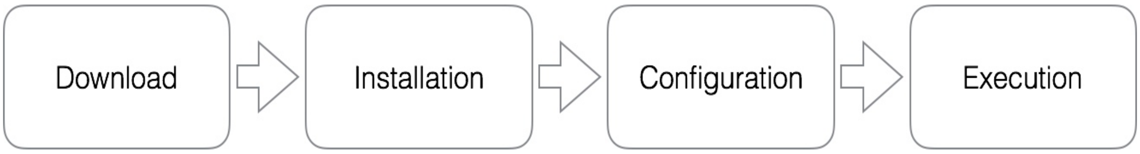

Figure 1: Usual phases in the implementation and use of a software tool.

In face-to-face teaching, the process just described can take place with the means and resources of the educational institution, and the student can ask for help when needed. Nevertheless, in distant learning, the student finds him/herself alone facing all types of technical and learning difficulties. This loneliness can be felt even more intensely in the specific case of OER, where students do not have any institutional or official tutoring contact with the creator of the learning resource and therefore cannot ask for any sort of support.

Some of the required tools entail a huge level of complexity to achieve their proper deployment. In addition, other learning contents require very subtle computing environments such as:

- Specific operating systems and versions.
- Pre-installed libraries, frameworks, and runtimes like Java, Python, dotNet, etc.
- Specific user permissions or admin rights for installing and running software.
- Specific hardware: processor, memory amount, GPU capabilities, etc.

Faced with these situations, the only alternatives are the following:

- Require the student to acquire or replicate the architecture and software conditions necessary for the activities and contents taught.
- Allow the students remote access to a controlled working environment, which is deployed and managed by the institution or by third parties (i.e., cloud-based hostings such as Microsoft Azure, Salesforce Heroku or Redhat Openshift),
- Limit the underlying technologies needed by the learning resource to those that enjoy a broad consensus and level of adoption, i.e., international standards such as W3C and HTML5, ECMA and C#, or ISO and C++.
- Virtualize each working environment through the so-called virtualization technologies, which are tackled in this article.

From our point of view, the only option from the listed above that can be successful for a vast majority of scenarios is, undoubtedly, virtualization, which will be justified below. There is a current tendency to think that cloud-based solutions are the best answer to the above-mentioned problems. Nevertheless, some applications require significant computational resources to be executed in a time-sharing/remote environment and performance may decline significantly in these cloud scenarios. In this paper, we propose virtual containers (discussed in detail in Section 3) as a vehicle for delivering complex educational resources. We study a specific implementation of these containers named Docker.

Docker concentrates a large portion of its appeal in the management of an openly accessible repository of virtualized environments or *images*. This repository behaves like an OER management tool and can be considered to be an OERaaS platform (*OER as a Service*) that is ready for use in distant learning scenarios. This attractive characteristic will be discussed in Section 4, but before addressing this possibility further, we will first discuss the contributions of legacy/classic virtualization technologies in e-learning.

2. State-of-the-art in virtualization of e-learning tools and OERs

In its traditional or *classic* conception, virtualization (also referred to as *legacy virtualization* in this paper), is the implementation of a partial or complete hardware component or system by means of software exclusively. These emulated components can include disks, processors, network infrastructures, peripherals, or full desktop computers (including graphics, media playback, and sound). Virtualized resources are managed by a so-called *hypervisor*, which adds an abstraction layer between the real hardware (*host*) and the virtual scenario (*guest*). The main companies related to classic virtualization are Oracle, Parallels, Citrix, and VMWare. On the other hand, the main open source projects are the well-known VirtualBox and QEMU.

Even when dealing with virtualized environments, the efficiency and versatility achieved by modern commercial and open/non-commercial solutions almost match those achieved by host systems (Soares Boaventura et al., 2014; Seo et al., 2014). Fig. 2 shows an example of the speed that is attainable in database access (VMware, 2008).

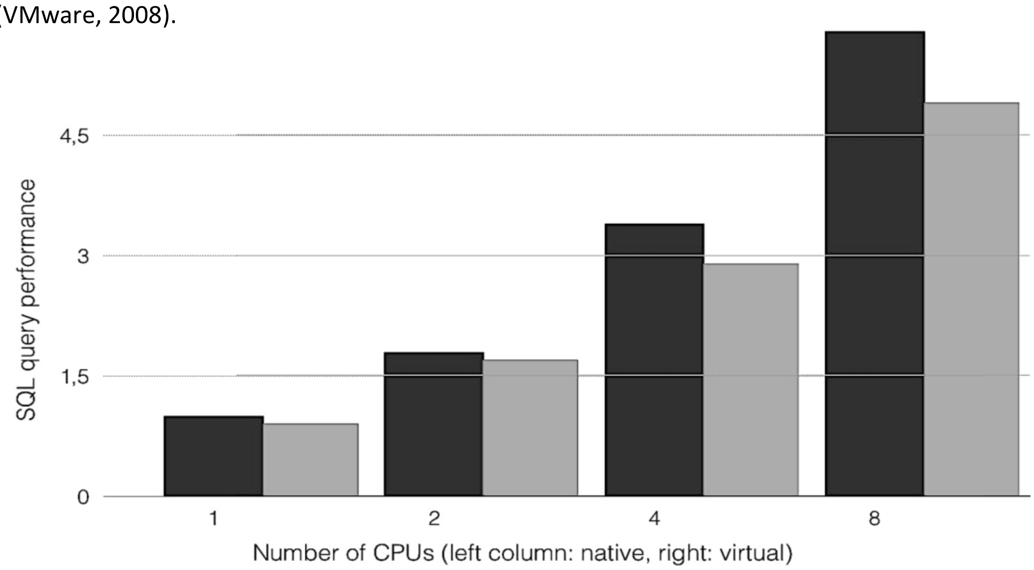

Figure 2: Native vs. virtual performance in SQL access to a database.

This type of virtualization has a huge disadvantage: each time a new activity or (educational) content is created, it has to be wrapped by a new complete virtual machine. This usually entails greater upload and download bandwidth requirements for both the student and the institution. It may also involve a reduction in performance when several exercises, and thus several machines, are executed concurrently. This disadvantage can be overcome thanks to virtual containers, which are discussed in Section 3.

Each new virtual machine is, in turn, distributed following specific conventions and formats (OVF, VDI, VDMK, etc.) agreed upon reputed companies and projects that are affiliated with the Open Grid Forum (OCCI-WG, 2010).

There is an interesting study carried out by (Bruce, 2010) about the application of virtual machines in education that analyzes the barriers that are preventing the entry of virtualization in schools. The main barriers are the following:

- Lack of skills and knowledge by teachers and students.
- Lack of resources by educational centers and institutions.
- Disagreements between the stakeholders in the educational system.

However, IBM (IBM, 2007) predicts an unstoppable rise of virtualization technology in all areas and recommends IT services in schools to join this trend. Other research groups in educational technologies such as (Nauczycielski, 2011) have performed a comprehensive analysis of existing virtualization technology and its application to the teaching of subjects related to networking.

Traditional virtualization and virtual machines have been used as educational tools in STEAM since their technological birth. Typically, these educational resources emulate full desktop environments with everything necessary for the student to begin solving the required tasks with the greatest ease of use possible. Usually, the choice of virtual machines has mainly been influenced by the degree of complexity of the resource to be used by the student. If a resource required an arduous configuration for its use, then, a properly configured virtual machine seemed to be the best choice. For example, that is the case for GATE (*Geant4 Application for Tomographic Emission*). GATE offers the download of a traditional virtual machine based on the popular Ubuntu Linux desktop distribution with all the software necessary to directly operate with this framework related to particle and medical physics.

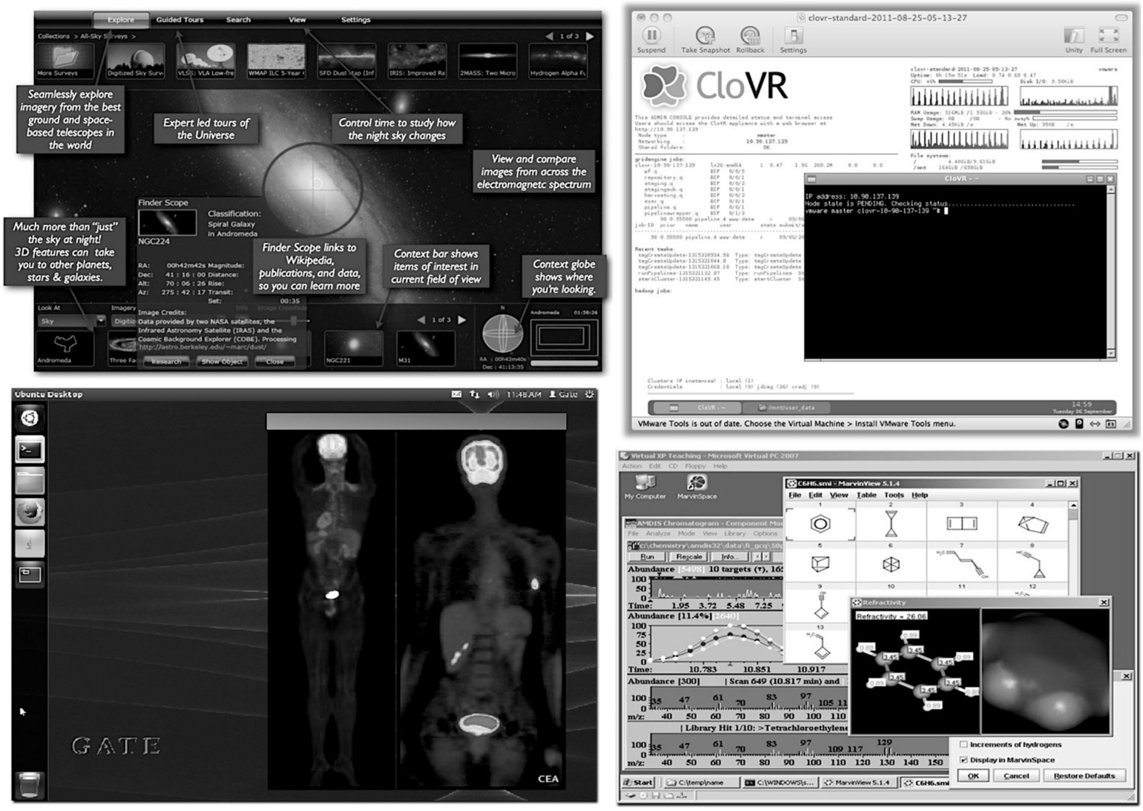

Figure 3: Some educational resources that are distributed as classic virtual machines (WWT, CloVR, vGATE, and a VirtualBox image for chemistry teaching).

Similarly, the authors in (Goodman et al., 2012) have developed a virtual machine-based learning environment for astronomy (WWT). The CloVR project (Angiuoli et al., 2011) shares the same goals, but it is focused on teaching genetics. The authors in (Kind et al., 2009) have implemented a VirtualBox virtual machine for teaching chemistry, and researchers in (Hamada, 2009) have done something similar in math-related subjects. The BioImg project (Dahlö et al., 2015) is aimed at centralizing a complete repository of legacy virtual machines with learning resources for the teaching of biology. The web pages of these projects are shown in Table 1. Fig. 3 shows some screenshots of these learning environments.

Table 1: Some STEAM educational environments that use classic or traditional virtual machines.

Project	URL	Description
GATE	opengatecollaboration.org	Simulations in medical physics and radiotherapy
WWT	worldwidetelescope.org	Framework for working with a virtual telescope
CloVR	clovr.org	Genetic analysis
BioImg	bioimg.org	Exercises in bioinformatics

3. Virtual containers

Virtual containers (Rosen, 2014) can be considered light virtual machines that are typically based on a shared GNU/Linux system. They are designed to run an instance of a specific application (and not a *canonical* full-screen desktop environment with a complete set of applications). A container's mission is usually to implement a web service: a Ruby on Rails, NodeJS, or PHP application that owns an interactive TCP/IP port. The way to do this is by running a virtual machine that implements just the components that are strictly necessary for such a service to run.

Containers have become the great allies of programmers, system administrators, and DevOps (*development and operations*) because they can be easily deployed on any computer infrastructure that has the minimum support pre-installed. The main advantage is its lightness and the ability to work in both development and production environments. The difference from traditional virtual machines is that all contained (or *container-ized*) applications share the same underlying software layer, as shown in Fig. 4.

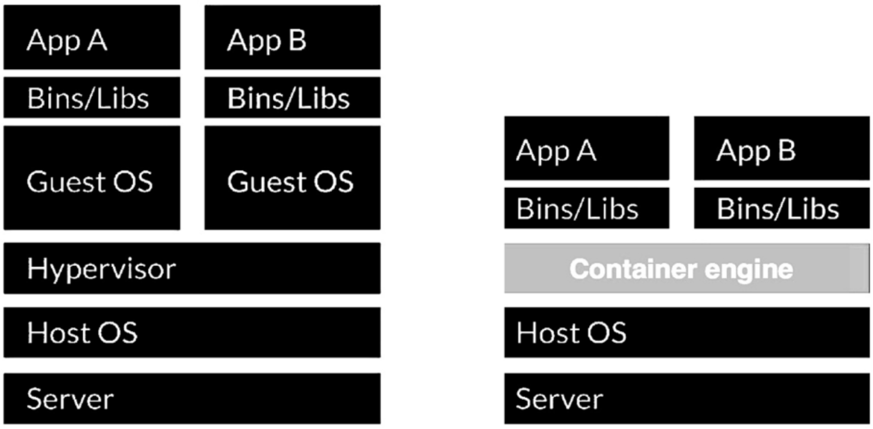

Figure 4: Classic virtualization (left) vs. container virtualization (right).

The main projects that use virtual containers are Xen (Barham et al., 2003), LXC (Rosen, 2014), Docker (Liu and Zhao, 2014), KVM (Kivity et al., 2007), OpenVZ (Kolyshkin, 2006), VMware ESX (Muller and Wilson, 2005), and libvirt (Bolte et al., 2010). There are also interesting comparisons between these technologies such as those carried out by (Deshane et al., 2008; Che et al., 2010, and Fragni et al., 2010).

In recent years, virtual containers have occupied an important niche in systems administration (Rosen, 2014). Container technology is currently considered to be the best answer to the problem of *how to get software to run reliably when shifted from one computing environment to another*. A container consists of a complete and packaged runtime bundle, which includes the target application and all its dependencies (i.e., linked or static libraries, helper programs, state or configuration files, etc.). By *containerizing* an application and its dependencies, differences in the underlying infrastructure are abstracted away. In contrast with conventional virtualization technology such as VMware Fusion, Parallels Desktop, Oracle VirtualBox, etc., several containerized applications share a single operating system (OS) kernel. This makes them lighter and less resource-hungry than conventional virtual machines (less than 100 megabytes or even less) and enables the distribution of large scale educational environments. As an immediate consequence, a container can easily be run either on humble local user/student hardware or on less expensive commercial cloud infrastructures (Joy, 2015).

Many projects related to the core technologies in containerization have emerged recently and many computer engineering companies, communities, and associations (both large and small) are involved. KVM from Open Virtualization Alliance, ESX from VMWare, or Docker from dotCloud are just a few examples (Che et al., 2010). As with other alternatives, Docker implements a simple, high-level interface to provide lightweight virtual environments that run isolated processes. However, Docker has a key advantage over other choices, the so-called *Hub*. The Docker Hub is a free online registry service for distributing containers (Fig. 5). It also provides search utilities for container discovery, management, and team collaboration (Hagstrom and Essary, 2009). As we suggest in Section 4, the Docker Hub can implicitly behave as a service for OER distribution and may be regarded as an OERs as a service (OERaaS) environment.

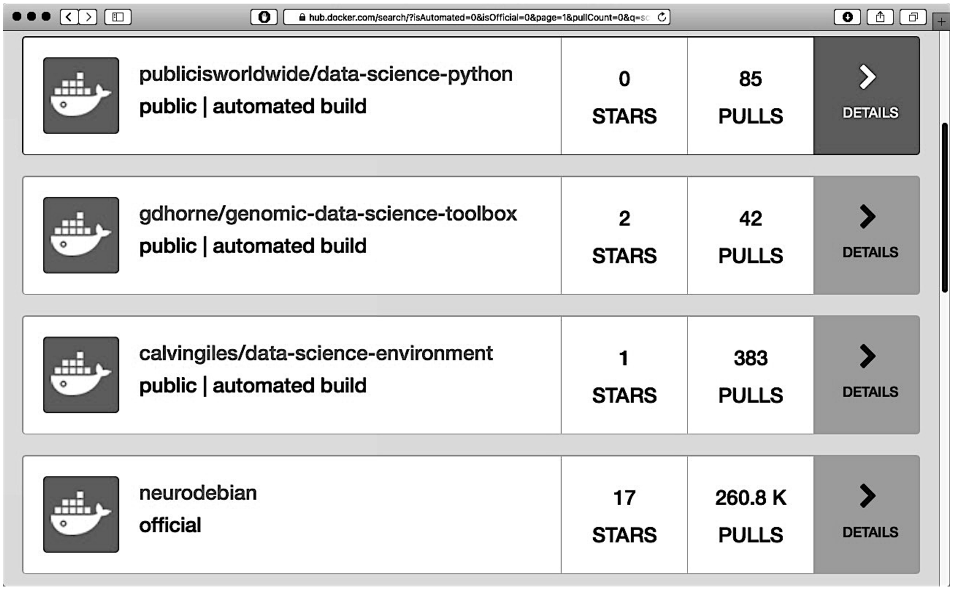

Figure 5: The web site of the Docker Hub.

Undoubtedly, the main application of virtual containers is the distribution of services and applications. However, containers are also catching the attention of science research groups as a means of assuring the reproducibility of experimental results. For example, the authors of (Boettiger, 2015) examined this possibility in the case of Docker and (Clark et al., 2004) for Xen. However, its application has hardly been explored in the academic realm, or mode specifically, as a core teaching resource in distant education. Therefore, we propose the suitability of Docker containers to ensure a correct, simple, uniform and open distribution of educational content. More specifically, we suggest the use of Docker and its Hub for the distribution of open learning resources. Another important reason for selecting Docker is its strong open source foundation and its healthy developer community only comparable to other worldwide relevant projects such as the Linux kernel.

4. The Docker HUB as an OER distribution platform

One of the most successful implementations in the ecosystem of virtual containers is Docker (Tuomas, 2015). This virtual container alternative works with the concept of inter-connectable and inter-dependent images, which gives it great flexibility and explains the commercial success that it is already having in its thus far short life. These images are container snapshots that fit together like puzzle pieces and form a virtual operating environment. Each container incorporates just the frameworks (libraries, binaries, configuration files, support scripts, etc.), specific configuration files, and the software necessary to perform one task.

Docker has a public, open, and free container repository that handles thousands of these snapshots that are already ready to be downloaded and deployed. This repository is called the Docker Hub (Fig. 5) or simply *Hub*. Because registration is free and does not involve any royalty, a registered user can upload images to the Hub and share them with a vast and growing community of users. Some of these images have markedly academic objectives because they are eminently designed to recreate specific educational environments for many of the knowledge areas of STEAM subjects. Therefore, the Hub behaves as a *de facto* OERaaS platform from which hundreds of educational resources are distributed and served daily.

Table 2 shows some Docker images that are related to science and education and in which repository (within the Hub) they can be found. A repository name usually has two parts: author/image. The first one refers to the author of the image and the second one to the image itself.

Table 2: Some repositories of container images related to education in the Docker Hub.

Hub repository	Description
bwawrik/bioinformatics	Bioinformatics through the Python programming language
arkadi/mathics	Alternative to Mathematica from Wolfram Research
sagemath/sagemath	Environment for symbolic and numerical mathematics
official/scratch	Environment from MIT to teach programming to kids
official/gazebo	Interactive robot simulation

The images belonging to the *official* repository are considered to be of great relevance in specific environments and are usually developed, maintained, and uploaded by institutions with a long tradition. This is case of the famous Scratch software (Resnick et al., 2009) from the MIT, in the field of education.

5. Research

As a practical example, we discuss the experiences carried out at the online School of Engineering & Technology at Universidad Internacional de La Rioja (UNIR). In the context of a Physics for Computing Engineers subject, we describe the satisfactory evolution from using conventional software distribution methods towards the transition to Docker containers for broadcasting each assignment's underlying software. Each homework set was given to the student as a virtual container. Our working hypothesis is that virtual containers can significantly improve the student experience when having to solve complex mathematics, physics and other STEAM-related college level exercises.

These assignments ranged from simple physics problems to be solved with a set of Python scripts to more complex simulation scenarios that required intricate software outlines. This is the case of an exercise related to the study of sub-atomic particle and photon tracks/collisions calculated with the legendary Geant4 package from the CERN. All of the containers deployed the necessary software tools for each physics task, examples, and companion resolution guides, thus freeing the learner from these duties and allowing him/her to concentrate on the problem itself and how to solve it. All of the containers (and all of the proposed activities) shared common resources such as the Kernel, basic libraries, or a Python environment.

The above-mentioned taught physics subject (our evaluation scenario) has an eminently applied focus. The methodology followed is the study of the main computing tools for projects that are currently part of modern physics experiments. The commitment to the implementation of these activities is voluntary since they usually involve more time and dedication by the student. That is why this block of exercises (Table 3) is called *alternative activities*. Although they are given some weight in the course grade, their execution and resolution is not mandatory. In early editions of this physics course, each of these tools was distributed in a more traditional way, i.e., through discrete software packages for each operative system that each student had to install on his/her own computer. Despite the careful preparation of each tool, compatibility problems and configuration issues arose in a fairly high number of cases. For this reason, in subsequent academic years, the use of classic virtual machines (complete desktop environments) was favored for certain activities. One of these activities was the particle physics lab. To minimize the complexity related to the deployment and execution of this exercise, a *headless* virtual machine (not desktop-based and without graphical interface) was created. This machine was downloaded by students, who could access it through a SSH session. This session enabled the execution of the necessary calculations. The only drawback related to this way of distributing a learning content of this type is that if this particle physics assignment ever requires (even minor) modifications, a new and complete virtual image has to be rebuilt from scratch.

As with the simulation of fundamental particle interactions, the vast majority of these cutting-edge scientific projects (particle physics, accelerator physics, nuclear medicine, electromagnetism, optics, circuit analysis, etc.) require very specific computing environments that are very difficult to reproduce outside of the research/academic field in which they were conceived. This means that when these tools have to be deployed in a foreign educational environment, technical difficulties may normally arise.

For the 2015-2016 academic year, the School of Engineering decided to move the implementation of some of these activities to Docker-based virtual containers. This has led to huge workflow and methodological simplification for all students since they were only required to install the basic Docker toolchain. Once installed, the students were able to download these resources from the Hub website or through the more modern tool called Kitematic (Fig. 6), which was developed by the Docker team to handle virtual containers in a more convenient way.

Our evaluation process consisted on measuring the rate of satisfaction of students relative to the use of virtual containers and the number of successfully completed tasks with and without virtual container-based technology. These assignments were submitted through the assignments tool in a Sakai-based online campus. Students also filled a simple satisfaction questionnaire at the end of the semester, rating their satisfaction regarding the use of Docker and virtual containers as an appropriate method for designing and delivering remote STEAM labs.

Table 3: Proposed activities executed with virtual containers

Activity	Software	URL
Circuit analysis	NGSpice	http://ngspice.sf.net
Symbolic maths	Maxima	http://maxima.sf.net
Function plotting and charting	GNUPlot	http://gnuplot.info
Optics	GNU Octave	http://octave.sf.net
	OpenCV	http://opencv.org
	Python	http://python.org
Particle physics	Geant4	http://geant4.web.cern.ch
	Root	http://root.cern.ch
Quantum physics	Ruby	https://www.ruby-lang.org
	Java	http://java.com
Word processing of scientific documents	$\LaTeX$	https://www.latex-project.org
	HTML5	https://www.w3.org
Medical physics	DCMTK	http://dicom.offis.de
	ITK	http://www.itk.org
	VTK	http://www.vtk.org
	C++	https://isocpp.org

These images were publicly available on the Docker Hub and they could be downloaded and used by any student, regardless of their institution. For this reason, these images can be considered as OER, and the Docker Hub has played the role of an OERaaS.

Figure 6: Kitematic allows the free download of container images created for the physics subject presented in this research

6. Results and discussion

Our results show how student engagement and satisfaction increased over time, partly because of the ease and swiftness introduced by the container technology in the distribution of each of the physics lessons mentioned above (Fig. 7).

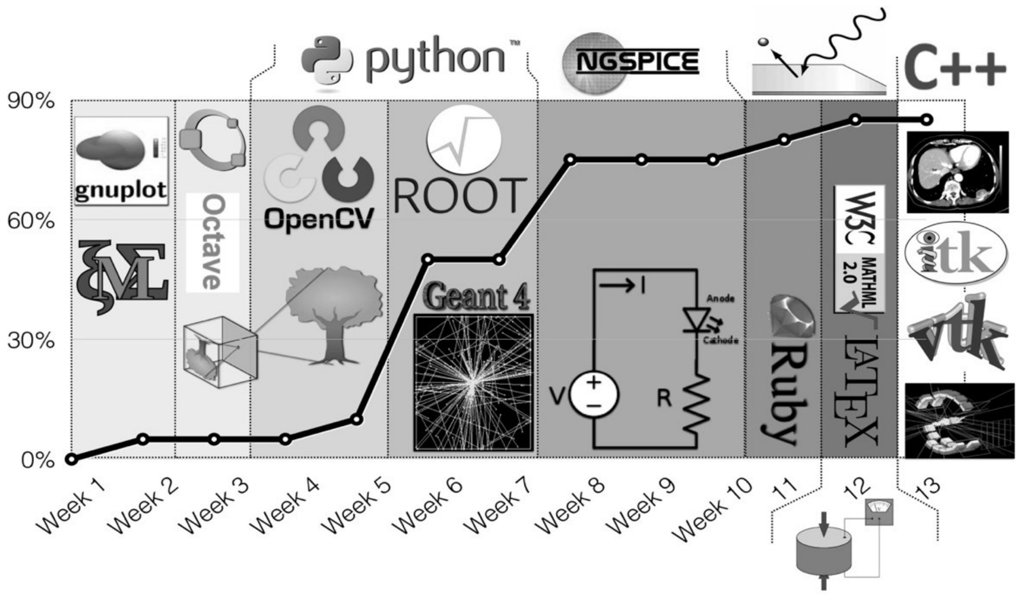

Figure 7: Evolution in the percentage of students (superimposed black line) committed to execution of alternative activities based on virtual containers. In each week, a complete new technology and science problem (entailing a radically different computing scenario) was introduced. Some of these technologies and frameworks are summarized in Table 3.

These resources were openly available in the Docker Hub for one semester. Enrolled students accessed, downloaded, and run them as plain OER in their own personal host systems. Our experience proves that combining containerized educational resources and free and open distribution channels can be one of the cornerstones of the OER approach in STEAM subjects. Fig. 8 shows the evolution in the commitment of students to the elaboration and submission of alternative activities involving richer computing scenarios. Clearly, the 2015-2016 semester represents a huge difference (in student commitment) when compared against the previous academic years.

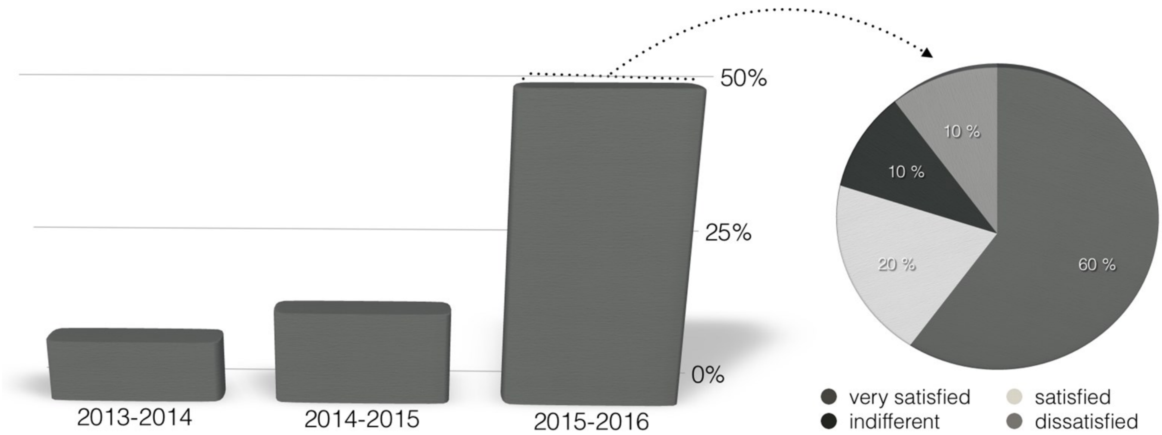

Figure 8: Evolution in the commitment and dedication to alternative activities based on the use of scientific software tools. Only in the 2015-2016 semester, virtual containers were used as part of the teaching methodology. The vertical axis entails the percentage of submitted alternative activities (discussed in Section 5). The pie graph shows the degree of student satisfaction with the technology of virtual containers (applicable only in the 2015-2016 academic year, when the satisfaction questionnaire was handed in to the students).

Similarly, during the 2015-2016 academic year, interest has been increasing with a significant rise in week 6 (Fig. 7). During that week, the students carried out the same exercise related to particle physics (described above). In this activity, the students simulated a beam of particles and their possible interactions with matter and detectors. The ease of implementation of this task by means of a virtual container attracted a large number of students to continue solving the rest of the proposed activities, which were also distributed as lightweight interdependent containers.

Also, our results correlate with the increasing number of Docker images available in the Docker Hub and that are related to education in STEAM subjects (Fig. 9).

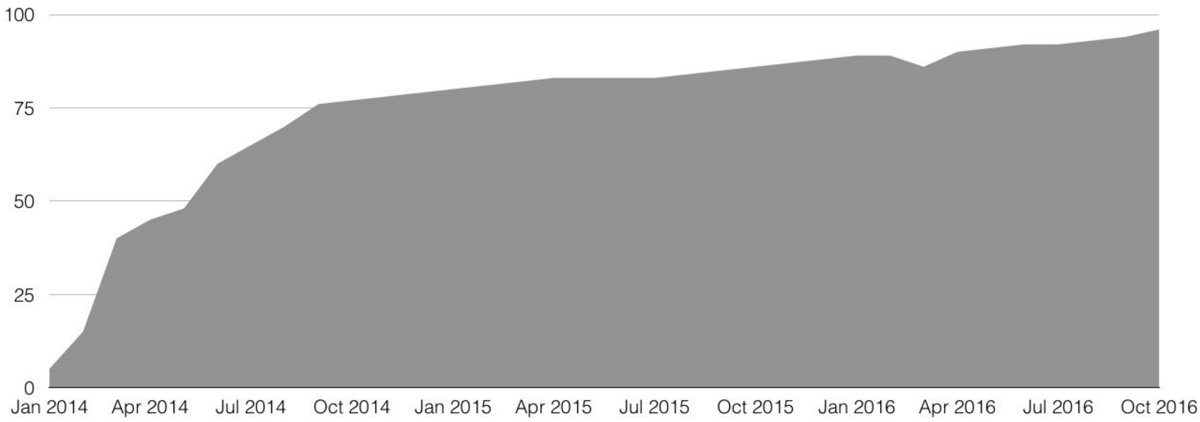

Figure 9: Evolution in time on the number of Docker images dedicated to STEAM education.

7. Conclusions

The simplification of the distribution of computing environments in education is a key element in attracting students to the use of modern and highly complex STEAM learning tools. The virtual containers represent a powerful tool for distribution of OERs. In this article, we have focused on the Docker project and its Hub platform, which are aimed at the easy and open delivery of virtual containers. We have demonstrated through an actual case study how this tool can operate as an OERaaS platform. Throughout the duration of this case study, we perceived and measured a progressive increase in the interest and commitment of students towards the use of the proposed educational tools. As a future line of work, our research group is considering the use of *unikernels* as a method for delivering rich technological and scientific content (including related assignments). Unikernels represent and deeper simplification of the virtual container approach, given that all necessary computing elements (operative system kernel, basic libraries, frameworks, drivers, scientific application, etc.) reside in just one minimal, binary, executable file. The main advantages of unikernels over containers are the improved security, the small footprint and the increase in speed.

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04 Corbí, A, & Burgos, D. (2015). Semi-automated correction tools for mathematics-based exercises in MOOC environments. IJIMAI, 3(3), 89-95. DOI: https://doi.org/10.9781/ijimai.2015.3312

Semi-Automated Correction Tools for Mathematics-Based Exercises in MOOC Environments

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Abstract **— Massive Open Online Courses (MOOCs) allow the participation of hundreds of students who are interested in a wide range of areas. Given the huge attainable enrollment rate, it is almost impossible to suggest complex homework to students and have it carefully corrected and reviewed by a tutor or assistant professor. In this paper, we present a software framework that aims at assisting teachers in MOOCs during correction tasks related to exercises in mathematics and topics with some degree of mathematical content. In this spirit, our proposal might suit not only maths, but also physics and technical subjects. As a test experience, we apply it to 300+ physics homework bulletins from 80+ students. Results show our solution can prove very useful in guiding assistant teachers during correction shifts and is able to mitigate the time devoted to this type of activities.**

Keyword s— assignments, semiautomated correction, maths, physics, framework.

I. Introduction

MOOCs and online campuses nowadays represent an observable reality when it comes to self-education [5]. Together with *OpenCourseWare* platforms, they are definitively impacting our current TEL scene. Even in MOOC environments, students are usually required to carry out some homework. Nevertheless, these homework bulletins are hardly ever supervised by a tutor or a teacher. Quite the opposite, the students themselves are required to self-correct and self-assess their exercises based on correction grids, templates and answer keys. Peer reviewing also takes place, as we will discuss in section II. Fully automated quizzes are also commonly displayed and correction is normally done by the MOOC and/or e-learning platform.

Technical documents from the STEM fields (Science, Technology, Engineering and Mathematics) increase document richness with many sorts of structured objects: mathematical and chemical formulae, diagrams, tables and relations, etc. These additions usually carry essential information that complements the texts the student has to read. At first sight, homework assignments related to these disciplines are good candidates for automated correction processes. However, many teachers are interested not only in the accuracy of the result but also in the correctness of the resolution process, which might turn out to be as important as –or sometimes even more important than– the final outcome itself. Corrections performed by a human (a teacher/assistant) can also add value to the teacher's view on how his/her students learn and progress. The teacher's feedback on a correction sheet always entails a unique opportunity to improve the learner's knowledge and build a more robust awareness on the matter they are currently working on.

Exercises in physics deepen this reviewing philosophy and student-teacher interaction. Keeping an organized and coherent resolution flow is as relevant to the understanding of the underlying physical phenomena as the final output itself.

Besides, in physics, results can belong to a broad spectrum of mathematical natures and entities, ranging from simple and isolated numbers or scalars (e = 2.7182), vectors $(\vec{v} = 3\vec{i} + \vec{j})$, signed quantities (-*k*) and physical units (3.3 kΩ), to name a few that might appear on a basic physics course. In addition, slightly different numbers, notations and/or symbols can represent exactly the same correct result and account for the same reality. For instance, $\left|\vec{B}\right| = 5\,\mathrm{N/Am}$ and $\|\mathbf{B}\| = 4.99\ \mathrm{T}$ can both be labeled as correct and the student should receive a positive score/comment. If such minor discrepancies could be detected, an automated system might be able to send back an explicit recommendation as [26], for example, does. In the same sense, and as a last example, all of the following expressions have the exact same meaning: partial differentiation of function *f* with respect to an independent variable *x*:

$$f_x, f'_x, d_x f, \partial_x f, \nabla_x f, \partial f/\partial x, D_x f$$

Finally, students attending physics courses in online institutions and/or MOOCS come from very different backgrounds and behavior is easily altered over time, as described by [1]. The *human touch* in the reviewing process has always proven to be the key to success, independently of the academic environment: online, formal, higher education, etc.

All this being said, in MOOC environments, the amount of homework bulletins to be reviewed, and the substantial tutoring effort that takes place if every exercise from every

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student is manually revised, can reach disproportionate levels. One of the goals of our project is concerned with assisting teachers during the correction phase. This target is achieved by pre-classifying student bulletins as ready to be *teacher-reviewed* or not. In the latter case, an automated message can be issued to the student, who can re-edit his/her own document before reissuing it to the teacher, for a second time. Of course, this assistant tool would heavily depend on the type of subject and content to be analyzed. In this paper, we focus on assisting teachers in online campuses and MOOCS when reviewing homework related to mathematical content.

II. Overview of the Current Status of MOOCs, Online Education and Student Assignment Management

MOOCs face nowadays a number of challenges: accreditation management, credit recognition, monetization implementation and content and methodology quality assurance. Among them, methodology quality becomes the foundation from which the other four are built. MOOCs are taking over the long-tradition role of Open Educational Resources. Some MOOCs also combine face-to-face strategies with online learning and even merge formal and informal settings. In addition, MOOCs highlight the current need for basic and specific competence acquisition, as a complement to the current courses, very much focused on personal interests and continuing education. They are also turning out the ultimate tool to fight against the lack of access to teaching resources (disadvantaged individuals, regions and countries).

MOOC platforms require support for teachers and tutors, based on their needs, skills, and teaching context. One of these has to do with grading essays and activities. Since MOOCs seeks the enrollment of hundreds or thousands of students, the evaluation becomes a real challenge. At present, some MOOCs rely on peer-assessment and counseling. Peer-to-peer seems significant and useful, so there is, at first sight, no need for a replacement. However, a complementary evaluation resource would be welcome by the educational community.

There are some approaches for automatic or semi-automatic assessment, like ontology networks [23], where the conceptualization of the domain model becomes the cornerstone to categorize and shapes the results properly. Another strategy involves the temporal hiring of additional teachers as *graders*, so they can act as complement to those professors officially assigned to the course. In addition, a detailed comment and assessment on the submitted final activity might not be compulsory, as long as the learner does not require a formal accreditation. This strategy scales down the number of assessments to those learners who actually send a formal/official request. At Universidad Internacional de La Rioja (UNIR), there is a prototype implemented, and under testing phase: A4Learning [30]. This tool is integrated into the Sakai LMS, and retrieves behavioral and academic information from users, so that they can be compared with previous records. Out of this comparison, the tool makes an estimate on every student on how his/her progress will be, based on similar profiles. In doing so, the professor gets a detailed analysis of every learner, 1 by 1, and clustered by similarity. With A4Learning, the teacher can analyze the student current status, anticipate potential academic future, and react in consequence. There is another early prototype, AppMOOC, which will retrieve basic requirements to grade activities, so that, when the professor gets an essay, a previous checking mechanism guarantees that the work fulfills these minimum information and/or structure. These two prototypes, A4Learning and AppMOOC, will be implemented along the next academic year at a larger scale, with the clear objective of supporting teachers on their functions as evaluators and feedback providers, big mid-size and large-size groups of learners, worldwide. The research work described in this paper is in intimate relation with the aforementioned projects.

III. Towards an Automated Helper System for Maths and Technical Student Homework Preliminary Screening

We have designed a special workflow and protocol that automatically analyses student assignments and checks whether they contain coherent mathematical information related to specific fields. This set of tools also takes into account equivalent expressions, exemplified in section I.

In order to check for this coherence, simple –but also highly configurable and easily editable– content-checking rules designed by the teacher are submitted to the correction engine. Then, for every exercise in the student digital notebook, mathematical expressions are semantically compared with the correction template submitted by the teacher. A more detailed review of the practical implementation is tackled below.

Of course, designing such a protocol is no easy task and has required working with state-of-the-art mathematical language-processing techniques and mathematics representation standards, also reviewed below.

A. State-of-the-Art Language Processing in Mathematics

Despite the fact that linguistic analysis of scientific documents is currently seen as an interesting line of research, the current work in the field is still limited. Mathematical literature represents a rather isolated linguistic niche embodying its own challenges. We can identify a significant contrast between this linguistic realm and, for instance, the domain of medical/healthcare research publications that have been studied by many scientific groups in recent years. Two of the current main issues that make mathematical texts challenging to work with are:

- Natural language –expressing complex symbolism– and mathematical representation are usually mixed and hosted in the same document.
- Almost a complete absence of accurately labeled linguistic compilations.

Indeed, state-of-the-art analyses largely try to bypass these problems by restricting their scope to *well-formed* sections of mathematical text and reports, as in the *controlled* approach reviewed below.

The first challenge of the recognition process is the recovery of the so-called *layout tree* [9] of the mathematical expression. The next step involves creating operator trees. These trees are data structures that hold the logical relationships within an equation, as opposed to its horizontal and vertical links. The structure of the mathematical expression can then be made computationally transparent, which is necessary for any practical application involving a mathematics recognition process, like the one we are introducing in this paper. The layout tree also carries a burden of uncertainty in its correctness, which adds to the difficulty of establishing the expression's logical structure.

A holistic and detailed analysis of the processes of extracting and retrieving mathematical expressions and mathematics recognition has already been carried out by [28].

We will now review some lines of enquiry that have recently attracted interest in the research community around math semantics and language processing.

1) Controlled Natural Language

In this approach, a restrained natural language for mathematics is incrementally built [12]. With it, we are then capable of supporting a sufficient subset of natural language elements that would allow an author to write math expressions in a simple way but also be limited enough to allow unambiguous interpretation. Its primary goal is building formalized libraries of mathematical content, focusing on establishing pipelines over a narrow subset of language. Next, a systematic and careful widening takes place. Current projects implementing this view are:

- FMathL [21] described in `mat.univie.ac.at/~neum/FMathL.html`
- MathLang [13]
- MathNat [12]
- Naproche [3], [6], available at `naproche.net`

2) Natural Mathematical Discourse

The opposite 2of the controlled approach is to try to model the original language of real scientific documents [6, 29]. Consistent work in the area has been developed by [27] and [11], as well as by [4]. The corpus used for this work is based on the arXMLiv archiving project of scientific documents [24]. arXMLiv is hosted at the Cornell arXiv (`arxiv.org`) which contains one of the largest collections of scientific literature on the planet. Unfortunately, its texts are in the TeX/LaTeX format, which makes it rather useless for knowledge analysis engines, even though LaTeX can be considered a *de facto* global standard of typesetting. The goal of the project described in [10] is to translate all these documents to a common and agreed XML scheme, which can then serve as a basis for revealing math-related semantics.

B. Computer Representation of Mathematical Content with LaTeXML

LaTeXML [7] uses a context-free grammar to establish the logical structure of a document with mathematical content. It can then be exported to Content MathML and OpenMath [2]. Content MathML (also referred as MathML v3 from the W3C consortium and described in `w3c.org/TR/MathML3`) uses just a few attributes and focuses on the meaning of the expression rather than its graphical layout. The `<apply>` element, for instance, represents the application of a function. Its first child element is the function itself and its operands and/or parameters are the remaining child elements.

Thanks to Content MathML and Open Math, digital libraries can be transformed into a more useful XML representation and be made more compliant with a mathematical knowledge-management approach. Two large-scale examples are arXMLiv and EuDML [22]. Only the first of those examples uses LaTeXML. The main challenges in this conversion step, in the case of arXMLiv, come from the fact that it is poorly knowledge-based, with minor exceptions in the form of clues provided via some infrequent and almost random in-line LaTeX annotations. It is then mandatory to infer additional semantics on all document levels. Fortunately, LaTeXML has proven to be extremely efficient at this task.

Consider the example in Fig. 1. There we have the standard mathematical notation –a simple equation of the form *f(x) = y*–, its Content MathML representation and, finally, the terms we extracted for indexing. Any mathematical construct can be represented in a similar way.

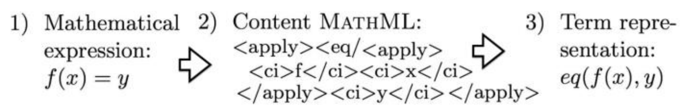

Fig. 1. From plain mathematical expressions to Content MathML.

LaTeXML also defines a conversion process and a set of tools that allow any plain LaTeX document to be translated [7]. LaTeXML can even work in daemon mode, which allows the deployment of server-centric conversion platforms [8] like the well-known *ltxMojo*, available at `latexml.mathweb.org`.

Once a mathematical text has been retyped as LaTeXML, search queries can take place. This topic is discussed in the following section.

C. The MathWebSearch Project

MathWebSearch [17], developed at the KWARC group (`kwarc.info`), processes XML-based content mathematics. Currently, the system supports MathML, OpenMath and LaTeXML (and any other document type that has been appropriately converted). It operates by computing an index term for each of the mathematical elements of a given XML document. Queries on this index are also expressed in a XML schema, reviewed below.

The MathWebSearch engine is used in our framework to analyse student-submitted mathematics assignments. On one hand, each student document is converted to Content MathML and indexed. On the other hand, a teacher's set of well-organized binary tests is coded as a variant of Content MathML –MathMLQ–. If all tests deliver a positive result, the assignment is flaged as *to be reviewed* by the teacher.

Finally, as MathWebSearch operates with terms, heuristics and semantics, it can understand a wider range of similar mathematical expressions. This ensures that the issues described in the introduction will hardly ever take place. Our engine is very tolerant to small variations of the same mathematical expression. In other words, we are able to understand that $\sqrt{x}$ and $x^{1/2}$ have the same mathematical meaning and discern that 4.5 kJ is different from 4.5 Kj (the Joule energy unit in physics must always be capitalized, while the *kilo*- multiple should remain in lowercase). In this manner, the student is free to express him/herself with mathematical and syntactical independence. At the same time, the teacher is also able to demand exquisite precision, if so desired.

Algorithm 1 Example of a MATHMLQ query.

```
<mws:query
xmlns:mws="http://www.mathweb.org/mws/ns"
xmlns:m="http://www.w3.org/1998/Math/MathML"
limitmin="0" answsize="30" totalreq="yes"
output="json">
 <mws:expr>
  <m:apply>
   <m:csymbol cd="ambiguous">
    superscript
   </m:csymbol>
   <mws:qvar>q</mws:qvar>
   <m:cn type="integer">2</m:cn>
  </m:apply>
 </mws:expr>
</mws:query>
```

D. The MathWebSearch Query Language

MathWebSearch makes use of a content-oriented query language called MathMLQ. It is XML-based rather than being a genuine query language by itself. More detailed information on the syntax can be found in [18]. An example of application can be read in algorithm 1. The query described there is able to identify both the square of a function or a variable (x^2 or $[f(x)]^2$).

Apart from describing queries using the MathMLQ syntax just introduced, more simple instances can be expressed using the plain LaTeX math toolbox and syntax. This code can be then converted to MathMLQ. This conversion takes place with the tool `latexmlc`, presented in [16], which can also establish relations between LaTeX and a variety of office documents (WML from MS Word, ODT from Open Office, etc.) In this simplified LaTeX syntax, variables are labeled with the question mark symbol (`?`). For instance, the following expression:

```
latexmlc --address = latexml.mathweb.org/
convert --preload=mws.sty --whatsin=math –
whatsout = math --cmml 'literal:\sqrt{?c}^2'
```

Would produce the same XML output as the one displayed in algorithm 1.

E. Summary of Implementation

We now summarize the skeleton of our software implementation, which is graphically represented in Fig. 2. Students submit their homework in a variety of formats (Microsoft Office Word, OpenOffice, OpenDocument, Portable Document Format, LaTeX and LyX, etc.). Disciplines related to theoretical fields, such as mathematics, physics and computer science, almost exclusively use LaTeX. On the other hand, more applied fields of research, like life sciences, chemistry and engineering, usually typeset on the so-called *office suites*. Moreover, depending on the discipline, each institution has its own focus and teachers expect homework to be edited using a specific software instance.

For this reason, our system tries to, in the first phase, convert each document type to a unified LaTeX representation. This is not always possible due to technical reasons (converter segmentation fault, faulty output, etc.). Several third party tools (both open source and commercial) exist and operate with greater or lesser degrees of success. Writer to LaTeX (`writer2latex.sf.net`) and Word to LaTeX (`wordtolatex.com`) are some examples. LyX has the advantage of being able to perform a clean LaTeX export [14].

A better tool to translate between LaTeX and traditional office formats is the `latexmlc` introduced above, which has been developed in recent years by the KWARC group. Finally, the tool that has recently been attracting significant focus in the computer language research community is Pandoc, described in [20] and [19]. Pandoc can convert documents in markdown, HTML, LaTeX, MediaWiki markup, TWiki markup, Microsoft Word docx and EPUB (among others) to other formats, such as DocBook, Adobe InDesign, LaTeX, PDF and many others, through the application of external drivers written in the Lua computer language.

Anecdotally, recent efforts are even trying to directly translate mathematical handwritten expressions to LaTeX. A nice summary can be found in [25] and an example of such an application can be tested online thanks to Detexify [15], available at `detexify.kirelabs.org`.

As a next step, the LaTeX source is parsed and transformed to LaTeXML, which already contains the necessary knowledge companion information to be harvested by MathWebSearch. On the other side, the teacher pulls a list with *N* wildcard expressions to the classification platform. Finally, an instance of MathWebSearch performs these *N* searches on each homework document and screens which of them provides some degree of equivalence. Our platform is responsible for filtering teachers' templates and student homework in a coordinated fashion.

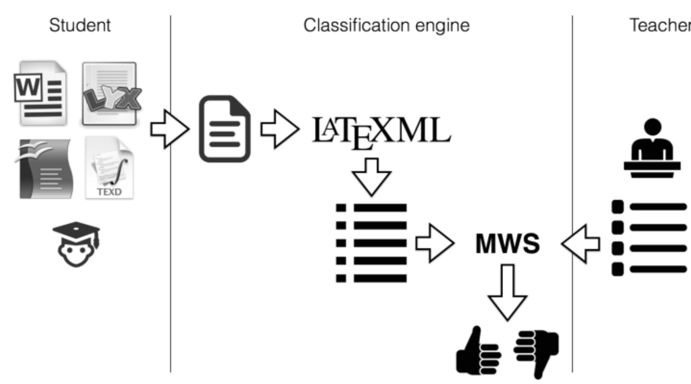

Fig. 2. Overview of our platform. Students submit their homework and a conversion process to LaTeXML takes place. On the other side, teachers feed the system templates with mandatory mathematical expressions.

IV. Practical Experience with Physics Students' Homework Bulletins

As a proof of concept, we have carried out a practical experience with 300+ homework assignments from 50+ students enrolled in a basic Physics course in the degree of Computer Science at the School of Engineering at Universidad International de La Rioja (UNIR, `ingenieria.unir.net`).

We have configured our classification engine based on MathWebSearch together with teachers' templates in order to pre-distribute assignments, before they are finally delivered to the teacher/assistant for an in-depth (and manual) conventional correction phase.

A. *Experimental Setup*

The online campus platform deployed at UNIR is an instance of the Apereo Sakai CLE. Students submit their homework to this platform digitally, using the assignments tool. Usually, documents are formatted using Microsoft Word®, WML or OpenOffice ODT, though some students have used LaTeX or LyX for their submissions. A very small percentage of students submitted bulletins in other office suite formats, such as Apple Pages® or Microsoft PowerPoint®, which were easily translatable to WML or ODT.

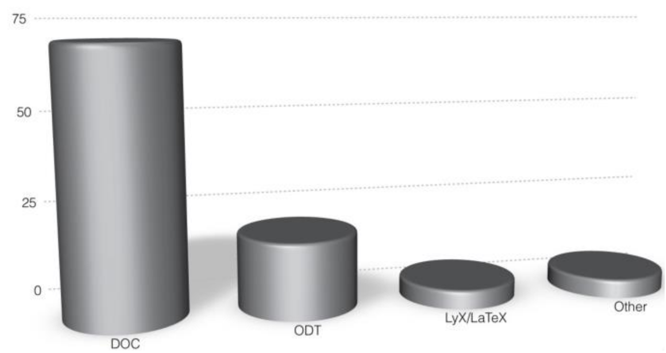

Fig. 3. Percentage of document types used by students.

The rate of conversion success to LaTeX and LaTeXML from this range of commonly available office suites is summarized in Table I. After running each of the conversion tools, further refinement can take place if the source office documents are pre- or post-manually processed.

TABLE I.
CONVERSION LEVEL OF SUCCESS FROM OFFICE DOCUMENTS SUBMITTED BY STUDENTS TO LATEX AND LATEXML

Source *office* format	% of success	after manual edition
WML (recent MS Word ver.)	75 %	90 %
.doc (legacy MS Word ver.)	70%	90%
ODT (OpenOffice)	80 %	95 %
Other office suites	50 %	70 %
LyX	100 %	100 %

The conversion tool most used in our setup, given its success ratio, was Pandoc, as described above. Fig. 4 shows a real example of the result of the conversion of a MS Word-submitted homework file to its LaTeX twin. PDF output (from LaTeX) is also shown as a proof of the fidelity of the file-translation process.

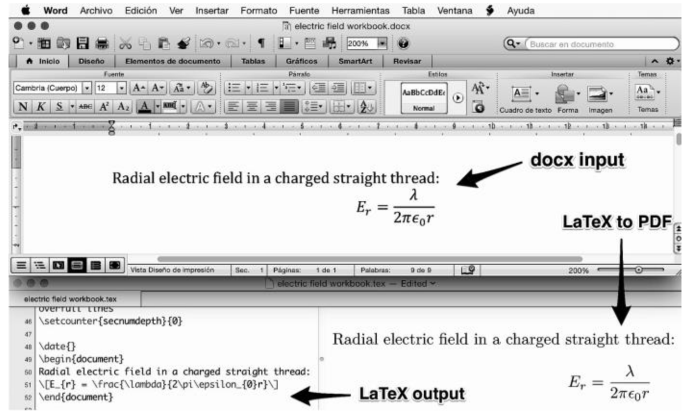

Fig. 4. Example of the conversion process performed with Pandoc.

Fig. 5 shows the ratio of success in the process of translating to LaTeX, of some of the file-conversion tools that are mentioned above and were used in this project.

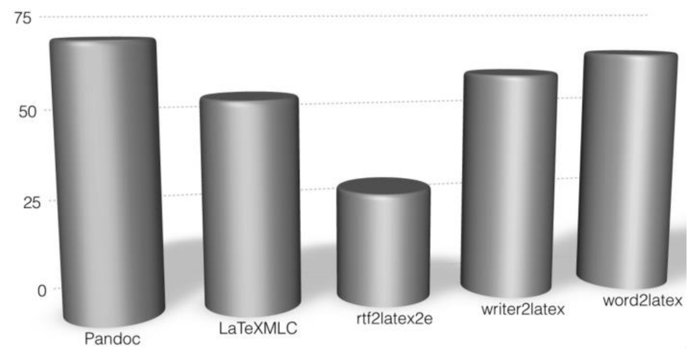

Fig. 5. Rates of success for some of the converter tools (to LaTeX).

B. *Methodology*

The physics course mentioned above, as it is part of the Computer Engineering degree's curriculum, is mainly based on areas related to electromagnetism. Most required homework exercises should include at least some of the mathematical expressions appearing in table II –depending on the specific topic being studied– in order to be considered suitable for further analysis by the teacher and manually assigned a score. This mathematical content has been agreed with the academic staff. The corresponding set of simplified queries (introduced above) has also been defined and has been made available to the system.

In Table III, there is another example of how our implementation can also handle more complex formulae, for instance those related to quantum theory and thermodynamics, which could prove useful in a Physics MSc.

Our solution has been tested offline (no real feedback has been sent to students or teachers) with pre-existing homework bulletins from an already concluded semester. A batch process, similar to that described in Fig. 2, has been implemented and executed.

Besides taking into account specific mathematical content related to the topic *electromagnetism*, we have also established a special and separate realm devoted only to pure mathematical transversal correctness. This means that our solution can separately test for the exactitude of common mathematical statements, like the ones listed in Table IV

TABLE II.
SOME MATHEMATICAL EXPRESSIONS RELATED TO THE TOPIC ELECTROMAGNETISM TO BE TESTED.

Electric field by an infinite plane (perpendicular)	$E_x = 2\pi k\sigma$
Electrostatic force (vector form)	$\vec{F} = k\frac{\lvert q_1 q_2\rvert}{r^2}\hat{r}$
Charge linear density	$dq{=}\lambda dx$
Capacitor equation	$C = \epsilon\frac{S}{d}$
Electric field by a charged ring	$E_x = \frac{kQx}{(x^2+R^2)^{\frac{3}{2}}}$
Electric field by a charged circle	$E_x = 2\pi k\sigma\left(1 - \frac{x}{\sqrt{x^2+R^2}}\right)$
Electric field by a charged thread	$E_y = k\lambda\frac{L}{y\sqrt{\frac{1}{4}L^2+y^2}}$
Electric potential by a set of isolated charges	$V = \sum_i \frac{kq_i}{r_{i0}}$
Relation between potential and electric field	$dV(r) = -\mathbf{E}(r)\cdot dr$
Electric field outside a charged a spherical cavity (radial component)	$E_r = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^2}$

TABLE III.
EXTENDED PHYSICS-RELATED EXAMPLES.

Heat diffusion law	$\frac{dQ_x}{dt} = -kA\frac{\partial T}{\partial x}$
Entropy	$S = \sum_i p_i \ln p_i$
Tunnel effect	$T = \frac{e^{-2\int_{x_1}^{x_2} dx\sqrt{\frac{2m}{\hbar^2}(V(x)-E)}}}{\left(1+\frac{1}{4}e^{-2\int_{x_1}^{x_2} dx\sqrt{\frac{2m}{\hbar^2}(V(x)-E)}}\right)^2}$
Momentum by a photon	$p_f = \frac{h\nu}{c}$
Gyro dynamics	$\omega_p = \frac{MgD}{\mathbf{I}_s\omega_s}$
Charged particle in accelerator	$\mathbf{F} = q\left(\mathbf{E} + \mathbf{v}\times\mathbf{B}\right)$

TABLE IV.
TRANSVERSAL MATH EXPRESSIONS.

Two-component vector definition	$\vec{V} = (V_x, V_y)$
Vector sum	$\vec{V_1} + \vec{V_2} = (V_{1_x} + V_{2_x}, V_{1_y} + V_{2_y})$
Vector length	$\lvert\vec{V}\rvert = \sqrt{V_x^2 + V_y^2}$
Vector dot-product	$\vec{V_1}\cdot\vec{V_2} = V_{1_x}\cdot V_{2_x} + V_{1_y}\cdot V_{2_y}$
Scalar-vector product	$N\cdot\vec{V} = N\cdot(V_x, V_y) = (N\cdot V_x, N\cdot V_y)$

With this external test, our system allows teachers to filter bulletins based only on pure mathematical fidelity, ignoring topic-specific inaccuracies or errors

V. RESULTS AND DISCUSSION

After running a batch process with the 300+ homework bulletins and specific rule sets, results show that around 63% of the documents that could be safely converted to LaTeX satisfied the formulae template requirements (both for the topic electromagnetism and for the transversal one related to mathematics). Of these homework assignments, 78% were given a positive score by the teacher at the moment of the reviewing process. The remaining 22% of documents that were classified as incorrect, though encapsulating the required mathematical expressions, contained inaccuracies and/or were poorly developed by the student.

VI. CONCLUSIONS

Our simplified and relatively quick set-up proves that semi-automated correction processes may represent an acceptable compromise between the pure self-assessment approach –typically present in MOOCS and courses with a large enrolment rate– and the more conventional scenario in which the teacher manually reviews assignments for each student.

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Institutional mapping of open educational practices beyond use of Open Educational Resources

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ABSTRACT
Many initiatives exist to increase the adoption of open educational practices (OEP) within universities, but few initiatives start by exploring the capacity of educators to adopt open approaches. This paper addresses this challenge, suggesting that in order to build OEP capacity, universities should build on the existing skills of local champions who are familiar with open approaches. The paper builds on the *Open Educators' Factory* methodology to map the capacities of university teachers across four areas: open design, open content, open teaching and open assessment and presents the results of its application to a case study within an Italian university. The pilot demonstrates that by using this approach, it is possible to map universities' existing OEP and connect them with the capability of local educators. This enables university managers to build on the expertise of open education practitioners to raise the overall capacity of their staff to adopt open approaches.

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The problem of mapping the capacity to work with open education approaches within universities

Open educational practices (OEP) are "practices which support the (re)use and production of Open Educational Resources through institutional policies, promote innovative pedagogical models, and respect and empower learners as co-producers on their lifelong learning paths" (Ehlers, 2011, p. 4). These practices are generally recognised as potential enablers of quality, access and effectiveness within universities (Weller, 2014). Governments are stressing the importance of openness in education worldwide, as demonstrated by a recent series of international events on the topic, including the 2nd UNESCO International Forum on ICT and Education 2030 held in China (https://es.unesco.org/node/273232), the 2nd World Congress on OER in Slovenia (http://www.oercongress.org/) and the XXVII ICDE World Conference on Online Learning in Canada (http://onlinelearning2017.ca/en/). Concurrently, an increasing number of universities are striving to mainstream the adoption of open approaches across their educational programmes (Allen & Seaman, 2017; Young, Daly, & Stone, 2017). However, those universities that are investing time and resources in open

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education are typically focused on the creation of open educational resources (OER) or the development of massive open online courses (Agbu, Mulder, de Vries, Tenebe, & Caine, 2016; Grodecka & Śliwowski, 2014). Universities that support openness through formal open education policies are still limited (Souto-Otero et al., 2016). In addition, few higher education institutions are focusing on one of the main enablers for mainstreaming the adoption of OEP, that, is the development of educators' awareness, motivation and capacity to work in the open education space (Nascimbeni, 2015).

Some national initiatives exist that aim to build OEP capacities among university teachers, such as the OEPS Programme in Scotland and the OER Info initiative in Germany; these usually focus on awareness raising and practical training (IMulder, 2013; Namorato Dos Santos et al., 2017). While these top-down programmes are useful, we believe that they should be complemented by bottom-up capacity building initiatives, planned and designed within universities, which aim to transform teaching staff into open educators (Nascimbeni & Burgos, 2016). In order to do this, university leaders first need to understand the capacity of their educators to work with open approaches across the main areas of their academic practice, and second, they need to identify the best open practitioners within their institutions and use their experience to help build capacity across the university. By having a picture of the OEP capabilities of staff across the whole university, academic leaders can understand who is in need of training and support, and how to provide this capacity within the institution.

The problem is that the OEP capacity of the teaching population of a university (faculty members) is difficult to quantify, because openness is a social construct that evolves over time, where educators both shape and are shaped by their open practices (Veletsianos, 2015), and because it is connected with educators' individual attitudes and cultural behaviours (Cronin, 2017). Consequently, while there may be general consensus among policymakers, researchers, academic leaders, teachers and managers about the potential benefits of open education, they may not have an overview of the level of OEP adoption among individual educators (Veletsianos, 2015).

Academic literature on open education is abundant in conceptualisations, definitions and frameworks, especially as far as OER are concerned (Paskevicius, 2017), and much has been written about the potential benefits of OEP and the barriers to adopting open approaches (Weller, de Los Arcos, Farrow, Pitt, & McAndrew, 2015). Still, only a few studies have managed to provide empirical data to demonstrate what proportion of teaching staff at a given university have actually adopted open practices (Veletsianos, 2015). Jhangiani, Pitt, Hendricks, Key, and Lalon (2016) describe the patterns emerging from a survey of all British Columbia universities on the use of open content, stressing the importance of educators' personal values and noting that faculty with more open personalities tend to be more likely to use OER. Pete, Mulder, and Dutra Oliveira Neto (2017) shed some light on the perceived value of OER by students and faculty in four Kenyan universities, concluding that despite the low awareness of OER and open licencing, some capacity for openness does exist in the universities studied. Hilton, Fischer, Wiley, and Williams (2017) analysed the impact of OER on students' performance in a United States university and suggested that the use of OER has a positive impact on students' performance in both face-to-face and online contexts. Cox and Trotter (2017) analysed OER adoption by lecturers in three South African universities, connecting this to the institutions' capacity for open education and stressing the importance of institutional culture to leverage OER adoption. All these studies provide important insights on how to increase the adoption of OER within universities, but they are limited to some degree as they do not extend their analysis beyond open content. A number of authors have called for research on open education to shift its focus away from open content and towards a more holistic understanding of openness that can demonstrate the impact of open practices in supporting innovative education (Ferguson et al., 2017; Kimmons, 2016; Weller et al., 2015).

Through our literature review, we identified two studies that have gone beyond the adoption of OER and attempted to map the capacity for OEP within specific universities. Analysing the adoption of open practices at Tall Mountain University (pseudonym), Veletsianos (2015) found that open practices were not mainstreamed within the institution; he discussed this finding in relation to enabling factors and collaborative practices, concluding that OEP adoption is based on individual motivation rather than institutional drivers and that teachers' attitudes to sharing are a key enabling factor for OEP adoption. By analysing the situation at the National University of Ireland, Cronin (2017) notes a relationship between the use of OEP and the priority given to learners being actively involved in the learning process, in the sense that all participants in her study who use OEP value social learning. Cronin also explores the multidimensionality of the decision-making process with regard to being open or not, concluding that "a complex picture emerges of a broad range of educators: some open (in one or more ways), some not; some moving towards openness (in one or more ways), some not; but all thinking deeply about their digital and pedagogical decisions" (p. 7). These two studies shed important and much needed light on the way educators work in the open and on the dynamics connected with a rounded vision of OEP within universities.

This paper aims to contribute to filling the gap in the current literature, by providing a case study of an exercise to map a university's capacity to adopt OEP. We build on a comprehensive approach that stems from individual educators' attitudes to openness and their willingness to adopt open practices, thus providing university leaders with the potential to build on the expertise of leading open practitioners to raise the overall capacity of their teaching staff.

The Open Educators Factory framework: mapping open education capacity in an integrated way

The present research is grounded on the Open Educators' Factory (OEF) framework, an approach that aims to facilitate an understanding of the different interrelated dimensions of university educators' capacity to adopt OEP. The framework was designed in 2016 following an extensive literature review that identified definitions, conceptual frameworks and guidelines aimed at improving university teachers' ability to adopt open education approaches, and on subsequent discussions with a number of experts in the domain of open education (Nascimbeni & Burgos, 2016). As an open research project, the framework is constantly under development, with improvements based on feedback received by peer researchers and the validation of the tool by users. The framework identifies four areas of educators' practice that can be influenced by open approaches – *design, content, teaching* and *assessment* – and grades the ability of educators to adopt open approaches in these areas (Table 1). The intention is to communicate that being an open educator means more than producing and using OER, and that OEP should not be understood as a binary concept, where an educator is either open or not, but rather as a continuum along which educators may position themselves in each of the four areas or practice. It should be noted that the framework does not accommodate open research practices, such as open access publication or open peer review, as the aim of the study is limited to academics' teaching practice.

Table 1. The OEF framework.

	Areas of activity			
	Design	Content	Teaching	Assessment
Educators categories	Open designer	Expert OER user	Open teacher	Open evaluator
	Collaborative designer	Familiar with OER	Engaging teacher	Innovative evaluator
	Individual designer	New to OER	Traditional teacher	Traditional evaluator

Starting with the first area of practice, *design*, three types of educators have been identified: *individual designer*, who designs their courses individually based on prior knowledge and experience, *collaborative designer*, who co-designs their courses with close colleagues either from their own university or from the broader subject domain, and *open designer*, who shares their course ideas and curriculum openly through the web, for colleagues and students to engage with and enrich the course design.

In terms of *content*, the framework identifies the *new to OER* educator, who might use digital resources found on the web to enhance teaching and learning – usually without considering whether they are openly licensed, and who does not release their content under open licence. The *familiar with OER* user produces and shares their resources under open licences and reuses resources recommended by trusted colleagues, and the *OER expert* re-shares resources they have reused through social media and OER repositories, searches for OER through social media and repositories and shares resources beyond the classroom.

With regard to *teaching*, the *traditional teacher* adopts conventional lecture-based pedagogy, the *engaging teacher* opts for collaborative seminars-like strategies, either offline or through restricted online spaces, and uses innovative teaching methods such as the flipped classroom approach. On the top of the column, the *open teacher* implements methods that foster students' co-creation of knowledge, nurtures students to contribute to public knowledge resources and shares examples of teaching practice in open subject-related communities. Importantly, this classification is not related to the use of ICT per se. For example, *traditional teachers* may extensively use the university learning management system to share resources; however, if these resources are shared only with the students on their courses, they are not necessarily adopting open approaches, despite their intensive use of technology.

In terms of *assessment*, the *traditional evaluator* assesses students through conventional methods such as tests or classwork; the *innovative evaluator* experiments with new assessment methods adding some elements of collaboration, and finally the *open evaluator* implements practices such as open peer assessment or open e-portfolios, engaging communities of practice to assess students' work.

By covering diverse levels of OEP awareness and adoption in different areas of practice, the framework shows that openness is not a binary concept where educators are either open or not, but is instead a multidimensional continuum where open can mean different things to different educators in different contexts. Indeed, the results of our case study demonstrate that teachers are generally more open in some aspects of their work than in others, depending on contextual factors such as national legislation and institutions' receptiveness to open approaches, but also on their personal approach to balancing attitudes to privacy and sharing (Cronin, 2017).

Methodology

The main aim of this research was to map the overall capacity of a university to adopt open education approaches, starting from the level of OEP adopted by individual educators within the institution and integrating those in an overall institutional view. In addition, the secondary aims were to demonstrate that this mapping can provide university leaders with important information that they can use to increase the adoption of OEP across their institutions, and to validate the OEF framework and inquiry tools in a real-life case study.

We investigated the adoption of OEP within an institution through an online multiple-choice questionnaire. The questionnaire (see the Appendix) was delivered in English through an online platform and aimed at investigating the existing level of OEP adoption along the four dimensions of the OEF framework presented above. The questionnaire was first validated in terms of usability and relevance within the research group, and then in collaboration with senior managers of the university being studied. Nine multiple-choice answers were designed to connect each response to one level of the OEF framework, enabling respondents to be placed automatically at the appropriate level. Finally, in order to allow some qualitative validation of results, responses that diverged from expected patterns were checked with participants to ensure that they understood the questions correctly; in most cases this resulted in appropriate corrections being made.

It should be noted that the online questionnaire did not refer to concepts such as OER or OEP, in order to avoid being perceived as an exercise for e-learning or open licensing specialists. Once respondents had completed the questionnaire, they were provided with real-time feedback, illustrated in Figure 1, showing their position in each column of the framework, along with a set of guidelines tailored to their experience and capacity, in the form of links, readings and courses. This feedback mechanism has been extremely useful in helping to motivate respondents to participate in the survey.

This case study is based on analysis undertaken at the Polytechnic University of Turin (Politecnico di Torino, or PoliTo), a public technical university in Turin, Italy. PoliTo is Italy's oldest technical university, offering courses in the fields of engineering, architecture and

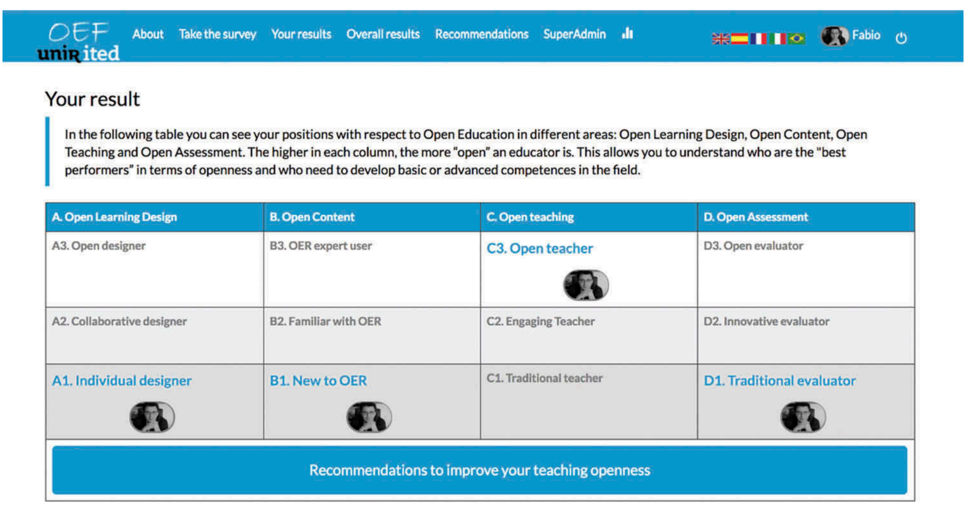

Figure 1. Example of the feedback received by teachers once they fill the online questionnaire.

industrial design. It enrols 35,000 students (academic year 2016/2017) with an academic catalogue of 22 bachelor programmes, 29 Master of Science programmes and 16 PhD programmes. PoliTo currently (in 2018) has 890 teaching faculty, 307 researchers, 371 associate professors and 212 full professors.

This institution was chosen for the case study as it is typical of many higher education institutions, in that it does not have an internal policy mandating the use of OEP, although it does support a number of open education initiatives, including the release of a large number of freely available online resources. Although policy guidelines on the implementation of OER do not exist within the Italian higher education sector (Tammaro, Ciancio, De Rosa, Pantò, & Nascimbeni, 2017), PoliTo has engaged with OER and educational technology since the late 1990s, when it began recording lessons and disseminating them using different platforms. This university is a typical example of an institution where educators are free to adopt open practices and produce open-licenced resources, despite the absence of an official policy on OER and open education.

A sample of 181 teachers from PoliTo completed the online questionnaire: 19% of respondents were full professors, 49% associate professors and 31% researchers with some time dedicated to teaching. In terms of academic discipline, 63% were from engineering, 19% from physics, sciences and mathematics, 10% from architecture, 8% from other fields, including economics and business, social sciences and education. In terms of age, the majority (60%) were between 35 and 50 years, 6% were between 25 and 35 years, while the remaining 34% were over 50. Of the respondents, 32% were female and 68% male. This sample of respondents is broadly representative, as it is proportional to the overall teaching staff population of the university as a whole.

The data has been analysed by cross-referencing the results with respondents' gender, age, role within the university, and use of social media for personal and professional purposes. The preliminary results have also been compared with the studies discussed earlier in the paper, seeking confirmation that some forms of OEP are more common than others (Veletsianos, 2015), that resources are often shared without the use of appropriate open licenses (Veletsianos, 2015), and that a correlation exists between respondents' adoption of OEP and their use of social media for personal and professional purposes (Cronin, 2017).

Three limitations of this study must be highlighted. Firstly, the results are based on the responses of 181 out of a total of 890 teaching staff at PoliTo. Even if the respondents are broadly representative of the teaching population as a whole, it must be remembered that the data represents only a proportion of the teaching staff. Secondly, participation in the survey was voluntary, so teachers who were more motivated and familiar with the use of ICT were more likely to respond. Thirdly, given the complexity of quantifying openness, we are aware that quantitative self-reported data may not be sufficient to draw sound conclusions about educators' attitudes to openness and adoption of open approaches (Cronin, 2017). Despite these limitations, the findings of this structured survey provide a useful indication of the overall capacity of individuals within the university to adopt OEP and it therefore represents a good starting point to build capacity from within the institution.

Results: an overall picture of OEP within the university

The online questionnaire has generated abundant data: this paper presents only a fraction of the results, focusing primarily on the overall level of openness within the university, discussing aspects of particular interest, and looking for emerging patterns between educators' characteristics and level of openness.

In the first instance, the collected data presents a comprehensive picture of educators' capability to adopt OEP and of the adoption gaps within the institution, as illustrated in Table 2.

Table 2. Overall positioning of PoliTo staff with respect to OEP.

	Areas of activity			
	Design	Content	Teaching	Assessment
Educators' categories	Open designer 7 (4%)	Expert OER user 23 (13%)	Open teacher 9 (5%)	Open evaluator 13 (7%)
	Collaborative designer 118 (65%)	Familiar with OER 98 (54%)	Engaging teacher 81 (45%)	Innovative evaluator 9 (5%)
	Individual designer 56 (31%)	New to OER 60 (33%)	Traditional teacher 91 (50%)	Traditional evaluator 159 (88%)

The results demonstrate that a degree of capacity is present in all four areas, and that in all areas except *assessment*, close to 50% of educators fall into the middle tier, meaning that collaboration and experimentation are strongly embedded in the institution's educational practices. As might be expected, *content* is the area where open practices are most widely adopted among educators at PoliTo, with more than 65% of respondents being familiar or proficient with the use of OER, while *assessment* is the area where traditional methods are still the norm for the majority of respondents.

In the following sections, we will explore in detail how the teaching population is performing with respect to openness in the four areas of the OEF framework. By cross-referencing the survey results with the profiles of the respondents, we will try to connect the use of open approaches with key characteristics of teaching staff and to provide grounded indications of how to improve the level of openness of all educators across the institution.

Open learning design

As shown in Figure 2, most respondents (65%) design their courses in collaboration with colleagues and peers, either from the same university or from other institutions, while 31% of participants stated that they plan and design their courses on their own, based on previous knowledge and experience. Interestingly, 7 teachers, corresponding to 4% of the total, stated that they design their teaching activities in an open and collaborative way, by sharing ideas and curriculum openly through social media with colleagues and students before their courses start, in order to get ideas, feedback, and criticism. Opening the way educators think about and design their courses, is not only "a creative way to breathe new life and fresh ideas into course design" (Cochrane & Antonczak, 2015, p. 3), but also a fundamental component of open education culture and practice, as it reveals the existence of an open attitude from the very beginning of the teaching cycle (Conole, 2013). Knowing the identity of these seven open educators would be beneficial to university management as they could inspire and encourage other colleagues; however, it is important to consider their privacy and identity before starting any capacity building activities that might require their input.

By cross-referencing these results with key characteristics of respondents, no correlation was seen between the tendency to design courses in the open with age, gender or academic discipline. However, it seems that the individual's role within the institution does influence the use of open design practices: full professors and, to a limited extent, associated professors tend to be more active in opening up their design processes in comparison to researchers. One explanation for this might be that implementing open design practices takes time and confidence, and researchers, especially in their early careers, might not be in the position to experiment with these innovations.

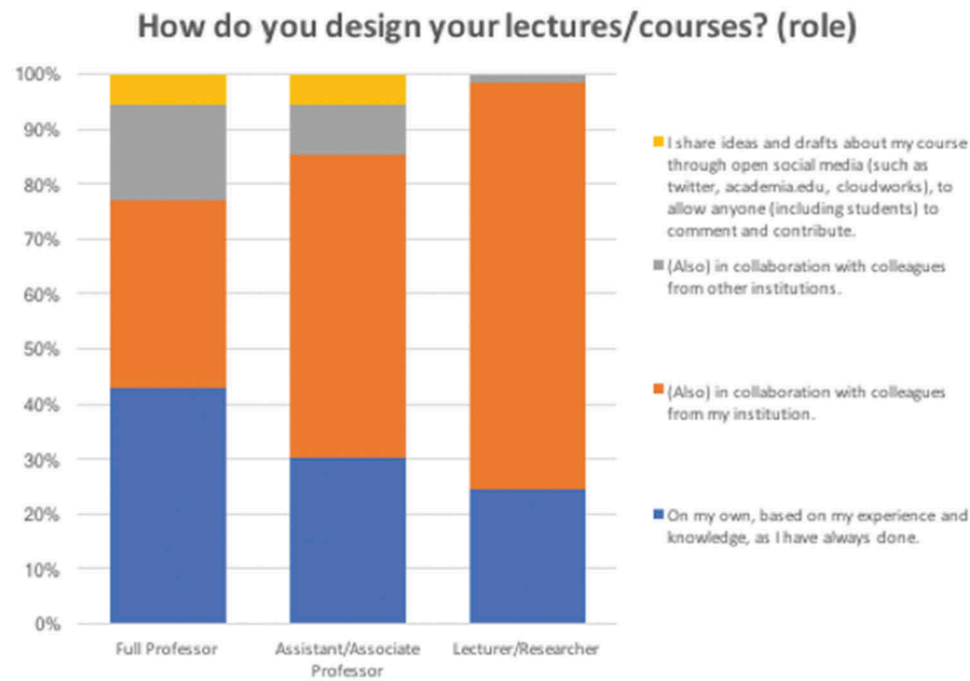

Figure 2. Relationship between open design and use of social media for teaching.

Open content

When it comes to the use of open teaching resources, the evidence from PoliTo is rather encouraging: although 33% of participants stated that they were not aware of the benefits of using openly licenced materials, the majority of respondents, 54%, were aware of and already using OER, applied open licenses to their materials, used resources recommended by colleagues, and/or shared resources among their peers. Note that we say "and/or" because in order to qualify as *familiar with OER*, respondents had to respond positively to at least one question regarding the use of open content. This distinction is important because, in contrast to *design*, where a single question was put to educators regarding the way they designed their courses, in the case of *content* a number of questions was posed, so the position of each educator depends on more than one variable. This means, for example, that teachers who use content created by others but do not apply open licenses to their resources will fall in this category, as well as teachers who use open licences but do not reuse existing materials. Interestingly, if we look at *OER expert* users, we find 23 respondents (13%) who are confident and familiar with open teaching resources, meaning that they search for, adapt, reuse and share resources not only in collaboration with colleagues they know, but openly through OER repositories and social media. Knowing that a pool of experienced OER users exists within the university can represent an important starting point to further spread the "openness virus" (Weller, 2014, p. 200) across the institution and to kick-start a process of institutional implementation of OER production and use.

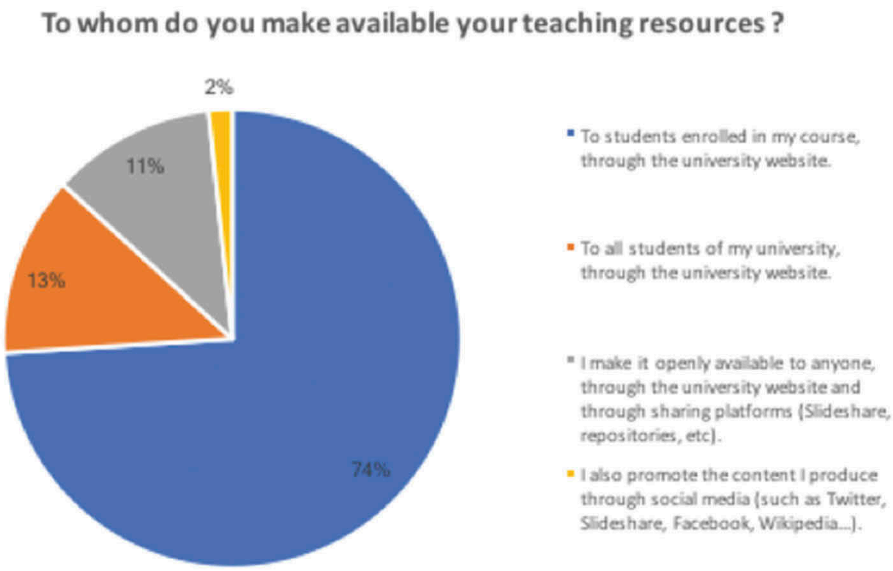

Figure 3. Level of openness in resource dissemination.

An interesting indicator of openness is the degree to which teachers share their own teaching resources. As we can see from Figure 3, a large majority of teachers do not disseminate their resources beyond the university (74% only make their content available to students enrolled in their courses and 13% to all students enrolled in the university), while just 13% of respondents make their materials openly available to anyone, and of these, 2% disseminate their resources through social media.

Another indication of open practice is the degree to which educators use resources produced by others (Figure 4).

Of the respondents, 43% do not use resources produced by others, while 57% do. Furthermore, 16% of those respondents who do use resources produced by others indicated that they only use openly licensed resources, demonstrating both awareness of licensing issues and the capacity to understand and use resources with different open licenses.

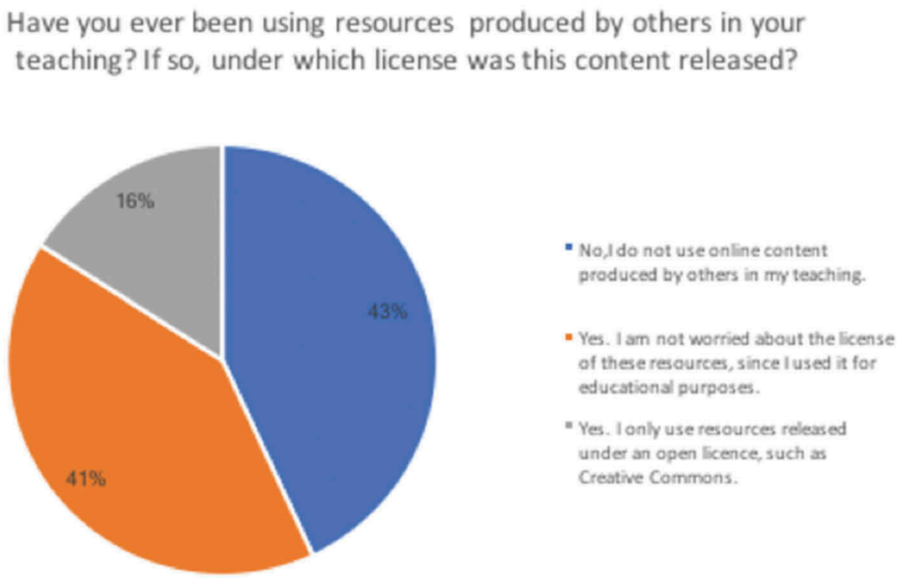

Figure 4. Level of reuse of resources.

Open teaching

During the investigation of *open teaching* practices, respondents were asked about their most common modality of teaching: 86% used traditional teaching methods, 13% engaged students through offline and online collaborative methods, while only 1% of respondents tried to foster co-creation of knowledge by students, working with wikis, blogs, and communities of practice (Figure 5).

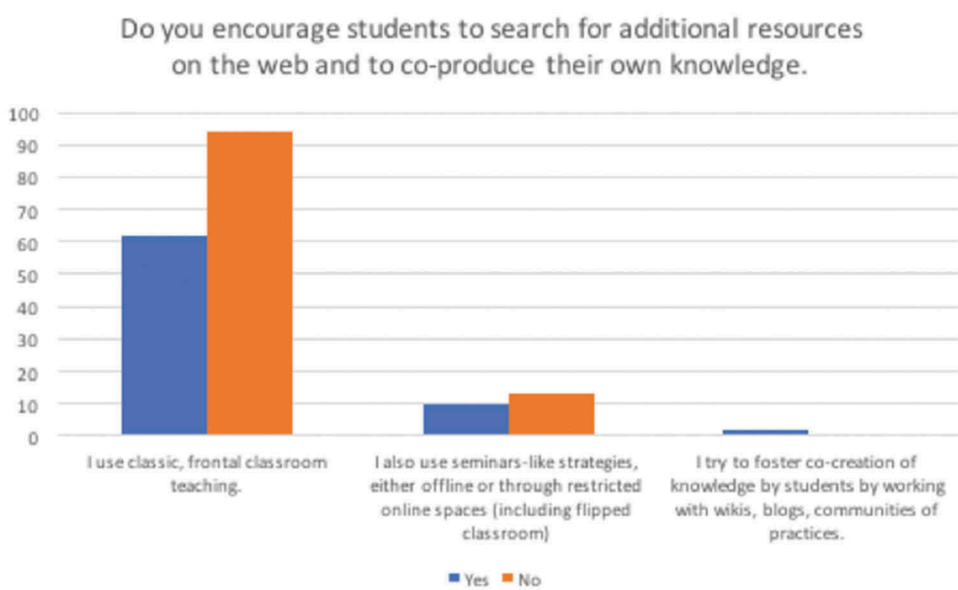

Figure 5. Open practices and teaching styles.

This metric is important to understand how OEP relates to different teaching styles. When asked whether they encouraged students to search for resources on the web and to co-produce their own knowledge, a number of respondents from all teaching styles replied positively. Consequently, the percentage of *open teachers* within the university is higher than those who declared that they use innovative teaching methods. If we look back at Table 2, we can see that 50% of respondents are identified as *traditional teachers*, 45% as *engaging teachers* and 5% as *open teachers*. If we look in detail at the responses of this last group, we see that in addition to encouraging students to co-create content and to access freely available content online, this group (comprising nine teachers) also shared their teaching practice in open communities. These nine educators can potentially act as mentors to both *engaging* and *traditional teachers*, as they are familiar with sharing their teaching strategies and methodologies openly. Furthermore, being open practitioners, they should be willing, in principle, to share their experiences with colleagues.

Open assessment

As might be expected, *assessment* is the one area where more work needs to be done in terms of capacity building, as demonstrated by the fact that the great majority of respondents (88%) use only traditional assessment methods. Interestingly, *open evaluators* (7%) are slightly more numerous than *innovative evaluators* (5%).

This can be explained with the fact that, since assessment tends to be strictly controlled within universities, innovation is typically a matter of individual initiative. As a result, approaches such as engaging communities of practice to assess students, open blogging or cross-commenting among learners are adopted more commonly than institutionally supported practices such as e-portfolios. In addition, open assessment appears to be strongly connected with open teaching practices. This suggests that open assessment can have a positive impact on educators overall teaching practice, as Paskevicius (2017) notes: "when

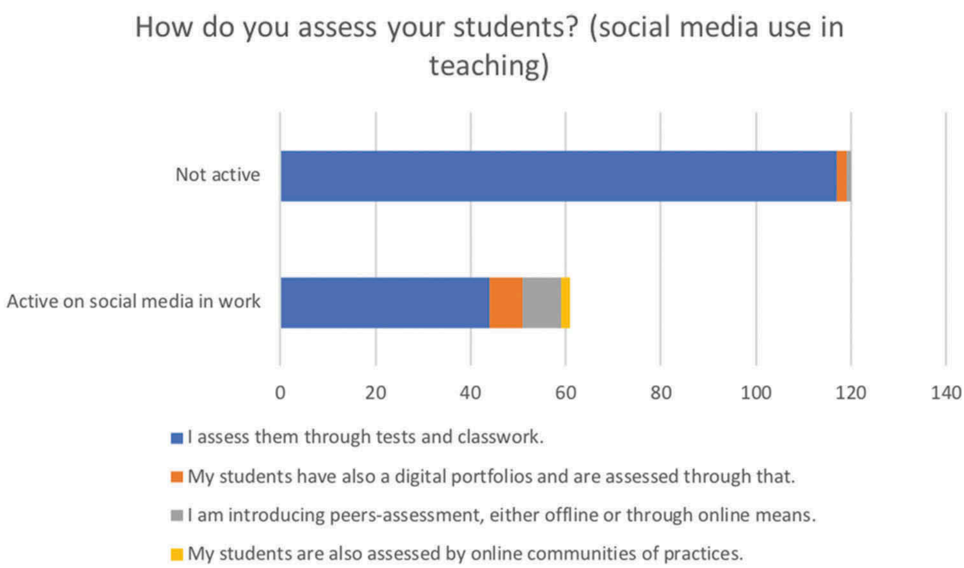

Figure 6. Open assessment and social media use.

designing assessment and evaluation activities, faculty may enact OEP by exploring ways in which they can engage students as producers of content, find ways to integrate peer-review and assessment, promote student collaboration, and develop digital literacies" (p. 9).

As we have seen for the other areas, open assessment is also strongly related to the general collaborative attitudes of teachers. The results in Figure 6 suggest that a direct relationship exists between using innovative open assessment methods, including e-portfolios, peer assessment and community-based assessment, and using social media for professional practice.

Discussion

As Figure 7 shows, in each of the four areas of the OEF framework a cohort of skilled open education practitioners exists, and it is these individuals who could be motivated to inspire and build capacity among their colleagues.

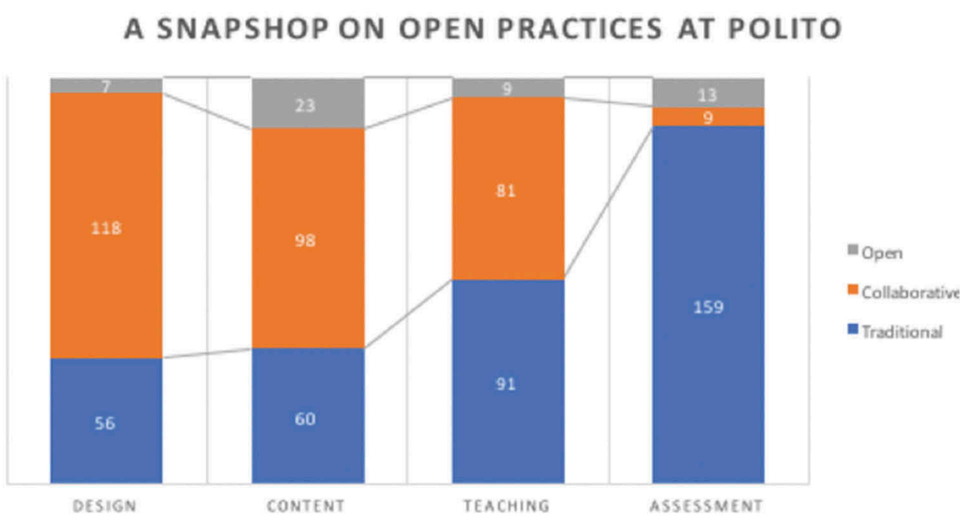

Figure 7. Overall openness level of PoliTo staff.

However, our research also shows that it is rare for a single educator to be skilled across all four areas of the framework. This finding corroborates the hypothesis that open practice looks different for each individual and that educators will typically be more open in some areas of work than in others. For example, some lecturers who release their content under open licence, and also foster collaboration among students through flipped-classroom methods, have never experimented with open design or open assessment. Similarly, some teachers who adopt peer-based assessment practices do not release their content as OER for whatever reason. This is why, in order to plan capacity building interventions in such a multifaceted field as open education, it is important to consider educators as individuals, regardless of whether we identify them as champions or whether we want to increase their capability in a certain field. The strength of the proposed methodology is that it can highlight different levels of openness in diverse areas of practice and can therefore motivate teachers to explore areas where they have the opportunity to adopt more open approaches.

It is also important to consider the relationship between educators' level of openness and their key characteristics. What we have seen across all the areas of this analysis is that there is no direct correlation between openness and age. When awareness of OER is examined by age group, it is the oldest faculty, aged 55+, who have the greatest degree of awareness, while the youngest, those under 35, trail behind. The largest proportion of younger faculty claim to be very aware of OER, with lower proportions reporting that they are aware or somewhat aware.

Openness does not show a strong correlation with academic discipline, although educators from some disciplines do seem to be more open to sharing. Even if reuse of resources seems to be more common in scientific domains such as physics than in social sciences, it would be an oversimplification to identify bounded academic fields with specific cultural features as teaching is increasing becoming more specialised and interdisciplinary (Becher & Trowler, 2001).

The research does show some correlation between certain characteristics of respondents and their propensity to adopt open practices. Firstly, openness seems to flourish within small collaborative groups and to stem from the sharing culture that naturally exists among close colleagues, particularly with regard to the use of resources produced by others. This observation is in line with the findings of Lopukhova and Makeeva (2017) and Veletsianos (2015), who claim that both individual and systemic barriers exist to the adoption of open approaches and that close collaboration can strongly influence individual agency in the practice of openness. Secondly, openness is closely connected to collaboration; across all four areas of practice the data confirms that a strong relationship exists between the use of open approaches and collaborative attitudes of university teachers, where open online identities and networks seem to be a key to developing open teaching strategies (Nascimbeni & Burgos, 2016). As noted by Weller (2012) and Cronin (2017), educators' positive attitude towards openness and their collaboration practice are related, confirming that the use of OEP can have an impact on educators' personal networks, and vice versa. It is interesting to compare these findings with Cronin's conclusions in her recent article on a study run within an Irish university:

> Overall, for the participants in this study, using OEP (Open Educational Practices) was primarily characterized by having a well-developed open digital identity; using social media for personal and professional use, including teaching; using both a VLE (Virtual Learning Environment) and open tools; using and reusing OER; valuing both privacy and openness; and accepting some porosity across personal-professional and staff-student boundaries. (Cronin, 2017, p. 7)

Conclusions

The aim of this research was to map the overall OEP capacity of a university, by examining individual educators' existing adoption of open practices, beyond the use of OER. As stated earlier, to our knowledge no previous research has been able to provide such a comprehensive overview of the OEP capacity of teaching staff within a university. This has been achieved by focusing on four different areas of academic practice: *learning design, content, teaching* and *assessment*.

The case study results presented in this paper show that OEP capacity is scattered across the university, and across the individual teachers' competences, in the sense that very few educators are highly practiced in all four areas the study explored. OEP is a multifaceted concept, and this approach encourages the identification and further analysis of educators' individual capacities and preferences. In addition, the case study confirms that some forms of OEP are more common than others, as noted by Veletsianos (2015); for example, the use of OER and collaborative design practices are much more widespread than the use of open assessment methods. Furthermore, the motivation and capacity to adopt OEP is only marginally connected to age and discipline, but rather stems from small collaborative group working where a culture of sharing already exists among colleagues. Teachers' personality and attitudes are the key to openness: our research extends the findings of Jhangiani et al. (2016), who suggested that faculty who score highly in terms of open personality traits are more likely to both create and reuse OER and to adopt OEP. This is confirmed by the connection between respondents' adoption of OEP and their attitudes to sharing more generally, as noted by Cronin (2017), and as indicated in this case study by the connection between adoption of OEP and use of social media for personal and professional purposes.

With respect to the secondary objectives of the study, our research provides PoliTo leaders with important information that they can use to increase the adoption of OEP across the institution. By undertaking self-assessment of OEP capacity, teachers with little or no experience of open approaches can be encouraged to learn from their peers and colleagues. This research has also helped to validate the OEF framework and inquiry tools through a real-world case study, confirming that evaluating openness through multiple and complementary routes (learning design, content, pedagogy, evaluation) can enable educators to validate their existing practices and to improve their skills in other areas.

The next step in this research will be to run a qualitative analysis of the most experienced open practitioners, selected from the survey cohort, and to search for common patterns that will help us to understand how faculty can be motivated to explore areas of openness where they are not proficient, building on areas where they have already adopted open practice. This next phase will also facilitate the validation of the results presented in this paper through quantitative analysis. This will help understand the relevance of contextual variables, such as national legislation or institutions readiness to adopt OEP and further explore enablers for building open education capacity across universities.

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Appendix

Questionnaire

(1) **How do you design your lectures/courses?**
  (a) On my own, based on my experience and knowledge, as I have always done.
  (b) In collaboration with colleagues from my institution.
  (c) In collaboration with colleagues from other institutions, through bilateral contacts.
  (d) I share ideas and drafts about my course through restricted social media (such as subject-related discussion groups) to allow colleagues from other institutions to contribute.
  (e) I share ideas and drafts about my course through open social media (such as Twitter, academia.edu, cloudworks), to allow anyone (including students) to contribute.

(2) **To whom do you make available your teaching resources (PPTs, documents)?**
  (a) To students enrolled in my course, through the university website.
  (b) To all students of my university, through the university website.

  (c) I make it openly available to anyone, through the university website.
  (d) I make it openly available to anyone, through sharing platforms (Slideshare, repositories, etc).
  (e) I also promote the content I produce through social media (such as Twitter, Slideshare, Facebook, Wikipedia…).

(3) **Under which license do you release the teaching resources you produce?**
  (a) I do not apply any licence, I just make it available to through the university website.
  (b) Through a restricted license (all rights reserved).
  (c) Through a licence that makes it openly available (such as Creative Commons).

(4) **Have you ever been using online resources (PPTs, videos, documents, articles) produced by others in your teaching? If so, under which license was this content released?**
  (a) No, do not use online content produced by others in my teaching.
  (b) Yes. I am not worried about the license of these resources, since I used it for educational purposes.
  (c) Yes. I only use resources released under an open licence, such as Creative Commons.

(5) **How did you get to know about these resources?**
  (a) I have been searching for them on Google or other search engines.
  (b) Through a colleague from my university.
  (c) Through social media (such as Twitter, Slideshare, Facebook).
  (d) Through OER repositories.

(6) **Have you ever re-shared resources produced by others after using/adapting them?**
  (a) No, never.
  (b) Yes, among colleagues from my university.
  (c) Yes, openly through social media (such as Twitter, Slideshare, Facebook).
  (d) Yes, openly through OER repositories.

(7) **How do you teach?**
  (a) I use classic, frontal classroom teaching.
  (b) I use the university Learning Management System (LMS) in support to classroom teaching, to share links and documents.
  (c) I use seminars-like strategies, either offline or through restricted online spaces (Chats, forums).
  (d) I use "flipped-classroom" methodologies (using classroom time to discuss content that students have studies at home before the lesson).
  (e) I encourage my students to search for additional resources on the web and to produce their own knowledge.
  (f) I try to foster co-creation of knowledge by students by working with wikis, blogs, communities of practices.

(8) **Do you encourage participation from non-enrolled students in your course?**
  (a) Yes
  (b) No

(9) **How do you assess your students?**
  (a) I assess them through tests and classwork.
  (b) I am introducing peers-assessment, either offline or through online means.
  (c) My students have a digital portfolio and are assessed through that.
  (d) My students are assessed by online communities of practices.

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DANIEL BURGOS

10. A CRITICAL REVIEW OF IMS LEARNING DESIGN

Recommendations for a Revised Version

INTRODUCTION

The work presented in this paper summarizes the research performed in order to implement a set of Units of Learning (UoLs) focused on adaptive learning processes, using the specification IMS Learning Design (IMS-LD). Through the implementation and analysis of four learning scenarios, and one additional application case, we identify a number of constraints on the use of IMS-LD to support adaptive learning. Indeed, our work in this paper shows how IMS-LD expresses adaptation. In addition, our research presents a number of elements and features that should be improved and-or modified to achieve a better support of adaptation for learning processes. Furthermore, we point out to interoperability and authoring issues too. Finally, we use the work carried out to suggest extensions and modifications of IMS-LD with the final aim of better supporting the implementation of adaptive learning processes.

A BRIEF DESCRIPTION OF THE IMS LEARNING DESIGN

IMS Learning Design (or simply IMS-LD) (IMS, 2003) is aimed to transform regular lesson plans into interoperable Units of Learning (UoL). This specification is able to use any pedagogical model to get a UoL run-able and editable in an interoperable way. IMS-LD augments other well-known e-learning specifications aforementioned, like SCORM, IMS Content Packaging, IMS Question and Test Interoperability or IMS Simple Sequencing. Furthermore, IMS-LD provides a language to describe the teaching and learning process in a Unit of Learning. It describes among other things the roles, the activities, the basic information structure, the communication among different roles and users; and all these under the pedagogical approach decided by the teacher and-or the learning designer. In this section, we show what is IMS-LD and how it is structured, as well as how it provides Adaptation within the UoLs

IMS-LD is able to describe a full learning flow with several elements -such as roles, activities, environments or resources- and features -such as properties, conditions, monitoring services or notifications (Burgos & Griffiths, 2005; Koper & Tattersall, 2005).

M. Maina et al. (Eds.), The Art & Science of Learning Design, 137–153.

The usual life-cycle starts with a lesson plan modelled according to the IMS-LD specification, defining roles, learning activities, services and several other elements, inside an XML document called Manifest. An information package written in IMS Content Packaging (IMSCP, 2001) is used as a container for the resources and links them with the IMS-LD structure. Later, the Manifest is packaged with the nested resources in a compressed ZIP file, meaning a UoL. Several examples available are shown later on.

IMS Learning Design uses the metaphor of a theatrical play to visualize how to model Units of Learning. A play is performed by a number of actors, who may take up a number of roles at different times in the play. Similarly in learning design a learner can take up different roles at different stages of a learning process. At the end of each act the action stops, all the learners are synchronised, and then a something new can begin.

IMS-LD consists of three levels: Level A, with the definition of the method, plays, acts, roles, role-parts, learning activities, support activities and environments. It is the core of the specification, contains the description of the elements that configure IMS LD and the coordination between them. For instance, role-parts define what activities must be taken by a role in order to complete an act and, subsequently, a play.

Level B, adds properties, conditions, calculations, monitoring services and global elements to Level A, and provides specific means to create more complex structures and learning experiences. Properties can be used as variables, local or global ones, storing and retrieving information for a single user, a group or even for all the characters involved. Through these mechanisms the learning flow can be changed at the run time, as decisions can be made taking into account dynamic content. Logically it is the used level to express the most of the pedagogical needs concerning Adaptation, personalization, feedback, tracking and several other usual requests of teachers and learning designers.

Finally, Level C adds notifications to Level B, meaning an email sent and a show/hide command to a specific activity, depending on the completion of another one (Koper & Burgos, 2005).

IMS-LD AND ADAPTATION

In addition to the basic structure of Level A, the elements in Level B and Level C are actually the key for more expressive UoLs (for instance, based on Adaptation or Collaboration), as they combine several features that encourage and make the content and the learning flow more flexible (Koper & Burgos, 2005). Furthermore, the combination of these elements allows for the modelling of several classical adaptive methods (i.e. reuse of pedagogical patterns, adaptability, navigational guidance, collaborative learning, contextualized and mobile distributed learning, Adaptation to stereotypes), making use of different structural elements of IMS-LD, like i.e. Environment, Content, User groups and Learning flow (Burgos et al., 2007).

In a literature study, we identify eight different kinds of Adaptation being carried out in eLearning systems (Burgos, 2008): Interface based, Learning flow based, Content based, Interactive problem solving support, Adaptive information filtering, Adaptive user grouping, Adaptive evaluation, and Changes on-the-fly. All of them use various inputs provided during the learning process and aim to tune the activities and actions of the learner to get the best learning experience as possible (Butz et al., 2003). A wide and consistent set of rules of dependencies among users, methods and learning objects is needed to describe these eight types of Adaptation, and moreover their possible combinations. If we categorize all these types of Adaptation, we can group them in two clusters (Ahmad et al., 2004; Chin, 2001; De Bra et al., 2004; Baeza-Yates & Ribeiro-Nieto, 1999; Van Rosmalen & Boticario, 2005; Merceron & Yacef, 2003; Romero et al., 2003). The first one consists of three types of Adaptation:

1. Interface-based (also called adaptive navigation and related to usability and adaptability) where elements and options of the interface are positioned on the screen and their properties are defined (color, size, shadow, etc.); this is closely related to general customization and supporting people with special needs which influence personalization, such as colour impairment or poor hearing, for instance.
2. Learning flow-based, where the learning process is dynamically adapted to sequence the contents of the course in different ways. The learning path is dynamic and personalised for every student, but even also for every time that the course is started (also called run or instance), so that the student can take a different itinerary depending on his performance.
3. Content-based, where resources and activities dynamically change their actual current content, as in Adaptive and Intelligent Web-Based Educational Systems based on adaptive presentation (Brusilovsky & Miller, 2001). For instance, the information inside a learning activity can be classified in three levels of depth, and every level is shown based on a number of factors.

The first cluster with three types of Adaptation becomes the base for the next one. Additional kinds of Adaptation feed a second cluster: 4) Interactive problem solving support; 5) Adaptive information filtering, 6) Adaptive user grouping; 7) Adaptive evaluation; and 8) Changes on-the-fly.

METHODOLOGY OF ANALYSIS

This section describes how we have carried out the analysis, as well as the methodology followed to do the research in this paper. Previously, we have described how adaptation is envisaged by IMS-LD and which types of adaptation can be expresses with this specification. Furthermore, we have described, modelled and implemented a number of Learning Scenarios which show features for adaptive learning processes.

First, we have defined, modelled and analysed five Units of Learning (UoLs), which are described as learning scenarios (Table 1). In these learning scenarios, we describe adaptive learning processes and features. Further, we carried out an analysis of a real application case from the ATOS University, where a Unit of Learning (UoL) with adaptation features modelled with IMS-LD, was implemented (Figure 1).

Table 1. Learning scenarios

ID	*Type of adaptation*	*Description*
1	Adaptive Assessment	adaptation on the learner´s performance and knowledge
2	Adaptive Authoring	adaptation on the learning designer´s method
3	Adaptive Content	adaptation on the learner´s decision
4	Adaptive Mentoring	adaptation on the teacher´s decision
5	Combination of adaptive types	Application case on Corporate training

Last, every learning scenario is analysed and reports on shortcomings and recommendations to improve the expressiveness of IMS Learning Design to achieve a better adaptation process. These scenarios are focused on every single adaptation feature that makes a recommendation useful on the learning itinerary of a user. On this regard, they go from assessment to content, through authoring or mentoring. What every scenario provides is a setting to test this specific adaptive feature on a group of users. For instance, on Adaptive content, the user is entitled to select a resource (e.g. PDF file) out of a list of available files in a repository which are selected by the system for the user based on his/her inputs like, i.e. performance or background profile. On the tutor's side, on Adaptive mentoring, the teacher-tutor gets a set of actions to take on a user or user group to increase their skills, knowledge or competences. These actions are designed on the basis of the user's inputs like, i.e. group interaction, response time or previous selections. The tutor will have the last word to take the decision, independently or guided by the recommendations report.

Our analysis is focused on the main challenges and limitations to performing adaptive learning with IMS-LD. These mainly focus on the need for improving the flexibility and interoperability of this specification, while model-ling adaptation.

All of them are available at the GRAPPLE Project website (http://www.grapple-project.org)

HOW IMS-LD EXPRESSES ADAPTATION

In this section, we examine how IMS-LD can be used to represent each of the eight types of Adaptation afore-mentioned. A combination of the following proposals on Adaptation could support the performance of every role in an eLearning process.

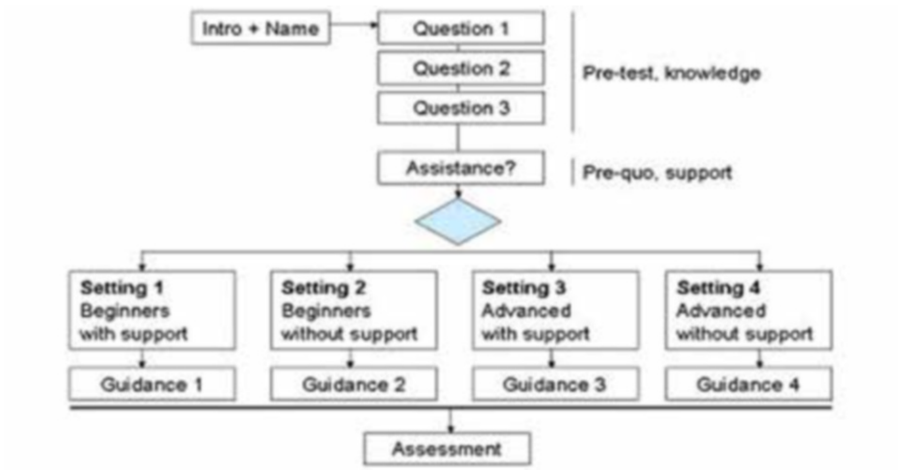

Figure 1. ATOS application case

Taking the first block (which consists of the three main types), IMS-LD is able to model Adaptation.

Adaptation Based on the Interface

Interface Adaptation is based on options, navigation and visualization facilities. Interface Adaptation is not possible with today's tools for IMS-LD, such as CopperCore Player (Vogten et al., 2006). As long as the Adaptation of the interface is based on the tool and not on the Unit of Learning that is interpreted by the player, this is still true. Today's players do not yet provide facilities to change the size or the position of the navigation panels, or even open and close the working areas in the player. Either, these tools cannot change the style sheets related to a HTML file, part of the content, and any of the linked features, as font-size, font-type or background colour, for instance. Although the CopperCore engine provides the appropriate infrastructure, no player uses it so far. Nevertheless, some kind of adaptive interface is possible, using DIV layers and environments.

Adaptation Based on the Learning Flow

The modification of the learning flow as the Unit of Learning is being executed is one of the most often used types of Adaptation. Taking the flow as a base, the Unit of Learning provides different activities, resources and services, depending on these four inputs during execution (user's behavior and performance, user´s decision, teacher and set of rules). The activity structure in an IMS-LD UoL is defined using plays, acts, activity structures, learning activities, support activities and environments. We can also use the property of visibility to hide and show these elements and to adapt the learning flow. In these cases the property works as a flag, switching on and off the elements referred to.

Adaptation Based on the Content

Content Adaptation is based on the information inside an activity that is shown and handled. We know that a learning flow is mainly focused on the sequence of the activities in a Unit of Learning. However, content based Adaptation is focused on the information of every activity, and on the activity itself. There are two main approaches for content based Adaptation in IMS-LD: Flag properties and content of properties. Flag properties hide and show elements like e.g. activities or environments. On the other side, the content of specific properties can be modified on the run, making use of global elements in the specification.

Elements in Levels B and C to Model Adaptation

The elements in Level B and Level C providing support to Adaptation in Units of Learning are categorized as a) properties, b) conditions, c) global elements, d) calculations, e) monitoring services, and f) notifications (Koper & Burgos, 2005; Burgos & Specht, 2006):

1. Definition, set-up and use of properties: Properties are taken as variables to store values. There are several types of properties: local, local-personal, local-role, glob-al-personal, global. There is also a property-group that is able to compile a number of the others.
2. Conditions: IMS-LD is able to define a basic structure if-then-else, or multiple structure with several chained basic if-then-else in a row, for instance to change the value of a property or to show and hide one element.
3. Global elements: Global elements provide a communication flow between the imsmanifest.xml, where the different levels of IMS-LD are set-up, and other XML files. Mainly, they can get an input from the user and they can show a value of a property. Furthermore, they can manage DIV layers in XHTML, for instance to show and hide specific content.
4. Calculations: IMS-LD is able to make some basic arithmetic's (sum, subtraction, multiplication and division) and some combination of a number of them in a row, to get a more complex formula, like a simple average, for instance.
5. Monitoring service: The specification allows monitoring any kind of property assigned to a user or a role, for instance. In order to start this action, firstly the component monitor must be set-up inside an environment and later the property can also be monitored.
6. Notifications: An action is automatically launched de-pending on the state of a property or a previous action, i.e., when a student ends an assignment an email is sent to the tutor.

IDENTIFICATION OF CONSTRAINTS, GAPS AND ISSUES TO COPE WITH

We use every learning scenario aforementioned as a base to find restrictions, drawbacks and elements to improve within the specification. These resources show how far IMS-LD supports adaptation, when different inputs and roles are involved. We also make links to the integration of UoLs, when needed. Out of the modelling and development of those UoLs we perform an analysis on which features, elements and components are missing or could be modified in order to achieve a more adaptive and expressive-oriented general definition, with the ultimate aim of improving the specification and bringing it closer to actual needs on eLearning.

In this section, we provide a detailed analysis of what IMS-LD can and cannot model, in its current information model, with regards to adaptation. This analysis concentrates on the weak points and main features of every learning scenario. These remarks will be addressed to produce a set of recommendations (i.e. extensions and modifications) to improve the pedagogical expressiveness on IMS-LD, focused on adaptation, in the next section.

Following, we summarize our main findings. With regards to the specification itself:

- The definition of properties and the link through several working XML files is too complicated to become useful
- The relation between layers and actions is not straightforward and it has to be done interlacing files, through global elements and XML
- The lack of a richer conditional structure makes the editing of the set of rules more complicated on paper than they actually are from a rational point of view
- Controlled iterations in the activities are not allowed. Furthermore, a closed activity cannot be re-initialized and/or go backwards
- The monitoring service doesn´t cover any kind of user grouping. Therefore, a user (e.g. either a teacher or a learner) cannot follow the performance of several other users at the same time
- Questions and answers are not personalised for user; they are identical for all users with the same role
- The communication between teacher and student is little and indirect. They can view the values of properties but there is no other communication service between them
- There is a lack of flexibility in the input point of changing the itineraries. In the type Sequence, the learning activity with the question appears always at the same place. In the type Selection, the question is always presented after 2 completed learning activities. In case the learning designer/teacher wants to shift this input point, they cannot do so
- There is no possibility to handle absolute time to start the course and/or a specific activity. Only relative time to the precise time when the instance is created out of the UoL, it is possible

- There is no chance to make a connection to an al-ready existing database (for instance, to make a query or to import already enrolled students or teachers). The data type of connection is not supported. Therefore, every enrolment has to be done by hand or running a specific tool for that
- Furthermore, any connection with the external world is impossible. For instance, a real-time effective communication between an LMS and an IMS-LD UoL is not possible so far, so that in fact they cannot benefit each other from mutual services and resources. There is no foreseen dispatcher or service in the specification allowing such connection (Moreno et al., 2007)
- When an executable module is developed with other technologies (Macromedia Flash and PHP, for instance), it cannot be integrated with IMS-LD in any way. Therefore, we also identified an interoperability problem. Although IMS-LD is not developed with the intention of supporting such interactivity with users, it could allow for a valid integration with external resources using a layer of communication/dispatcher.
- A file uploaded from the hard disk of a computer is stored in a file-type property inside the internal database of the engine (CopperCore, in this case). There is no possibility to change the default configuration for storing or retrieving resources. There is no facility to manage those uploads either. Although this is an issue concerning tools too, the core documents of IMS-LD do not provide this information and/or service either
- IMS-LD does not allow saving information into external files or retrieving information from any external source
- To perform a dynamic user selection in order to create groups is not possible. The teacher can monitor each user, and provide him/her with some feedback on a personal basis. We could set-up a property to be dealt by groups, but these groups should be established before the actual start. However, if the teacher wants to make a dynamic creation of a group of students depending on their answers, this is not possible so far. To this extent, groups and roles are the same thing
- IMS-LD does not allow for recording the user's behaviour; in fact, no measures (i.e., Total Time Needed, Time Before First Move) can be restored or retrieved
- As a consequence, adaptation based on the user´s behaviour cannot be developed using the IMS-LD specification. Furthermore, the current state of tooling does not support it either

1. In addition, with regards with the current engines, we highlight a few issues that would support a more powerful use of the specification:

- Changes on-the-fly are not possible. In case that the teacher or the learning designer wants to change i.e. the questions, the answers, or the content of the next activity to be carried out, they find that. Every single resource has to be packed in design and publishing time before the actual running of the instance

- In questionnaires and other forms with fields, the teacher/learning designer cannot modify the number of questions or answers, once the UoL has started
- There is no option to run the UoL (the whole UoL or a part, such a Learning Activity) twice within the same instance. Once a Learning Activity is closed, the user can read it again but the associated learning flow cannot be executed. For instance, after the question to change the itinerary is made in the historic-route, there is no way to go back
- There is no flexibility to change the content. When the teacher/learning designer wants to keep the same method and the same structure, but he/she wants to change one single HTML page with some content, the UoL has to be validated and published again. In this case, the learner and the teacher would have to be enrolled and the learning process starts from the very beginning
- Users cannot be dynamically enrolled within the UoL, once it has started, and they have to be managed by an external tool

FURTHER ANALYSIS

In the next section we show specific recommendations which deal with extensions, modifications of modelling structures, elements and components, as well as with the architecture of IMS-LD. Those recommendations are based on the constraints pointed out in Section 5. However, there is a need for presenting some further analysis, which can bridge both sections, from the constraints to the recommendations, since this in-between step is crucial to understand the rationale. We have organized the analysis as follows:

1. Analysis on general-purpose modelling. These elements will be used as part of others specifically implemented in learning processes, like personalisation. Furthermore, they become a basic set to be re-purposed in different contexts and goals. Therefore, this initial analysis comprises adaptive learning. A few very specific processes cannot be approached with just general structures. They need on-purpose elements which come across on-purpose goals on personalisation
2. Analysis on the integration of Units of Learning and a bi-directional communication with other external resources, systems and standards. When needed, we high-light the need for a way of communication (e.g., a communication layer) although its development is something outside of the scope of this research. We are focused on the specification itself and how to improve the pedagogical expressiveness, and not on building any ad hoc technical artefact to get this aim through.

Out of this analysis, we conclude that specific recommendations should be categorized in three groups:

Modelling, that compiles every single extension, modification or addition, general or specific, to the specification and the information model; and b) Architecture, that deals with functional requirements of the spec, with a focus on the interoperability, communication and integration of IMS-LD with other external means. In both cases, we look for the highest performance along with the minimal structural change. Furthermore, we respect the original specification as much as possible and try to make as few changes as possible; on the other side, they all are needed to build the suggested solution, and cope with the overall approach. In addition, c) we reflect some recommendations about the authoring tools. Although they are not responsibility of the specification, they are indeed related to IMS-LD, since the tools which allow the end users to create useful and applicable Units of Learning, can make the process easier or more difficult, and therefore it constraint the actual use and outcomes.

Furthermore, we depict our conclusions within the same two main blocks that we have used to carry out the analysis: modelling (with a special focus on adaptation) and integration. Out of our solution, we also provide a brief note about authoring tools.

Modelling and Adaptation

With regards to general modelling, and modelling focused on adaptive learning we conclude that IMS-LD shows a metaphor difficult to understand. It is not as much to say that people do not understand what a theatre is or how a play is performed. The key issue comes when a teacher needs to translate this well-known structure into specific pedagogical resources and features. This translation process turns not to be so obvious. The conceptual model is clear: play, acts, roles, role-parts, and so on. But all of them, interlaced in a whole structure of learning, become complex. Even the simplest scenario requires some knowledge of the specification in a technical way. And this is far from being user-friendly, moreover when the usual target people consists of non-technical profiles.

The notation itself follows a usual XML Schema and the definition of the several elements and components of the spec can turn too complex, even for skilled programmers. The description of activities, activity structures, environments, and et cetera, and the long cascade of relationships amongst them, makes a difficult-to-trace chain out of a simple scenario. Not to mention when several roles are involved, when some components of Level B are used or when adaptive processes are required. The programming structure is quite easy, but the combination of elements, components and metaphor, makes it hard difficult to implement.

The programming components provided by IMS-LD are quite simple (i.e., simple condition, based arithmetic, visualization of variables, visibility, DIV layers, and et-cetera). On the other side, their syntax is long, which hinders the rationale of the modelling process itself.

Communication, Interoperability, Integration of Units of Learning

We study three ways of communication: 1) simple link between parts, 2) embedded information packages with no information exchange, and 3) full communication of information packages, sharing variables and states. This third solution becomes the most effective one. It implies the development of a communication layer that deals with effective bi-directional exchange of data between information packages. Furthermore, this solution allows for the communication and sharing of services, along with variables, values and states, between IMS-LD and any outside counterpart, i.e., other specifications (e.g. SCORM), languages (i.e. PHP, Java, and Action Script), and LMSs (i.e. LAMS, Moodle,. LRN).

Should this exchange actually happens, it will encourage the re-use of information packages in different contexts, and the development of templates, fostering the re-purpose of Units of Learning within and amongst the several communities of practice (target groups) involved in IMS-LD, beyond the very only technical niche.

In the same line, exportation and importation of Units of Learning is not developed so far; neither does any connection with a database. Once more, no information exchange with other entities is possible so far.

The current two-step working process that makes two isolated parts out of design-time and run-time, makes IMS-LD to be compiled and not interpreted. This distinction stops an on-the-fly visualisation and modification of the learning design, which would improve the interactive personalisation of the learning process. This issue deals with how IMS-LD is interpreted by tools and engines developers and not with how the specification is actually designed.

Authoring

As aforementioned, this research and paper are focused on the specification itself and it does not deal with tools. However, authoring tools largely influence what can be modelled and how. Therefore, we point out a couple of key issues that could support the actual adoption of IMS-LD by the target groups:

1. There is a need for high-level visual authoring tools. Nowadays there are two types of tools: effective but too technical, even for technical profiles; and simple to understand but not powerful, since they usually deal with the very basic Level A. The creation of UoLs should be as far as possible from technical requirements or the underlying elements, components or structure. A more visual approach would encourage the understanding and use of IMS-LD in a broader sense by target groups. Technical low-level editors should live along with the visual high-level ones, though
2. Any authoring tool should allow for an integrated modelling, working with the manifest, the resources and the required external XHTML files with a common interface. It should dependencies and ease setting of properties. This is a hot challenge, not possible so far.

RECOMMENDATIONS: EXTENSIONS AND MODIFICATIONS

This section presents a rich and structured set of recommendations, modifications and extensions to improve the expressiveness of IMS Learning Design on adaptive learning processes. It lays on the aforementioned analysis. The following set of tables show a summary of the constraints, analysis, and recommendations (Table 2). The tables are structured as follows: in the grey-coloured, first row of each table, Column 1 (ID) numbers the constraints and analysis issues. Prefix M relates to issues concerning Modelling, and prefix A relates to issues concerning Architecture. Column 2 (Constraints.) provides a description of those issues numbered in Column 1. The white-coloured row(s) afterwards, presents the recommendation/s in the same couple format: ID and description.

Table 2. Constraints, analysis and recommendations

ID	*Constraints, analysis and recommendations*
(M.01)	Programming structures and resources are very basic (simple condition, simple arithmetic, properties set-up, visibility, DIV layers)
(Rec.01a)	Condition type case
(Rec.01b)	Condition type case with automatic ranges
(Rec.01c)	Conditional loop, type while
(Rec.01d)	Integer loop, type for-next
(Rec.01d)	Modification of the element <calculate>
(M.02)	There is no management of absolute time. There is no synchronization nor input point to work with relative time from
(Rec.02)	Modification of reference to relative time. Addition of reference to absolute time
(M.03)	Notification service, in Level C, is under-used. It only sends an email or plays an activity
(Rec.03)	Extension of the notification service, beyond using *sendmail* and playing an activity. It can be called from other structures besides the <on-completion> part of a learning activity
(M.04)	There is a blur way to handle the definition and use of properties and links amongst the several XML with global elements
(Rec.04)	Syntax modification, definition and use of elements view-property and set-property, as long as the properties which make use of them
(M.05)	Relationship between DIV layers and the visibility property is difficult to make and follow

Table 2. (Continued)

ID	*Constraints, analysis and recommendations*
(Rec.05)	In principle, the visibility property of any layer is turn off (hide), making simpler the conditional structure which could make use of it
(M.06)	There is no chance for iterations in any of the basic structures of the IMS-LD metaphor (learning activity, support activity, activity structure, act, play)
(Rec.06)	Extension of the current syntax of every element with a parameter <iteration> which defines a integer loop (type for-next) and-or a conditional loop (type while)
(M.07)	There is no synchronization input point in the manifest
(Rec.07)	Addition of an element GOTO which allows for a direct guiding of the learning flow
(M.08)	There is no chance to assign a specific activity to a selected user
(Rec.08a)	Addition of an element ASSIGN-ACTIVITY-TO-USER which allows for a direct match amongst users, groups and roles, with learning activities and activity structures
(Rec.08b)	Addition of an element ASSIGN-USER-TO-ACTIVITY which allows for a direct match amongst users, groups and roles, with learning activities and activity structures
(Rec.08c)	Addition of an element SWITCH-ACTIVITY which allows for turning on-off activities and activity structures
(M.09)	There is no chance to make groups out of a selection inside the instance
(Rec.09)	Addition of an element CREATE-GROUP which allows for grouping users of the same role
(M.10)	The monitoring service does not allow for monitoring of groups
(Rec.10)	Extension of the monitoring service to trace roles and groups
(A.11)	IMS-LD does not allow for saving or retrieving data in external files, of any kind of format. In addition, connections with external databases or modules developed with other languages are not described or supported within the specification
(Rec.11a)	Addition of the elements EXPORT and IMPORT to handle files with specific parameters (e.g., type TXT) and which is defined in a new property type FILE-IO
(Rec.11b)	Addition of the elements FROM-DB and TO-DB which allows for saving and retrieving data in a database of type MySQL. The connection is defined in a new property type DATABASE

(Continued)

Table 2. (Continued)

ID	*Constraints, analysis and recommendations*
(A.12)	There is no chance to modify the learning skeleton, method, roles definition or any other structural element in run-time
(Rec.12)	Addition of two couples of global elements: a) *view-IMS-LD* y *set-IMS-LD*, b) *view-resources* y *set-resources*, which allows for the visualisation and modification of the learning design and the related resources in run-time

At the project website pointed out in Section 3, every recommendation is expressed in an XML format, along with a full description, and one example. For instance (Figure 2):

```
                <act        t e  c        t       >
                        <t  tle>          t    a  t       t  e act        t  <  t  tle>
                        <  te                    le     t  ue e     ede t       >
                <  act  t       e  c        t       >
                <  te   at        >
                 <     >
                        <          e  te  e          e     >
                        <          e  talue>  <           e  ltue>    a
                 <       >
                <     te   at        >
   <  lea              aet       t
```

```
   <calculate>
   <                                              >
         <          e  t    e  e               >
         <  ult      l>
         <        u u  t   tal    e               >
                <          e  t e  e                        >
                <   u >
                        <          e  talue>  <       e  t    alue>
                <      u>
         <          u  u   t   tal>
         <   ult      l>
   <  calculate>
```

a

```
   <lea                act         t         le     t  ue        actt          >
                <t  tle>  ct      t  t ca       ut<   t  tle
```

Figure 2. Example snippets of two recommendations

CONCLUSIONS AND FURTHER WORK

This paper shows the background about IMS Learning Design and how to model adaptive learning with this specification. In addition, we provide a thorough analysis of a number of learning scenarios and a detailed list of issues to be modified and improved in the specification to better express adaptation. Based on these outcomes we provide recommendations, modifications and extensions to IMS Learning Design in order to improve its expressiveness of adaptive learning.

With these regards, Level A of IMS-LD provides the basic skeleton and a general framework to work with Units of Learning. It makes the 80% of the whole structure. Level C, and above all Level B provide both the spec with stronger and more versatile resources. These two upper levels are the actual responsible means to model some of the current learning and teaching challenges (i.e. active learning, collaborative learning, adaptive learning, runtime tracking).

Furthermore, we examine how to represent adaptive and adaptable Units of Learning with IMS Learning Design in order to model different types of Adaptation. Based on a literature study, a distinction is drawn between eight types of Adaptation that can be classified in two clusters: a) the main group, with interfaced-base, learning-flow and content-base; b) interactive problem solving support, adaptive information filtering, adaptive user grouping, adaptive evaluation, and changes on-the-fly. Out of this research and modelling efforts we derived a number of findings focused on the limitations that IMS-LD provides. These findings are mainly focused on adaptive learning process. However, since this topic cannot be isolated from the overall approach of the specifications, some of the limitations, and further recommendations, also address other topics, like interoperability, or even authoring tools.

Indeed, IMS-LD will benefit from a re-structure and modification of several elements focused on modelling and architecture. It will also improve the overall pedagogical expressiveness, along with specific features on adaptation of learning processes and integration with other specifications, LMSs, and learning resources. These are two main objectives of the specification: personalised learning and interoperability. At the same time, IMS-LD would increase its level of implementation in real settings and a wider support from Communities of Practice of end users if one or several high-level visual authoring tools are developed. Nevertheless, this issue is out of the scope of this research, and it deals with research groups and companies working on the adoption of IMS-LD.

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L.I.M.E. A recommendation model for informal and formal learning, engaged

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***Abstract* — In current eLearning models and implementations (e.g. Learning Management Systems-LMS) there is a lack of engagement between formal and informal activities. Furthermore, the online methodology focuses on a standard set of units of learning and learning objects, along with pre-defined tests, and collateral resources like, i.e. discussion *fora* and message wall. They miss the huge potential of learning via the interlacement of social networks, LMS and external sources. Thanks to user behaviour, user interaction, and personalised counselling by a tutor, learning performance can be improved. We design and develop an adaptation eLearning model for restricted social networks, which supports this approach. In addition, we build an eLearning module that implements this conceptual model in a real application case, and present the preliminary analysis and positive results.**

***Keywords* — Technology-enhanced Learning, eLearning, Personalization, Social Network, Conceptual Educational Model**

I. Introduction

Social networks focused on a specific topic or community are a powerful and precise means for user communication and interconnectivity, no matter the role they stand for. These can be learners, teachers, employees, staff, academic managers, or financial directors, who show a very determined attitude, depending on their context and their objectives. Every user can question, answer, start an activity, follow another, comment on someone else's job, score a job made by others, search onto Internet, follow a scheduled test, participate in a video-conference with a teacher, and so on. And, in all these activities, any user can be pro-active, reactive, passive, consumer, producer, dealer, and yet to show some additional facets.

To this extent, we design and develop a conceptual model, L.I.M.E. as for Learning, Interaction, Mentoring, Evaluation. These four vectors are measured and analysed as the pillars for the learning scenario, and they are depicted in various inputs which feed the model. Furthermore, we implement this model in a learning ecosystem, restricted by user access and topic. This implementation of the personalised learning model, which deals with every single input and feature aforementioned, provides the user with adaptive tutoring, thanks to a rule system. In this ecosystem, the users interact one with each other, and with the system, and they get personalised counselling.

Before and after the design and implementation of the L.I.M.E. model as a case study, we have carried out a hybrid approach mainly with qualitative studies, supported by some additional quantitative studies, with various groups of experts and end-users. Hence, we have designed and executed a Delphi study to retrieve and categorize the user requirements, as well as a number of semi-structured interviews. Furthermore, we have organized two focus groups with different experts, and one quantitative questionnaire with the students involved in the application case. In addition, we have elaborated a comprehensive state-of-the-art which combines cross-engaged topics for eLearning processes like, i.e. Education, Communication and Technology.

It is proven that the learning itinerary provided by the L.I.M.E. model is efficient and effective, and therefore, it increases the user performance. To show this approach, we have designed and implemented a learning scenario in a real class, which we have split in two groups (experimental and control) of 24 students, each. We have selected and analysed a subject of an official university online programme, during 4 weeks. This scenario engaged formal and informal activities with a comprehensive approach. The implementation shows successful results which prove the validity of the model. In addition, we have got useful recommendations and promising conclusions for further versions of the model, out of the rounds of expert and end-user consultations.

The combination of 48 learners, along 4 weeks and related milestones, the measurement of 30 inputs focused on informal and formal settings and distributed along the four main vectors, has resulted in a large dataset with sufficient information to retrieve meaningful and significant interpretation. The main outcome highlights that there is a clear and positive influence in the user performance, when the L.I.M.E. model is implemented. Furthermore, L.I.M.E. shows to be effective and efficient. This conclusion is supported by a 10,53% overall average difference between the experimental group and the control group (66,72% - 56,19%), with a peak difference between corners of 37,37% (81,41% - 44,04%). These overall results, along with the partial ones which are presented along this research, support seamlessly the online personalised learning model for thematic, restricted social networks, L.I.M.E.

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II. Current developments and added value

In most of the e-learning environment designs, interaction and behavioral strategies have generally been neglected and therefore satisfactory uses of these strategies have rarely been realized, so that informal and formal settings are not engaged in a combined approach. Most learners are not even aware of what they have been studying (Kurt, 2007). Even when students monitor their learning, there is a broad theoretical notion that students experience illusions of competence [1], which leads to inaccurate judgment of their learning progresses and outcomes [2, 3]. For these reasons, learners need to be guided towards reflecting on their learning and improving their cognitive models of expertise. For instance, with the use of meta-cognitive expertise, which becomes crucial [4] in fostering individual's awareness of different cognitive, social, emotional, and meta-cognitive capabilities that are needed, knowledge of when and why they are useful, as well as development of regulatory skills, such as planning, monitoring, and reflecting.

Another approach makes use of recommendation settings. A recommender system is a tool that helps users to identify interesting items from a large pool of objects. It has been widely used in many commercial sites for recommending books, movies, CDs, and news articles (e.g., [5, 6]). Meanwhile, the success of these implementations has been inspiring for e-learning researchers. Multiple efforts have been made to design educational recommendation systems to recommend quality learning resources to learners to help reduce cognitive load and improve learning efficiency [7-10]. However, recommendations alone do not ensure learning performance, and how learners respond to the recommended resources defines the critical part of successful learning. Furthermore, Recommendation Systems emerge as a solution to find the right, personalized information in electronic commerce, knowledge management systems, learning management systems, social networks (open and restricted), and other fields and markets. To this extent, there are various inputs which can be used as information sources like i.e. user similarities with other users, user profile, user preferences, user behavior, user interaction, user ratings, and many other user tracking inputs [11, 12]. All these inputs provide the system and the teacher with valuable data to recommend a personalized learning itinerary and feedback.

Other sources of information are i.e. user interests, goals, and objectives, all of them more useful for educational applications. However, current educational applications lack of enough amounts of data to establish user similarities in a precise way. In this case, recommendations are based on information stored in a user model which is extended explicitly or implicitly. There are also hybrid approaches which ask some minimum information to the user and the rest is obtained in an implicit way, but none of them engage formal and informal learning in a combined model, since expressing user preferences, behavior, interaction, goals and interest with rules can be difficult, in general. Large amounts of data are required to narrow down the recommendation, although this solution comes along with an additional problem: the size and complexity of the rule-set can be unaffordable, and inconsistencies may appear.

In this paper, we design an eLearning model for personalized learning, with special focus on the combination of formal and informal settings in a combined paradigm. In doing so, we cope with the artificial difference between Learning Management Systems and specific, restricted social networks which complement the user formal activity with informal interaction.

III. Description of the LIME Model

The L.I.M.E. model is based on three vectors:

- What every learner does based on his/her own contribution (**L=Learning**)
- What the learner does to support interaction based and the relation with others, in addition to group interaction (**I=Interaction**)
- and what the teachers/experts value (**M=Mentoring**)
- In addition, there is a forth, transversal vector, being applied to the three previous vectors, focused on evaluation (**E=Evaluation**)
- being the final acronym **L.I.M.E., as of Learning, Interaction, Mentoring, and Evaluation**

In doing so, we take into consideration every single main role in the model (i.e. the learner -individual, group-, the teacher, the expert, and the designer), as well as the main factors for a fine adaptation, such as, i.e. the learner's performance, the group's performance, trust, and reputation. In addition, this model is based on the **knowledge structure** depicted in the beginning of this section that consists of LE (Learning Environment), LO (Learning Object), UK (Unit of Knowledge), and PLN (Personal Learning Network).

In order to define the best setting, the model designer (e.g. teacher) must design a **strategy** and (s)he should follow a step-to-step process to select a number of key elements of the model:

- **Setting**: Balance between formal and informal **settings**: the system collects specific inputs from both settings, keeping an overall balance of 100%. For instance, if the designer requires just a formal setting, the balance should be Informal:100% - Formal: 0%
- **Category**: Balance between Learning, Interaction, and Mentoring **categories**: In the L.I.M.E. model, every category is assigned with a specific weight, keeping an overall balance of 100% Watch that Evaluation is a cross-category. For instance, if individual and group actions matter alike, and there is no mentoring, the balance should be Learning: 50% - Interaction: 50% - Mentoring: 0%
- **Input**: List of specific inputs for each **category** and assigned **weight**: every input should reflect a number of diverse types of potential interaction and-or actions from the user to the community, and vice versa.

As an example, we provide a form with the following parameters:

- **Informal**: 40%. Rationale: informal activities matter, however they are not enough to pass

- **Formal**: 60%. Rationale: formal activities (e.g. exam) are key to pass, however, informal activities are required to achieve an optimum score
- **Learning**: 40%. Rationale: individual activities are key in this setting, however they are not enough to pass
- **Interaction**: 30%. Rationale: interaction itself is not enough to pass, although combined with Mentoring and-or Learning, become the key for success
- **Mentoring**: 30%. Rationale: just mentoring is not sufficient, however mentoring inputs provide they key to pass, along with learning or interaction inputs

Specific **inputs**: as listed, looking for a fine distribution between individual and groups actions; pro-active and re-active actions; personal-group-mentoring inputs; formal and informal contribution. This list is not exhaustive, but tentative, and provides a set of inputs based on the analysis of user requirements. These inputs have an assigned **weight**. These weights are shown as an example, and they should be designed and adapted by the designer based on specific requirements and objectives. For clarity's shake, in the following tables, we depict the weight in three columns, showing the **Absolute value (Abs)**, the **Relative value (Rel 100)**, taken as 100% for every Category, and the final **Relative value (Rel 40)**, related to the specific value of the Setting, Category, and Input, taken as 100% for the three Categories (L.I.M.E.). This last column shows the actual values for the final calculation. The Evaluation (E) vector is included in every other vector, and relies on their needs. For instance, in the following table, Evaluation is included in L=Learning (External examination, External continuous evaluation, External essay, External degree thesis), and M=Mentoring (Quantitative assessment, Qualitative assessment). However, these inputs (sub-vectors) might be different, based on the specific model applied to a scenario

IV. DEVELOPMENT OF THE ELEARNING PLATFORM

In order to test and evaluate the L.I.M.E. model, we have developed a software application (i-LIME) to be implemented in a learning scenario, as it will be described afterwards. This application is supported by the Learning Management System of the International University or La Rioja (www.unir.net, http://research.unir.net) and it does not intend to be exploitable, but a prototype, since the final objective of this research is not oriented to programming but to the correct application of the model itself.

i-LIME is a learning environment (LE), built to apply the LIME model, based on Learning, Interaction, Mentoring, and Evaluation. It can be played stand-alone or integrated with another existing LE (e.g. Moodle), via web services. This platform is envisaged as a new cognitive learning concept to create, share and reuse scalable didactic content (Learning Objects, Units of Knowledge), to adapt the content to learners' individual needs, and to share with others (Personal Learning Network), according to the LIME model. In this context, the user becomes consumer and producer at the same time, the minimum unit of learning is based on a variety of resources. User education is also boosted, allowing a) more active participation in the learning process, b) objective teaching skills assessment, and c) encouraging collaboration with other teachers and tutors and trainees with different expertise.

i-LIME combines the use of didactic contents, and knowledge and learning resources, for online teaching (OT). We develop i-LIME as a technology-enhanced learning (TEL) platform which applies the LIME model, and which will facilitate a more interactive, personalized learning process. i-LIME enhances the user's experience (e.g. teachers and tutors) using a five-pillared architecture [13]: (1) an authoring tool of Learning Objects and Units of Knowledge ; (2) a content management system that incorporates a modular and scalable system to capture, catalogue, search and retrieve multimedia content; (3) an adaptation management system which retrieves information and inputs from the users and the system and provides specific, personalized recommendations for the learning itinerary, based on the LIME model; (4) an evaluation module, which in turn is used as an additional input to the LIME model and the recommender layer [14]; and (5) a social thematic network (restricted to registered users in the same field) for collaborative learning between users, which provides input date on behaviour and interaction to the LIME model and the recommender layer. To this extent, we have installed an instance of i-LIME, fully operational with regards to user inputs, data collection and analysis, and adaptation management system (3, following the afore notation), along with generic functions for end-users.

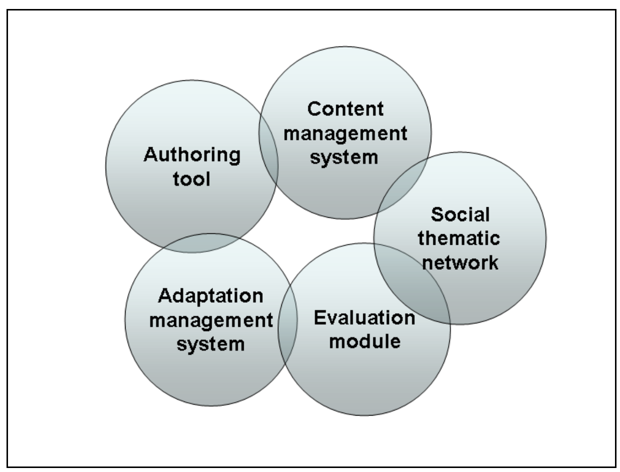


Fig. 1. i-LIME architecture

The first pillar, the **authoring tool for learning objects and units of knowledge (ATH)**, allows the building of scalable didactic content from individual users' knowledge by means of training resources (e.g. video footage) to enhance didactic information. The **content management system (CMS)** works with units of information, in the form of text, video, and audio files, or any other format required to provide useful learning objects.

Users' knowledge management is achieved within the second pillar. The **adaptation management system (AMS)** provides adaptive learning to users based on their progress (formal learning), behavior (informal learning), and other inputs, within their continuous formative path using the environment. Recommendations are given to users regarding

(1) the most suitable contents, (2) colleagues working in the same field, (3) interactions to perform, and (4) given their personal interests and progress in i-LIME, amongst other inputs. To this extent, the adaptation management system makes use of the **Recommendation Layer (Meta-Mender)**, which uses meta-rules in order to provide a new abstraction level suitable for increasing personalization and adaptation.

An important matter when developing a new training process is to develop new objective evaluation systems based on reliable and measurable data, which allow for automatic and immediate feedback and which are always available for trainees. Thus, objective evaluation is a key issue in the i-LIME environment. Thanks to the **evaluation module (EVAL)**, trainees are able to test their knowledge via closed exercises, which are immediately analyzed by the environment, and used to provide input to the **Recommendation Layer (Meta-Mender)**. Formative feedback is provided to trainees by means of corrections and future didactic content recommendations.

The final pillar in i-LIME is the **social network (SN)**, a thematic network restricted to registered members, which allows for the creation of collaborative networks of students and professionals and provides a space where users can debate and work together. In doing so, informal learning is encouraged continuously, and the social network provides feedback to the **Recommendation Layer (Meta-Mender)**, which will return a more accurate, personalized tutoring.

V. APPLICATION SCENARIO: INFORMAL AND FORMAL LEARNING, ENGAGED

The scenario consists of a Learning Environment (LE) adapted to a specific subject that compiles learning resources, tasks, and interactive activities, for future online teachers and tutors. These teachers and tutors have to get up-to-speed with techniques, processes, and strategies to foster, encourage, and facilitate actual learning and a clear methodology between the students. We integrate the i-LIME system in the Learning Environment of UNIR (UNIR LE), and hence the scenario is supported by two components: 1) the Virtual Campus at UNIR (UNIR LE), in which all the degrees lean on, and it is very much focused on daily administrative issues and scheduled events and activities (the formal component); and 2) the i-LIME component (the informal component, namely the Adaptation Management System-AMS) (Figure 2). This technical setting supports the open interaction between peers and between other target groups (i.e. learners, teachers, tutors, admin staff, et cetera). The overall system does require the following minimum software on the client side: Windows XP/7 or Mac OS X 10.x, Firefox 13.x or Explorer 8.x (both with Javascript habilitated). On the server side: the UNIR LE, Drools Engine, Microsoft Excel, PHP 5.x, Apache 2.x.

Our learning scenario (e.g. case study) was deployed from July 2nd, to July, the 29th, 2012. To this regard, we used a graduate course on “Design and management of research projects”, in the Master of Science in eLearning and Social Networks, an online, official master degree at the International University of La Rioja (UNIR). This course took place between July, 2nd and July, the 26th, 2012, with 49 enrolled students. All the students but 1 took part in the experiment. Therefore, we count 48 graduate students, between 35 and 45 years old, from 2 countries (Spain -45 students-, Colombia -3 students-) and 2 continents (Europe, South America), with a gender distribution of 28 females and 20 males.

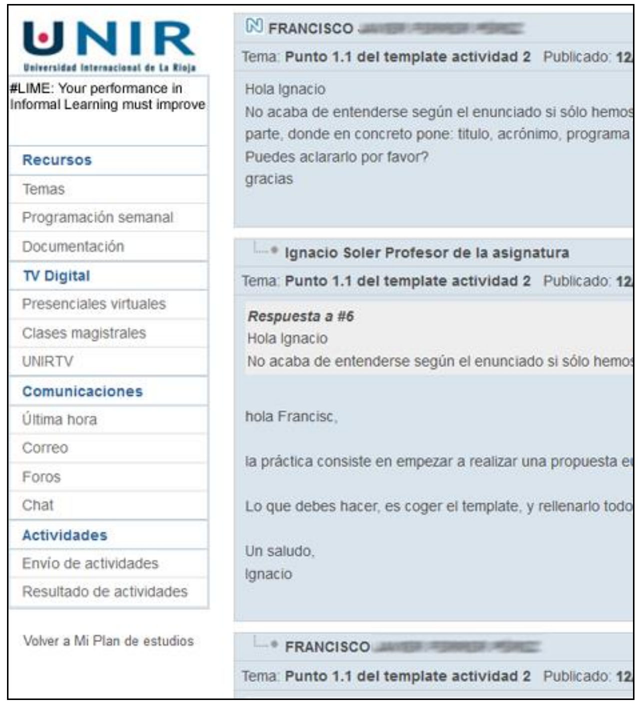


Fig. 2. Screenshot of the UNIR LE engaged with the i-LIME component

The support group consists of a teacher, an online tutor, an academic coordinator, and a master director. In addition, other cross-support departments might provide some assistant (i.e. administrative, legal, counseling, research, library, stages, et cetera). The environment is executed by every user only if the (s)he agrees with the terms described in a formal document, so that the recording of the their private date and tracking are explicitly authorized.

We have split the base group in two, equally distributed (24 members for each group). Group A (experimental) is engaged with the LIME model and receives personalized recommendation based on a number of inputs, including traditional (e.g. teacher, tutor, admin staff). Group B (control) follows the course, without the LIME model, and receives traditional support only. To make a balanced distribution of Groups A and B, on order to achieve a similar starting point, we take the previous results and evaluation. This master degree deploys the subjects in the academic program sequentially, and 9 subjects have already carried out. Therefore, there is a statistical information, quite valuable to evenly distribute members between groups (control and experimental). The final distribution is shown in Table 3 and Figure 3:

This distribution works with the individual average score after 9 subjects, out of 10-point maximum. It splits the final score of every group member in Formal (e.g. presence examination) and Informal (i.e. auto-tests, participation in online lectures, et cetera). Formal takes 60% of the final score; Formal provides 40% to the final score, based on a total of 100%. According to

TABLE 3: SAMPLE DISTRIBUTION BASED ON PREVIOUS ACADEMIC RECORDS

Group	Sample	Distribution	Formal	Informal	Total
A	24	Average Group A: Experimental	4,13	3,73	7,86
A	24	Maximum Group A	5,80	4,00	9,80
A	24	Minimum Group A	3,00	2,40	5,40
A	24	Standard Deviation Group A	0,81	0,53	1,19
B	24	Average Group B: Control	4,05	3,69	7,63
B	24	Maximum Group A	5,60	4,00	9,60
B	24	Minimum Group A	1,70	2,40	1,70
B	24	Standard Deviation Group A	0,88	0,58	1,67
Total	48	Average Total Sample	4,09	3,71	7,75
Total	48	Maximum Total Sample	5,80	4,00	9,80
Total	48	Minimum Total Sample	1,70	2,40	1,70
Total	48	Standard Deviation Total Sample	0,83	0,55	1,44

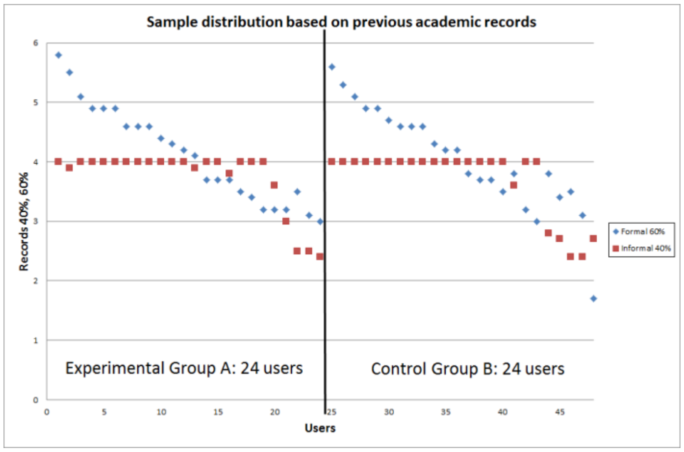


Fig. 3. Sample distribution based on previous academic records

This distribution works with the individual average score after 9 subjects, out of 10-point maximum. It splits the final score of every group member in Formal (e.g. presence examination) and Informal (i.e. auto-tests, participation in online lectures, et cetera). Formal takes 60% of the final score; Formal provides 40% to the final score, based on a total of 100%. According to the data provided in Table 3, there is a balance between Groups A and B that shows similar scores in every category, although the standard deviation is slightly different (1,19 in Group A versus 1,67 in Group B). This difference comes from a single member in Group B, who scores the minimum (1,7), while the previous one scores a total of 5,5. We can conclude that the starting point for both groups is quite similar, so that the experiment starts in the same context.

VI. LIME MODEL APPLIED TO THE LEARNING SCENARIO

With regards to the LIME model, we follow the pattern Informal50-L40-I40-M20, which the following basic rationale**:** "Informal and formal settings matter alike. Inputs from the user and the group make 80% of the total, being Mentoring actions taken as support and collateral ones. The Learning Environment (LE) is taken as the learning and communication platform, as well as the summative and formative resource for assessment". This model allows for an optimum adaptation to the features of the Learning Environment at UNIR, since combines formal and informal contexts, and supports self-learning and learning from others, including mentors (i.e. teacher and tutor). In addition, this pattern encourages the use of Units of Knowledge (UK, made of Learning Objects combined with complementary information), and Personal Learning Network (PLN, made of LO and UK, along with all the interaction elicited from other users).

Based on this model, the level of integration with UNIR's Learning Environment, the learner sample, the subject, and the overall objective, we have defined a set of Inputs, which will be used as a base to write the appropriate adaptation rules that will feed the LIME model (Figure 4**Fig**):

ID	Category	Setting	Input	Weight		
				Abs	Rel 100	Rel 40
	Learning		Input Learning Subtotal	100,00%	100,00%	40,00%
			Input Learning Informal	50,00%	50,00%	20,00%
	L		Input Learning Formal	50,00%	50,00%	20,00%
			Subtotal Learning	220,00%	100,00%	40,00%
			Subtotal Learning Informal	140,00%	50,00%	20,00%
			Subtotal Learning Formal	80,00%	50,00%	20,00%
L1	Learning	Informal	Post a message	10,00%	3,57%	1,43%
L2	Learning	Informal	Post a discussion topic	20,00%	7,14%	2,86%
L3	Learning	Informal	Meet a milestone	30,00%	10,71%	4,29%
L4	Learning	Informal	Upload a learning object	30,00%	10,71%	4,29%
L5	Learning	Informal	Enrich own learning object	40,00%	14,29%	5,71%
L6	Learning	Informal	Activity rate of recent contribution	10,00%	3,57%	1,43%
L7	Learning	Formal	EVAL: Self examination	20,00%	12,50%	5,00%
L8	Learning	Formal	EVAL: Continuous evaluation	40,00%	25,00%	10,00%
L9	Learning	Formal	EVAL: Self test	20,00%	12,50%	5,00%

ID	Category	Setting	Input	Abs	Rel 100	Rel 40
	Interaction		Input Interaction Subtotal	100,00%	100,00%	40,00%
			Input Interaction Informal	50,00%	50,00%	20,00%
	I		Input Interaction Formal	50,00%	50,00%	20,00%
			Subtotal Interaction	230,00%	100,00%	40,00%
			Subtotal Interaction Informal	205,00%	50,00%	20,00%
			Subtotal Interaction Formal	25,00%	50,00%	20,00%
I1	Interaction	Informal	Complete the profile	35,00%	8,54%	3,41%
I2	Interaction	Informal	Select topics	25,00%	6,10%	2,44%
I3	Interaction	Informal	Reply a post	20,00%	4,88%	1,95%
I4	Interaction	Informal	Rate a post	15,00%	3,66%	1,46%
I5	Interaction	Informal	Reply a discussion topic	30,00%	7,32%	2,93%
I6	Interaction	Informal	Rate a discussion topic	15,00%	3,66%	1,46%
I7	Interaction	Informal	Discussion activity	35,00%	8,54%	3,41%
I8	Interaction	Informal	Enrich other's learning object	30,00%	7,32%	2,93%
I9	Interaction	Formal	Link from-to an external subject	5,00%	10,00%	4,00%
I10	Interaction	Formal	Collaborative work rate	20,00%	40,00%	16,00%

ID	Category	Setting	Input	Abs	Rel 100	Rel 20
	Mentoring		Input Mentoring Subtotal	100,00%	100,00%	20,00%
			Input Mentoring Informal	50,00%	50,00%	10,00%
	M		Input Mentoring Formal	50,00%	50,00%	10,00%
			Subtotal Mentoring	285,00%	100,00%	20,00%
			Subtotal Mentoring Informal	105,00%	50,00%	10,00%
			Subtotal Mentoring Formal	180,00%	50,00%	10,00%
M1	Mentoring	Informal	Trust rate from a peer	25,00%	11,90%	2,38%
M2	Mentoring	Informal	Trust rate from an expert	30,00%	14,29%	2,86%
M3	Mentoring	Informal	Reputation rate from a peer	20,00%	9,52%	1,90%
M4	Mentoring	Informal	Reputation rate from an expert	30,00%	14,29%	2,86%
M5	Mentoring	Formal	EVAL: Final assessment	60,00%	16,67%	3,33%
M6	Mentoring	Formal	EVAL: Tracking assessment	60,00%	16,67%	3,33%
M7	Mentoring	Formal	Trust rate from a teacher	20,00%	5,56%	1,11%
M8	Mentoring	Formal	Reputation rate from a teacher	10,00%	2,78%	0,56%
M9	Mentoring	Formal	Interesting topic rate	10,00%	2,78%	0,56%
M10	Mentoring	Formal	Significant contribution rate	10,00%	2,78%	0,56%
M11	Mentoring	Formal	Quality of reply	10,00%	2,78%	0,56%

Strategy		Check
Cat-Setting	Weight	
Informal	50,00%	Ok
Formal	50,00%	
Learning	40,00%	Ok
Interaction	40,00%	
Mentoring	20,00%	

Fig. 4. LIME model for the application scenario. Settings, Inputs and Strategy

This set of inputs gathers most of the requirements of the LIME model, including Trust, Reputation, Assessment, Evaluation, formal activities, and informal actions. In doing so, we select a representative amount of inputs, across a variety of types, which feed (back and forth) the LIME model. We have assigned the EVAL inputs to Formal settings, since the EVAL inputs in Informal settings would have required a specific assessment model for informal learning, which is not a topic of this research, although and interesting one for the future.

The system retrieves input data and provides recommendation once a week. Since the selected subject lasts 4 weeks (from July 2nd, to July 29th), we have established four milestones in months 8, 15, 22 and 29. These milestones store the specific data for every input and user incrementally, so that we can analyze the evolution of any specific user, with and without recommendation. At the end of the period (M29), every user in Group A (experimental) has received a considerable amount of recommendations, which might or might not lead to a higher performance, and to and improvement throughout the activities and actions in the Learning Environment.

About the timeline, the recommendations are provided through the milestones M8, M15, M22 and M29. However, there is no rule defined to adapt these recommendations to the user progress. Therefore, they have to be taken in close relation to the timeline. For instance, in M8, the recommendation R9 about Evaluation (see Table 4) will be likely provided to everyone, since there is little time since the beginning to the course up to M8 to carry out the activities and actions related to the Evaluation. However, in M15, and in M22, since the course is running for a longer time, it is expected that R9 will be provided to less people, decreasingly, until the final recommendation in M29, which will show the actual performance on Evaluation of every learner. Therefore, the recommendation has to be put in context of the timeline and the user (i.e. learner, tutor, and teacher) has to achieve a contextualized, appropriate reading, in order to act accordingly. Other potential contexts might be: the user status, in relation to previous subjects; the user status, in relation to the group; the user status, in relation to other groups of the same graduation; the group status, in relation to other groups of the same graduation; the group status in relation to historic records; et cetera.

Once the experiment is finished, we analyze the overall data, in order to extract group information, behavior patterns, abnormal actions, and other relevant information which will allow for a refinement of the LIME model and, if possible, the i-LIME software development and implementation.

This stored information is processed by the recommendation rules in DROOLS (language for rules processing), which takes the raw figures, applies the LIME model, and provides a recommendation on the learning itinerary. For our research, we have implemented a rule-set, adapted to this specific learning scenario and context. This rule-set must be defined by the learning designer (e.g. teacher) and it applies the LIME model based on the collected figures, and the style that the designer wants to reach, in addition to group goals and individual thresholds. In our case, the pseudo-code that describes the rules is as follows (Table 4):

TABLE 4: DEFINITION OF RULES

RuleID	Applied to	RulePseudoCode
R1	Input (e.g. L1 or M3)	IF any input is lower than maximum AND higher than or equal to ½ maximum THEN positive feedback about this specific input
R2	Input	IF any input is lower than ½ maximum THEN warning about this specific input
R3	Subset (Informal-Formal)	IF any subset of inputs in a category is between maximum AND ¾ of maximum THEN positive feedback about the subset
R4	Subset (Informal-Formal)	IF any subset of inputs in a category is between ½ maximum AND ¾ of maximum THEN warning about the subset to the learner and to the tutor
R5	Subset (Informal-Formal)	IF any subset of inputs in a category is lower than ½ maximum THEN warning to the learner and to the teacher, recommendation of interaction with others and the tutor and the teacher, locking of further activities in this category until the threshold (1/2 maximum) is reached
R6	Category (Learning, Interaction, Mentoring)	IF any category is between maximum AND ¾ maximum THEN positive feedback and recommendation of complementary tasks
R7	Category (Learning, Interaction, Mentoring)	IF any category is between ½ maximum AND ¾ maximum THEN warning about the category to the learner, the tutor and the teacher; request of support from other learners
R8	Category (Learning, Interaction, Mentoring)	IF any category is lower than ½ maximum THEN warning to the learner and to the teacher, recommendation of interaction with others and the tutor and the teacher, request of support from other learners, locking of further activities in this category until the threshold (1/2 maximum) is reached
R9	EVAL	IF any EVAL input is lower than ½ maximum THEN locking of activity, request of interactive session with teacher, request of resubmission of activity-action

The specific coding of every rule looks like the following one, described for R1 (Table 5):

TABLE 5: EXAMPLED-PSEUDO CODE FOR RULE R1

RuleID	Rule Coding	Recommendation provided, adapted to L1
R1	IF (L* OR I* OR M* < REL X) AND (L* OR I* OR M* >= 50%*REL X) THEN R1("Positive feedback to USER")	"Well done, when you post a message"

Technically, the raw data were stored in text files, which were translated in tables (XLS type) for easier representation, calculation, and analysis. A software application was created to analyze these files and extract the information from the XLS files. The particular scenario described here should be taken into account in order to interpret the obtained data. Each time the user executed an action foreseen in the LIME model, all the related information from that specific user was written into a log file. Every record is uniquely identified, and consists of basic ID information (i.e. date and timestamp of the event, action taken, user) and specific values provided according to the input (i.e. reputation, trust, assessment, other rates). There is an additional field with warnings, errors, and comments from the system. The information extracted from the log files was inserted into a database (XLS type) in order to organize the information and to make the information process easier. See Figure 5 for a simplified representation of the described application scenario in combination with the Adaptation Management System, which depicts the information flow from-to the end user.

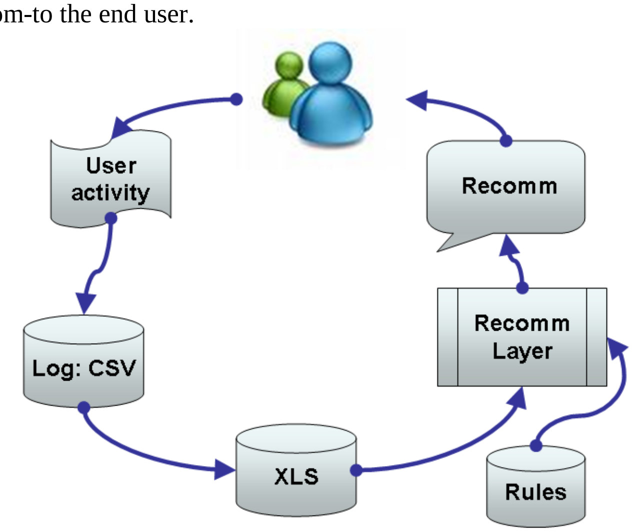
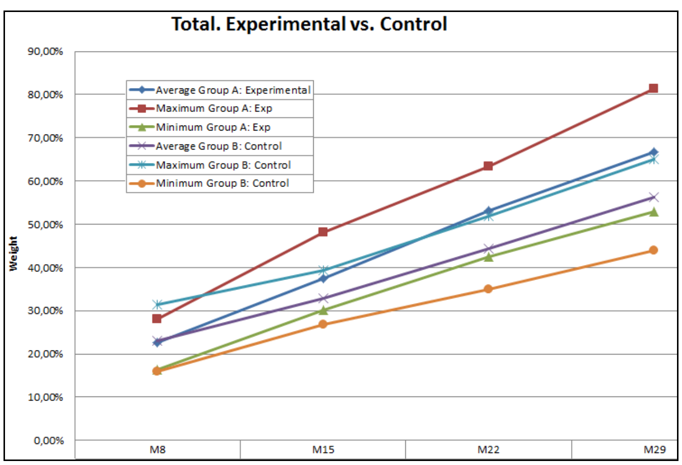


Fig. 5. Application scenario in combination with the AMS. Information flow

VII. Results and Analysis of the Application Scenario



M8	M15	M22	M29
22,61%	37,47%	53,09%	66,72%
28,15%	48,07%	63,36%	81,41%
16,42%	30,12%	42,48%	52,88%
23,01%	32,83%	44,39%	56,19%
31,32%	39,28%	51,94%	65,06%
16,05%	26,88%	35,06%	44,04%

Fig. 6. Total results. Experimental group versus Control group

In Figure 6, we compare final, general results of the experimental group (A) in opposition to the control group (B). We provide data for the four milestones (M8, M15, M22, M29), and three variables per each: Maximum score, Minimum Score, and Average Score. Therefore, we analyze a six-line web along four weeks. As expected from interviews with end users and the Delphi study, the final score is higher with the experimental group (A:66,72% vs. B:56,19%, in M29, over a 100% top). However, the crossed lines show a higher average position of the control group in M8 (A:22,61% vs. B:23,01%), before a linear increase up to M29. In addition, the maximum score in M8 is higher at the control group (A:28,15%; B:31,32%). These two higher scores at the control group at the beginning show a symptomatic progress of the impact from the recommendation system: although in the beginning A and B can be alike, or even B shows a higher rank, the systematic application of recommendations through the i-LIME environment overcomes the evolution without the LIME model

VIII. Conclusions and Future Work

L.I.M.E. provides an optimized formula which allows for finding the balance between all the inputs related to the online learning, as in our vision. The model describes the right weight for every input, directly related to the effect to achieve along the process and every role. Based on the ground objectives, the learning scenario will define the required interaction between inputs, roles, categories and settings. The model is based on behavior, performance and the relation among the end user, himself and the peers. Furthermore, there are four main pillars or vectors: Learning, Interaction, Mentoring and Evaluation (aka L.I.M.E.). Each of them provides a key to define the relation of the user within the mode, which is translated into a set of interconnected rules. Based on what the user does in the system, and how this web is weaved, the model provides the user with personalised guidance, dynamic along the timeline, which allows for a stable tutoring support along the learning process.

In order to validate the L.I.M.E. model, we have designed and implemented a learning scenario, during 4 weeks, and counting 2 groups (experimental-A and control-B) of 24 members each. The application of the model to the described scenario shows a clear and positive progress of the users in group A, those who received recommendations by the system. The overall average of inputs, categories and students shows a final positive difference of 10,53% between the experimental group and the control group (66,72% - 56,19%), in addition to a maximum difference between corners of 37,37% (81,41% - 44,04%). These results become a tangible proof for the success of the L.I.M.E. model, based on a large number of objective measurements. They back up the conceptual design from a practical experience. Furthermore, they support the combination of inputs and categories provided by L.I.M.E., which facilitates personalized counseling to the end-user, leading to an improvement of his average performance, implemented in the context of a thematic, restricted social network, and learning scenario which engages formal and informal settings, through learning activities and user interaction.

Future work points out at an early definition phase that should take into account every single role (i.e. student, teacher, admin, et cetera). This involvement should not come from the instructional designer only, but from actual users from every target group. In doing so, the designer builds an ecosystem which plays with every actor from inside, and not only a scenario in which the users are included from outside. In addition, the model would benefit of a more precise balance between settings, inputs and categories. The combination of these is crucial for a good use of the system. In our application case, we use a neutral approach, so that we did not influence the results because of an early selection of these elements. However, no matter what the selection is, since it always affects the result, even for being neutral. A clear definition of the implications and co-lateral effects of each configuration would better support the match between objectives and expectations from students, tutors, and instructional designers

ACKNOLEDGMENT

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A Predictive System Informed by Students' Similar Behaviour

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Abstract: It is quite complex to adapt instruction to student needs in view of online education owing to the ensuing communication disconnection in such learning environments. Decision support schemes offer assistance by automatically gathering students' data and forwarding them to the tutor in the appropriate perspective, in order to predict their behaviour and implement some action beforehand to avert or promote the final upshot. This study shows of a decision support scheme known as u-Tutor that is centred on the similarity computation between learners in the past, and how it was used in a real-case scenario. For this case study, this tool has been utilized by two real courses comprising of 392 learners alongside academic faculty, as of 2015 to 2019. The analysis offered focuses on 3 research areas: (1) perceived usefulness, (2) usability of the tool and (3) success rate of classification. From the acquired data, it can be seen that the teaching group managed to offer excellent approximations for those learners who eventually managed to pass the course, whereas u-Tutor seemed to be an early warning for learners at risk, indicating its capacity as a tutors' supportive tool.

Keywords: recommender systems; learning analytics; student's behaviour; background similarities; learning management systems

1. Introduction

1.1. Data Analysis and Learning Analytics

Methods of data analysis are presently receiving attention from educational research literature as a study field. When used in education, data analysis may be perceived from two dissimilar viewpoints: learning analytics and education data mining. The latter concentrates on algorithms, techniques and how to have them improved, while the former deals with how benefits are obtained by the educational scenario using these methods [1]. Learning analytics seeks to analyze the data arising from educational settings and come up with information to be considered in enriching the process of learning/teaching. Learning analytics methods may be utilized in numerous diverse educational environments, like distance, face-to-face or blended. For instance, Vieira, Parsons, and Byrd [2] examined 52 literature papers, from which 3 belonged to classroom settings, 30 to blended learning settings and 19 to online learning settings. As a result, it was apparent that the literature reviewed the ideal focus of the implementation of learning analytics to distance learning settings.

Moreover, distance learning is highly relevant in the learning analytics area based on two key reasons: to begin with, in online settings, both tutors and learners take part in a virtual learning environment (VLE) as their major interaction point. As a result, it is simpler, compared to blended or classroom environments, to capture the activity of most of the participants in the course [3]. The methods of data capture are, specifically, a research topic in the area, based on the existing literature [4–6]. In addition, online education is burdened with communication discontinuation [7,8]; based on this, it is particularly pertinent to create informative techniques to comprehend the course proceedings and the learning procedures of the students. As broadly examined by Mangaroska and Giannakos [9], the relationship between learning design and learning analytics has acquired mounting interest in the Technology-enhanced Learning (TEL) environment, given the potential of learning analytics tools in informing data-driven design decisions. Consistent with Vieira et al., [2] learning analytics methods may be used for numerous diverse purposes: comprehending teamwork, instructional design, comprehending motivation, enhancing reflection, or examining usage behaviors, among others.

1.2. At-Risk Learners

Of all the recognized objectives, early detection and mark prediction of at-risk learners have been examined in numerous studies. For instance, Jayaprakash et al. [10] and Bainbridge et al. [11] utilized activity logos merged with demographic data to attain early detection of at-risk learners, where more than 80% of such students were detected effectively. Identical results were offered by Cambruzzi, Rigo, and Barbosa [12], where the scholars examined distance learning and highlighted an architecture with the ability to capture and analyze data from diverse sources. Another study by Agudo-Peregrina et al. offered a similar illustration by analyzing the association between dissimilar variables and academic accomplishment, and identified a positive correlation in online courses but nil association in classroom settings. The findings, therefore, highlight the significance of educational environment in the success of a predictive analysis. Another study by Romero et al. [5] discussed the mining of forum interactions to estimate the performance of the students. There is ample literature in this field, like Papamitsiou and Economides [13], who were able to ascertain 17 research papers where the objective was to predict performance. Regardless of all the studies and development struggles in the scientific literature, Prieto et al. argue that integration problems presently remains inexplicable in view of learning analytics [14]. The scholars argued that regardless of the present increment in the learning analytics interest, their integration in daily classroom practices is still stagnant, while they ascertain the intricacy of communication among diverse stakeholders engaged in the procedure of implementing a learning analytics revolution in the classroom level as a key issue meriting discussion [13]. Alleged expediency and usability are equally issues influencing the integration of any technological invention, thereby being considered intricate and significant topics being examined in learning analytics systems [15]. Based on this, the facilitated solutions ought to be applicable, besides having a clearly explicable value that makes use of participants in their practical application.

As stipulated above, alleged expediency and usability are significant drivers in the integration of learning analytics. The present paper seeks to offer an experiential case study in validating the usefulness and usability of u-Tutor (the motto in full is *Alumni Alike Activity Awareness*) in a realistic situation. For this study, the precision of u-Tutor has been evaluated as a predictive system. Empirical literature is specifically pertinent in the learning analytics sector, given the fact that a significant number of the most-cited papers are theoretical rather than empirical [16]. Other sections of this study are as follows: the subsequent section offers a description of educational and technological details to comprehend the setting in which the case study was conducted. This is followed by the explanation of the research questions considered in the study. After that, the case study's methodology is explained in depth while the results and discussion of the results are offered in the last chapter.

2. Case Study Contextual Description

2.1. The Technological Context

In accordance with de-la-Fuente-Valentín and Burgos, u-Tutor is a decision support approach considered in the prediction of the behavior of the students by analyzing the similarities of present students to those from background courses [17]. This analysis has been correlated (by behavior prediction approach) with the scores of learners from previous courses attained upon completion of the course. Tutors/teachers are facilitated with a visual depiction of the learners in present courses and a measurement regarding the similarity of the present students with the learners from the previous courses. According to Shneiderman, this means that the tutor is able to have a fast overview of the course status in addition to acquiring information upon demand [18]. By offering tailored information regarding persons, u-Tutor enables the tutor to personalize instruction to the needs of the learners, where the tutor is the adaptation's key driver, while the tool becomes the information source. So as to foster institutional implementation of the tool, the technique involves the smooth incorporation being integral to the workflow of the teachers, while ensuring the significance of the solution and the usability of the tool are taken care of.

For the present study, any learner admitted in an academic course has been designated as a 'student', the professor as a 'teacher' and the assistant offering support to students all through an academic year as a tutor. In this specific context, the similarity of two students holds when they generate an identical event log within a certain arbitrary duration (for this study, 3 weeks). The measurement of similarity is founded on the event type and the total times per event repetition (such as four forum view, seven course content views, as well as a single activity submission), with the calculation having a subject scope (the ability of two students being identical in a certain subject and different in another subject). De-la-Fuente-Valentín and Burgos [17] provide a comprehensive discussion of similarity metrics. The design of u-Tutor is meant for online, distance settings with VLE being the tutors' interaction point with the peers and the course material. This context means the tutors possess regular consultancy time with the students, while it is imperative to identify similar students for the purposes of optimizing such consultancy. For the purposes of explaining the process of information retrieval from u-Tutor, the subsequent example has been presented: Simon (a student), is admitted in a programming major expected to run for 3 months and presently in its third week. Considering the preceding course edition (with equal duration and identical learning accomplishments, accessible tools, and pedagogical approach), other students' activities were captured by the monitoring system and now it is capturing the activities of Simon. Therefore, the pattern for Simon's activity (that is, the total occasions of dissimilar activities) is evaluated against that of the previous course's students and gives a feedback regarding the similarity of Simon against that of each historical student. This is followed by a visual comparison between the similar information and the resultant score in the following approach: the grouping of the previous courses' students is done founded on their attained score (from 0–1, 1–2, and so on, on a scale of 0–10). The calculation of Simon's similarity with a group is done by the u-Tutor as the average similarity of all the group's students. This similarity value is used to pick the color to denote the specific group in the visualization (with a higher similarity being epitomized by darker colors). The resultant visualization has been portrayed in Figure 1, indicating the behavior of Simon is similar to the students who attained a score ranging from 4–8.

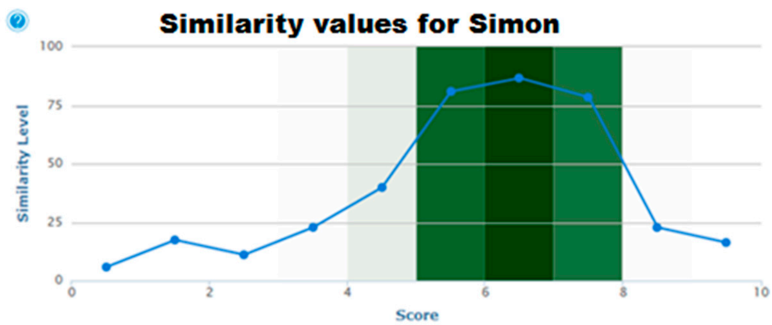

Figure 1. Student-centred view of similarities.

The teacher/tutor interface indicates students (current course) as rows. Figure 2 portrays the resultant visualization.

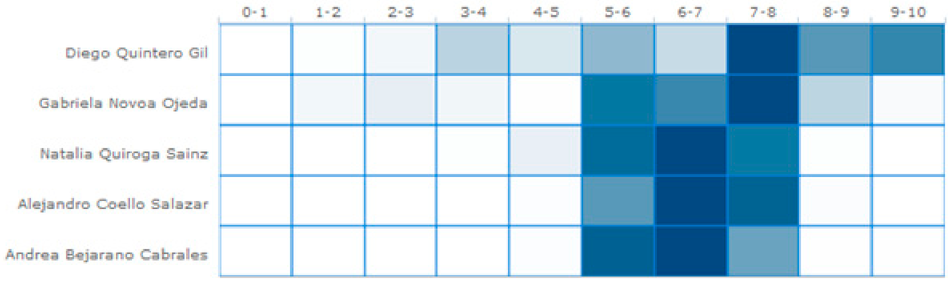

Figure 2. Grid view of similarities.

Rather than essentially approximating the score of Simon, u-Tutor is actually indicating the average score of the same historical students. This estimation is achieved by visually interpreting the Figure as observed. The tutor has systematic and personal communications with all the students either by use of emails or phone calls. This means that a tutor is aware of the student's personal situations and is able to contextualize the information through visualization and interpreting it, while engaging the necessary decision when required. There are three visualization approaches for u-Tutor: to begin with, global view is a pie chart classifying learners as 'at extreme risk,' 'at risk,' 'pass,' and 'outstanding.' This is followed by the grid view (refer Figure 2), with each student being represented by each row. Grid view is split into tabs, a single tab for each of the categorization in the global perception. The student-centric view (Figure 1) portrays the comprehensive information about a single student, incorporating a line having the similarity values. Additional information regarding the u-Tutor may be acquired from de-la-Fuente-Valentín and Burgos [17,19].

2.2. The Educational Context

The setup deployment was done on the implemented courses at the Universidad Internacional de La Rioja (UNIR), an online-distance learning institution in Spain, South America and USA, where most of their 40,000 students are Spanish and Latin Americans. The case study concentrated on two courses, both implemented in Spanish, "Web Projects Management" and "Web Services Administration," two parts involving 4-week duration and the same master's course. The courses were defined by the following features: a total of 392 students took part per course, for both courses. The distribution of each course is done using pools of 35 and with a specific teacher allocated, called tutor, with a total of 12 different tutors. The two courses commenced and completed with equal durations. In addition, throughout the 4-week duration, the students accomplished numerous activities and had them submitted by the final day of the course. These marks were evaluated at 40% of the overall marks. Besides that, the last face-to-face assessment facilitated the remaining 60% of the total marks. However, the online activity did not only comprise of the face-to-face activity. Further, several tutors tracked the activity of the students throughout the master's program and facilitated them with customized advice. As discussed, a total of 12 tutors were involved in this study. Additionally, it was required of the students to pass the course for the purposes of obtaining the master's degree. Lastly, the preceding courses considered in estimating the similarity measures included the course's 9 previous editions, where over 500 students were admitted in total.

Given the application of u-Tutor by the tutors in the present case study, there is the need to define the tutor's role in the learning process. The master's programme comprised of 20 independent courses, at a 4-week average duration. The initial two courses at the onset of the master's program and the subsequent two courses commence when the initial has finished. The courses considered as the study's subjects ("Web Services Administration" and "Web Projects Management") were conducted during the middle of the semester. The students were given support by the tutors throughout the 9-month duration of the master's course. Practically, the function of the tutor is to supervise and follow-up on the progress of the students from a transversal point of view, knowing them and offering support to them in their personal situations. For instance, the tutors are able to call the students, should they notice a decrement in the students' performances or if the tutors foresee a potential student drop-out. The tutor is able to understand the background of the student and approaches them beyond the range of a single course; this personal comprehension of a student's condition enables the tutor to relate any information emanating from the student.

3. Research Areas and Related Research Questions

The case study discussed was overseen by three research areas that were depicted in five research questions. The analysis considered the experiential setting as an entire entity, seeking the context for better comprehension of the observations. Instantaneously, the observations sought to answer several research areas expressed in a number of research questions that guided the researchers in focusing their efforts. The five research questions cover the areas of (1) perceived usefulness, (2) usability and (3) success rate of classification.

3.1. Perceived Usefulness

Notwithstanding the precision of the learning analytics algorithm, the integration process necessitates the usefulness of the tools. To this level, and beyond the tool's success rate in students' classification, the case study analysis ought to authenticate whether the tool was competent for the tutors and if it could be integrated into their daily workflow. As a result, the present case study comprises of mechanisms to evaluate the frequency of the tool's application and whether it actually endorsed the tasks of the tutors. The other key aspect under consideration is the tool's impact on the workflow of the tutors, that is, whether the tutors excluded or included activities in their daily obligations as a result of the u-Tutor application. The study duration of 4 weeks might have been insufficient to offer ideal changes in their workflow but it offered awareness into the impact of the tool. For this study, the definite research questions are as follows:

- [RQ1] What is the alleged practicality of u-Tutor?
- [RQ2] How effective is u-Tutor in causing tutor actions that would not occur without the tool?

3.2. Usability

Consistent with Lukarov and colleagues, usability is observed as a significant topic meriting assessment in learning analytics systems [15]. Thus, the design and application of a visualization tool ought to integrate usability by design, while the tool's validation ought to authenticate its usability. The design and creation of u-Tutor have considered an iterative method in refining the user interface [18]. The third specific study question is as follows:

- [RQ3] Do the tutors comprehend and be familiar with using the visual information and the interface options?

3.3. Success Rate of Classification

When it comes down to it, u-Tutor functions as a decision support system which is considered dependent on estimating students' results and categorizing them based on this prediction.

Therefore, it is imperative to verify the accuracy of the classification. The definite research questions included here are:

- [RQ4] To what extent do the classifications match the actual results?
- [RQ5] To what extent do the classifications match the tutors' beliefs?

The analysis of these questions follows a quantitative approach by comparing the estimated marks with actual marks.

4. Methodology

4.1. Settings of the Case Study

The work offered in this paper adheres to a case study methodology. This means that the u-Tutor approach was considered in a real setting using an online learning platform and gave its application to the tutors. The case study analysis is founded on observations made and data gathered from the instruments discussed in the Data Capture Methods section. u-Tutor has been configured for application in the courses previously discussed. This means that u-Tutor acquired events from the Learning Management System and analyzed them for the purposes of developing the similarities' visualization. Besides, as evident from Figure 3, u-Tutor was incorporated into LMS user interface, facilitating an easier access of the tool. It is easy to realize the Spanish language in some of the Figures since the course was implemented in Spanish.

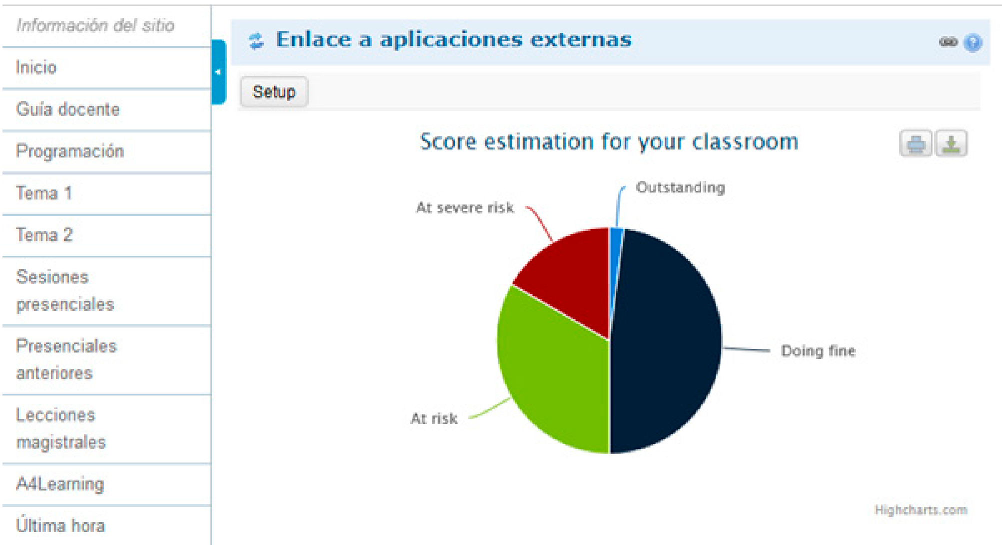

Figure 3. u-Tutor integration in the LMS.

Regardless of the course duration of 4 weeks, the case study only lasted for two weeks. The main reason is that, since the tool retrieves information from other previous courses and compares that information with current student's behavior, the tool requires a user tracking on the current cohort to be able to make the comparison and provide some useful insight. With insufficient data from the present, the coupling with the past becomes meaningless. Further, to avert the cold-start influence, the setup of the tool was done at the course onset but given to the tutors on the beginning of the course's third week. This was followed by assisting the tutors in a training session where the researchers discussed the tool's functionality and characteristics. Once this was done, the tutors were awarded login credentials to access the tool and inquired to freely interrelate throughout their daily tasks, utilizing the tool at their own speed. The tutors were asked to revise the status of the students in u-Tutor prior to getting in touch with them. Based on the framework suggested by Drachsler and Greller [20], the learning analytics' set-up in the present study uses the dimensions discussed below (Table 1).

Table 1. Set-up of learning analytics in this case study.

Dimension	Values
Stakeholders	*Data subjects*: The students *Data clients*: Tutors
Objective	*Reflection*: The system captures similarities among students to inform the tutor about the marks obtained by those who, in previous courses, behaved similarly to a given student.
Data	*Protected dataset*: Students' interactions within the LMS *Time scale*: The interactions were analysed within a frame of 3 weeks.
Instruments	*Algorithms*: Similarity measurements as described by de-la-Fuente-Valentín and colleagues [18]. *Visualization*: Graphical solution designed to support this tool
External limitations	*Ethics*: What are the dangers of misinterpreting the data? *Data protection*: The students have the legal right not to be analyzed.
Internal limitations	*Required competences*: Will the visualization be eloquent enough to be easily understood by the tutors?

4.2. Data Capture Methods

The researchers were guided by the subsequent artefacts in observing the case study:

Throughout the courses, integration of human-estimation was done into the single-student perception given by u-Tutor as a simple interface using a slider that enabled the user to provide an approximation of the student's present mark. This interface (portrayed in Figure 4) was unsystematically opened upon accessing the single-student view capable of being closed or opened upon request. In the recent study, the input attained by this means is referred to as 'estimation' or 'human' among the observations made and there are those which necessitatd further description. For these cases, the researchers reached the tutoring team using emails. The communication process was considered reliable and the emails did not take more than a single day. u-Tutor comprises of an interface enabling reporting of a problem (Figure 5). The primary idea was to acquire functionalities anticipated by tutors but not guaranteed by the tool; however, it was equally conisdered in capturing the tutors' generic comments. In addition, the analysis accounted for the ideal marks attained by the students in the daily activities (40%) and those attained in the final assessment (60%).

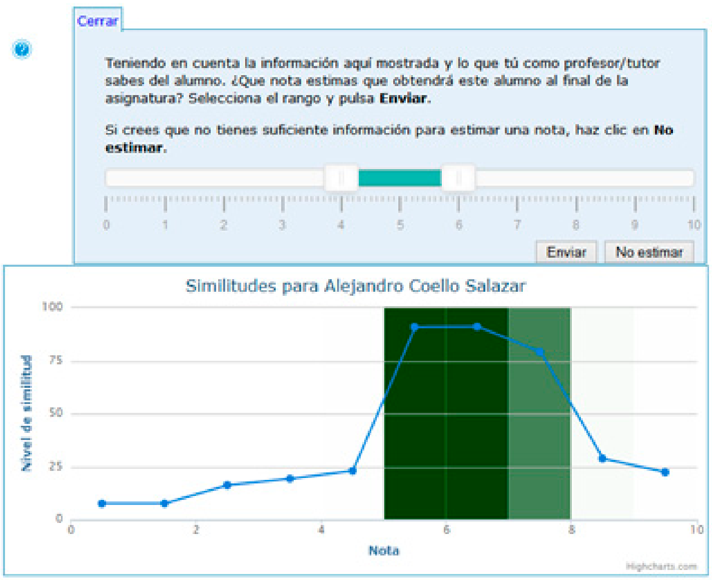

Figure 4. Human-estimation feedback collector.

Figure 5. Report-a-problem feedback interface. Closed (**left**) and opened (**right**).

A machine-determined score interval was proposed through visualization for each student with identical students in the preceding course. This was an ideal approximation that was stored for future evaluation against the real marks. u-Tutor user logs equally underwent storage, enabling an assessment of the users' interface with the tool.

Once the courses were accomplished, the tutors were presented with an online (anonymous) questionnaire with both open-text and multiple choice questions using the Likert scale approach. The questionnaire touched on the three research areas: (1) perceived usefulness, (2) usability and (3) success rate of classification (accuracy), and their overall opinions about u-Tutor. This was followed by personal semi-structured interviews, carried out and recorded in the form of video and audio conferences, comprising of all completed information from the tutors. Given the fact that the interviews were conducted after the questionnaires, preparations had to be done by the researchers through taking into consideration the answers provided for the questionnaires, even if the eventual scores were accessible.

4.3. Analysis Methods

Sticking to the codes of a case study approach [21], the analysis adheres to the exceptionality of the case and fails to generalize the results. For instance, the competence in the classification of students is dependent upon the characteristics of the present case, so the analysis seeks to establish the circumstances affected by the success rate in this specific case, rather than seeking to generalize the attained rate. The case study analysis was guided by the research areas and research questions presented under "The educational context" section, each having a dissimilar nature. With that said, each research question helps building the feedback around the related research area, and they have been analyzed as follows:

Considering research questions one and two, the researchers engaged a qualitative analysis. From one perspective, LMS usage and server log statistics were evaluated to identify whether the tutors utilized the tool on a daily basis; alternatively, the interview and questionnaire answers identified the subjective opinions of the tutors on the tool utility. The data sources triangulation was considered in reinforcing the findings. In view of the third research question, a qualitative analysis was conducted taking into consideration the questionnaire feedback, the issues reported using the report-a-problem feedback platform, and the interviews, which acquired the subjective opinions of the tutors on the tool's usability. Brook's SUS questionnaire [22] was taken into consideration but ended up being rejected owing to a decreased number of potential respondents. Last but not the least, the analysis of the last two research questions used three values: machine estimations, human estimations, and the real marks. The error and success rate estimation were done through a comparison of the estimates with the real outcomes. Besides, the questionnaire analysis estimated the attitude of the tutors towards the estimation approach. Figure 6 offers an account of the error and success rate estimation. In estimating the success rate, both machine and human estimations were founded on intervals rather than values. This means that tutors portrayed a scores interval where it was expected students would fall under.

The formula used in calculating the success rate was the total quantity of successful estimations divided by the total quantity of estimations made, as follows:

$$Success\ rate = (Successful\ estimations)/(Total\ estimations)$$

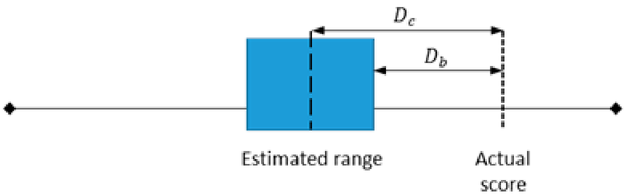

Figure 6. Estimated range versus actual score.

Further, given that estimation of the scores was done using intervals rather than values, the error measurement is expected to consider the interval size. For instance, if 8.2 is the score for a student, then an estimation [8,9] is highly accurate compared to an estimation of [5,9], regardless of the similarity of the border of the range in both instances. The formula below encompasses the range size in the error measurement with *D_b* being the distance from the actual score to the estimated interval, while *D_c* is the distance from the actual score to the center of the estimated interval.

$$Error\ in\ estimation = (D\_b + D\_c)/2$$

5. Results

As mentioned in the previous section, the courses were overseen by 12 tutors. As a result of work management issues, various responsibilities were shared amongst them, thereby influencing the manner in which u-Tutor was utilized, through coupling; one tutor played the role of actively engaging the tool and being in contact with the students, while another tutor oversaw the administrative duties without being directly involved with the students or utilizing the tool. The piloting of the study was therefore affected since it minimized the total information availed for the case study as regards to the perceived usefulness and usability. The following sub-sections show the results related to the three research areas: (1) perceived usefulness, (2) usability and (3) success rate of classification. As commented before, the author used five research questions as a way to retrieve the users' input towards a more informed analysis focused on those very areas. The research questions are addressed in the context of the research areas.

5.1. Perceived Usefulness

The platform logs' analysis considers the total times of logging in by the tutor on the u-Tutor, in addition to the part of the tool accessed by them. The application analysis is not quite meaningful by itself, but it aids in comprehending the perception of the tutor regarding its usefulness. The total number of views has been exemplified in Tables 2 and 3. The two tables focus on the previous week of each course since most of the activity among the tutors occurred during this period. Table 2 focuses on a comparison of the grouped-student with single-student view. The results indicate strong platform application on the first day and minimal application on the subsequent days. There is some logic in this since the information updates of the tool occurs on a daily basis, although the status of the students fail to change so swiftly and normally requires additional time. Besides, as discussed in the Methodology section, the training session preceded all activities. Therefore, broad application of the tool (124 single student views, out of over 392 students) at the start of the week gives an inclusive perception capable of being complemented on a daily basis with minimum intense application on the remainder of the days. Throughout the week, the tutor was able to pay a visit to approximately 29 pages on a daily basis.

Table 2. Daily views, grouped by type.

Date	Single Students	Grouped Students
Last day–0	12	13
Last day–1	19	15
Last day–2	19	41
Last day–3	15	19
Last day–4	26	116

Table 3. Views per day, grouped by classified score.

Date/Estimations Made	Severe Risk	Risk	Pass	Outstanding
Last day–0	9	2	3	1
Last day–1	15	3	4	2
Last day–2	7	9	5	7
Last day–3	3	10	4	3
Last day–4	18	16	15	17

Table 3 seeks to establish the likelihood of the tutor to perceive one of the views as highly useful in comparison to the rest; for instance, if the 'at severe risk' categorization was more interesting (hence, additional views) compared to the rest of the views. It can be seen that on the first weekday, all classifications were visited. Besides, it is evident that by the last day of the week, the 'at severe risk' and 'at risk' groups had much attention compared to the rest of the groups.

The total received estimations (equally offered in Table 3) is associated with the application statistics. This means that deep application of the tool occurred at the onset of the week. It was clear that the use of u-Tutor among the tutors was deep enough to authenticate the alleged significance of the tool. Upon completion of the course, a questionnaire (in Appendix A) and a set of interviews followed where tutors gave their feedback. Before the interview, the questionnaire answers were analyzed by the researchers. Table 4 offers a summary of answers provided as questionnaire feedback on u-Tutor's perceived usefulness. They are selected as a sample of significant answers, although the analysis is carried out by taking into account all the provided answers. Table 4 is, therefore, an excerpt of the output. A significant number of these questions were posed as multiple-choice questions, whose goal sought to use interviews in examining the reason for the answers.

An initial inquiry of the answers indicates that, at the outset, the tutors realized important information while utilizing the tool and utilized the gathered information in their everyday obligations. From the feedback, to begin with, the tutors were able to get significant information while utilizing the tool and employed the gathered data. Based on their u-Tutor application, they identified some situations and summoned the students involved (there, the eventual obligation of the tutor). Normally, they used the feedback from the tool to shape their contact with the student and provide personalized support and encouragement with specific performance and overall approach to the learning flow. In addition, the tutors identified the probability to have acquired equal information from additional sources, although u-Tutor simplified the task. Besides that, notwithstanding the total page views from the statistical application analysis (at least 30 pages on a daily basis), the tutors failed to perceive the tool integral to their workflow. Additionally, for the purposes of integrating u-Tutor in future courses, it was suggested that a few improvements be made, such as diversity in learning settings.

The third question sought to determine whether the tutors utilized the tool since they were asked to do so, or whether they actually identified significant information. This is a pertinent issue to establish the evidence validity in regards to the perceived significance, meaning that among the items mentioned in the interview, that they were equally associated with this issue. When inquired about it, the tutors who utilized u-Tutor argued that initially they considered the tool since they were asked to do so and they regarded it as additional work. Nonetheless, the tutors realized that identifying inactive students was quite an easy task and helpful. That is, they hesitantly began the application of u-Tutor but eventually recognized the positive utility of the tool.

Table 4. Summary of *perceived usefulness* questions.

	Question	Selected Answers
1	How often did you use the tool?	*Most of the time I worked in the supported courses. (Multiple-choice)*
2	About the information given by u-Tutor	*I could get the information by myself, but u-Tutor makes the task more agile. (Multiple-choice)*
3	When you used the tool, what was your purpose?	*Obtain information on the students. (Multiple-choice)*
4	Did you decide to actively support any student due to u-Tutor information?	*Yes, some of the students. (Multiple-choice)*
5	If your previous answer was 'yes', explain what type of support.	*It was easy to find inactive students. I called them to understand what was happening. (Open question)*
6	Choose the reason for your support action.	*I supported the student because u-Tutor warned me about a situation I would not have found by myself. (Multiple-choice)*
7	For what task did u-Tutor support you?	*To find students with low participation. (Open question)*
8	Did you integrate u-Tutor into your daily workflow?	*No, I did not./Yes, I have tried to integrate the tool. (Open question)*
9	Would you like to use u-Tutor in future courses?	*No, because in this case, all the marked activities are delivered at the end of the course, and I do not know if the activity is enough to classify students. It would be preferable to use it in courses with continuous submissions./ Yes, u-Tutor gives me an outstanding view of what is going on with my groups. I need to understand better how to use it more efficiently, but I think that the early results look promising and will help me in improving my support to the students. (Open question)*

Question 9 is of equal importance in identifying u-Tutor's usefulness, thereby discussing the issue during the interviews. In the questionnaire feedback, the tutors showed that they were not willing to utilize the tool for the second time when deployed under similar settings. The tutors suggested some features during the interview that would motivate them to consider using u-Tutor in future. Specifically, they proposed a tool that identifies specific students *('If I could search for a student, u-Tutor would be really useful for me')*, a student-centred view with all of a student's courses in a single view *('For the single-student view, I expected information for all the current courses in the same view')*, and already-marked activities as an additional source of the similarity calculations *('If the tool included already-marked activities, it would be really accurate and therefore useful')*.

The interview equally verified one of u-Tutor's design principles as a visual analytics approach, which is the requirement for human interpretation to have data contextualized before coming up with a decision. Specifically, the tutors argued that, *'In some cases, I found severe-risk students, but I knew their personal circumstances and know that they will do a good job,'* and *'In some cases, the estimation given for a student was in two score intervals (e.g., 4–5 and 6–7). In these cases, I selected the interval according to what I already knew about the student.'* Typically, the tutor's viewed u-Tutor as a decision-making support, but not an independent decision maker. The study further identified some weaknesses of the tool. To begin with, just as mentioned above, the tool lacks the aptitude to identify a student quickly. In view of this, the tutors argued that *'[because of not having a student search tool] using u-Tutor slowed down some of my tasks.'* This feature appears to be first-priority perfection for impending incorporation of u-Tutor into the scenario under study. The other issue raised is associated with the level of confidence, which was not utilized by the tutors. During the interviews, there was some confusion regarding the ideal functionality of the confidence level selection, although upon clarification, the tutors argued that this feature was not useful. Based on the researchers' point of view, this information is vital, especially in view of future recommendations involving the integration of confidence levels in a suitable manner. Last, but not the least, there is the need to indicate that the tutors recognized that *'A visual representation of the information helped me with understanding the statistical data from the learning management system.'*

5.2. Usability

The usability analysis sought to establish the level to which tutors comprehended and understood the application of visual information and interface options. Among the key concerns, as evident from the existing studies using u-Tutor, includes the complexity involved in substantiating the type of information offered in the visualization, specifically, the story defining the data. For effective application of this tool, it is important for u-Tutor's users to comprehend that the visualization portrays a measure of similarities with students' scores within a certain interval, and this is considered an estimate, thereby not an ideal prediction. Therefore, it is only through comprehending the story and defining the data that tutors will be able to contextualize the information; else, misinterpretations will occur, resulting in faulty decisions. For this study, there was a training session for the tutors involving explanation of the interface and the type of the visualized data by the researchers. Regarding the questionnaire, the tutors utilizing u-Tutor comprehended it as a tool that *'lets you to see the result that a student may have, taking into account students from previous courses that behaved similarly.'* During the interview, the tutors also recognized that, *'I know that u-Tutor also considers odd cases, because a student from previous courses may also have the same odd conduct.'* This quote argues that the system simply examines similarities; it does not involve judging the accuracy of a behavioral pattern. It was through this quote that the tutors realized that the main concern is the similarity measures, not really the level of activity. These questionnaire and interview quotations indicate that the tutor definitely understood the nature of the tool. The report-a-problem feedback interface was used once by the tutors in requesting a student-centric visualization. This means that the tool was considered in collecting a report from a single student (resulted being a typical situation). This type of an interface has not been facilitated by the present version of u-Tutor, hence, being considered a key usability concern and a future establishment feature. Additional questions based on the questionnaire sought to establish the intricacy of the tutors experience while attempting to comprehend the interface. Based on the answers facilitated, the tutors considered the system quite simple to use, besides being able to explicate the elements of the u-Tutor interface. Nonetheless, it was not required of them to learn a lot prior to utilizing the u-Tutor. Since the tutors did not complain about the usability issues (besides the student-centred approach), and they indicated agile application of the tool, the usability of u-Tutor is presently perceived in a stable state, with the users providing positive feedback.

5.3. Success Rate of Classification

Based on the interview data, it can be seen that tutors were unwilling to obtain automated estimates, by arguing, for example, *'You may find a student that downloads all the course content on the first day and stops interacting with the LMS. He may achieve good results, and the tool would misinterpret his data.'* This is definitely among the arguments not in favor of the utilization of analytics. As mentioned by Leony and colleagues [4], an approach to assess the analytics coverage would diminish the problem. Notwithstanding such an adverse opinion, the tutors portrayed some attitudes and answers illuminating their (relative) trust, as far as the obtained estimations were concerned. A typical example comprises the answers provided in the Questionnaire, as evidenced in Table 5. Another instance can be quoted from the interview *'[when I used the tool to make my estimations] I never selected an interval with a white color (lowest similarity).'* Based on this, it would be indicated that the visualization impacted the beliefs of tutors regarding the students. The tutors equally realized that *'In general terms, the u-Tutor estimations matched my opinion, built upon my conversations with the students.'*

Table 5. Summary of accuracy (success rate of classification) questions.

	Question		Answer
10	To what extent do you agree with the following assertions? 1 = strongly disagree 5 = strongly agree *(Likert scale)*	u-Tutor, without any contextualization, is quite often successful in classifying students.	4
11		After contextualizing information from u-Tutor, I often succeed in classifying students.	4
12		u-Tutor estimations match my estimations.	4

The opinions from tutors equally highlight one of the key features of u-Tutor as a visual analytic tool: the necessity for human interpretation of machine outcomes to have the data contextualized. The numeric breakdown of approximations and results equally supports such a requirement for contextualization. The precision of these approximations was evaluated by considering the approximations achieved by the machine (without any human construal), the approximations by the tutors (supported by u-Tutor), and the real obtained scores. The two measures considered included estimation error and estimation success rate. For the 29 human estimations acquired, success rate was computed, with the success rate of 27% (8 in total) being realized. For the 29 cases, the machine estimation realized success in 7 of them, and amazingly, there was no simultaneous success between the tool and the tutor. This shows the significance for analyzing the errors resulting from the estimations.

During success comparison, between automatic estimations and human estimations, the results indicated a better success ration by tutors for students who succeeded in the course, whereas the automated estimations prospered in those cases where students failed to take the final exam. This behavior has been portrayed in Figure 7. This means that u-Tutor is considered an early warning system for at-risk students, while considering the prosperous students and that u-Tutor remains a decision support tool necessitating human contextualization.

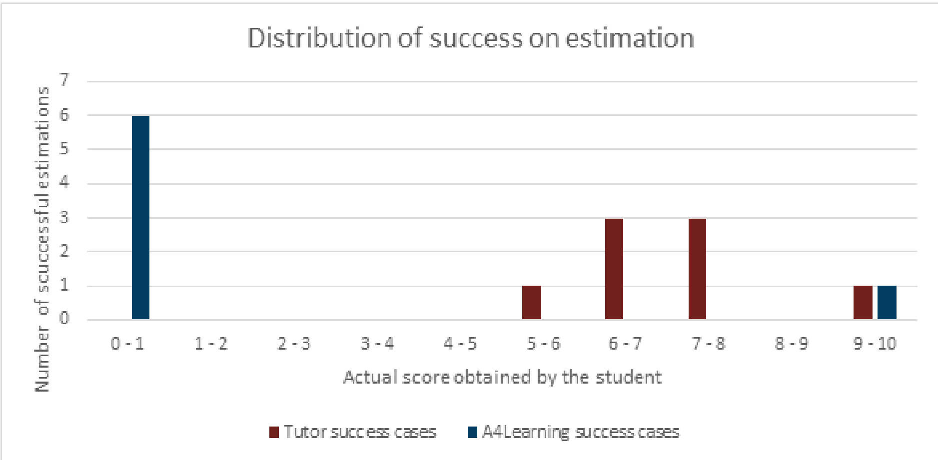

Figure 7. Distribution of success on estimation.

Practical applications aid in understanding error estimation, as evident from Table 6. The considered examples are more illustrative than representative. For example, error values lower than 1 symbolize good estimations to the practical score. 1–1.5 values are acceptable; those between 1.5 and 2 are borderline cases, while those over 2 are not acceptable estimations.

Table 6. Examples of error in estimation values.

Actual Score	Tutor Estimated Interval	Error in Estimation
6.92	[7,8]	0.33
6.42	[4,6]	0.92
9.3	[6,9]	1.05
8.04	[5,7]	1.54
8.14	[4,6]	2.64
0	[3,5]	3.5
8.34	[4,5]	3.59

From Table 7, it can be seen that the average error cannot be accepted as the approximation of the score. Nonetheless, a comprehensive analysis of the cases having higher values of error indicated that the cases with error values exceeding 2 belong to students who failed to take the examination, even though it was expected of them to do so. Devoid of considering those severe cases, the average value of error is within the satisfactory margins.

Table 7. Obtained error in estimation.

Average error in human estimation if no success (student failure)	2.39
Average error in human estimation if no success (student failure) (discarding dropouts)	1.42

To conclude, u-Tutor facilitated information to the tutors for the purposes of approximating the scores of the students within satisfactory error margins. Students who managed to pass the course eventually had better estimations being facilitated, whereas u-Tutor is considered an early warning system for at-risk students. This means that, notwithstanding the marks attained during the 4-week course duration, all students are expected to succeed in the final exam so as to pass the course. 'At-risk' students could be warned before their examination.

6. Limitations of the Study

It has been acknowledged by the researchers that the size of the sample (12) was small, thereby acting as a study limitation. While the research was initially scheduled for a higher number of participating tutors, organizational problems could not allow most of them to take part in the study. Nevertheless, the final results could not be considered generalizable since organizational results prevented the tutors from taking part. While this is considered less pertinent in qualitative research, it remains the major study limitation. Besides, there was a probability of cultural bias: the study setting was a Spanish institution with students being Spanish-speaking, from Latin America and Spain. This means that while interpreting the results, this issue has to be considered.

7. Conclusions and Future Work

This article offers a case study involving the deployment of u-Tutor in a practical learning setting where 392 students were given support by the faculty, in addition to the 9 preceding editions commencing 2015–2019. The tool sought to aid the tutors in adapting the tutoring experiences to the requirements of the students, utilize similarity metrics in comparing the students with those from similar courses, assessing their performances. In one approach, the system offers an evaluation of the current behavior of the users in estimating their future advanced behavior and the eventual associated outcome. The study's goal was to validate the tool based on 3 research areas: (1) perceived usefulness, (2) usability and (3) success rate of classification. As regards to perceived usefulness, the evaluation of the tool's application by the tutors, survey responses, and interview responses indicate their ability to ascertain cases that they would otherwise not have identified. Thus, u-Tutor was considered significant in enhancing tutoring experiences. Considering usability, the study did not conclude presence of any key usability problems, with the users portraying an affirmative view of the interface. This has considered the usability of u-Tutor as being stable. Last, in view of the success rate of classification, the information offered by u-Tutor underwent tutor contextualization, by being able to estimate the scores of the students.

The study findings show consistency with the existing research, demonstrating the usability stability of u-Tutor, indicating lack of key issues, while proposing the need to come up with novel functions to offer improved support. A key lesson evident from this study is the requirement to have estimation separated from description; that is, u-Tutor offers a visual depiction of the resemblances between previous courses' learners, while being able to comprehend such information as approximation. While the results indicated the estimation potential of u-Tutor, the tool is descriptive in nature, hence, the need for the end user to comprehend this while interpreting the results. According to the data, the predictions by u-Tutor were in complement to those of the tutor, indicating the ability of the tool to act as a supportive feature.

For a practical application of this research, including the u-Tutor tool, in other contexts or within the same educational context of the host university, a clear recommendation is to scale up the sample of the tutors. In practice, since every tutor is assigned to a group of students, this upscaling would require a complementary increase of students. In doing so, the results of the semi-structured interviews and the questionnaires could show a diversity of situations and user profiles, along with reactions from the tutors that could feed an informed database for further use and comparison. The second practical recommendation is to retrieve as deep a background as possible, so that the actual search for similarities uses a broader spectrum that can better categorize and identify every single case in a present cohort. This fine-tuning process would increase the chances for early prediction and supportive or corrective actions.

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Conflicts of Interest: To this end, there is no conflict of interest.

Appendix A

Nr	Question	Type of Question	Possible Answers
1	How often did you use the tool?	*(Multiple-choice)*	• *Always when I worked in the supported courses* • *Most of the time I worked in the supported courses* • *In some occasions that I worked in the supported courses* • *Rarely* • *Never*
2	About the information given by u-Tutor	*(Multiple-choice)*	• *It is redundant to what I already knew* • *I could get the information by myself, but u-Tutor makes the task more agile* • *I would not know how to extract this information*
3	When you used the tool, what was your purpose?	*(Multiple-choice)*	• *Obtain information on the students* • *To get useful information to support the pilot*

Nr	Question	Type of Question	Possible Answers
4	Did you decide to actively support any student due to u-Tutor information?	*(Multiple-choice)*	• *Yes, in many cases* • *Yes, some of the students* • *Yes, with just a few students* • *No, never*
5	If your previous answer was 'yes', explain what type of support.	*(Open question)*	-
6	Choose the reason for your support action.	*(Multiple-choice)*	• *I supported the student because u-Tutor warned me about a situation I would not have found by myself* • *I supported the student because u-Tutor helped me confirm critical cases already identified by myself* • *Other reason: __________*
7	For what task did u-Tutor support you?	*(Open question)*	-
8	Did you integrate u-Tutor into your daily workflow?	*(Open question)*	-
9	Would you like to use u-Tutor in future courses?	*(Open question)*	-

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Unveiling the Relationship between the Use of Open Educational Resources and the Adoption of Open Teaching Practices in Higher Education

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Abstract: The goal of this paper is to advance the understanding of the way university educators currently adopt open educational practices (OEP) by analyzing the relation between the use of open educational resources (OER) and the implementation of open teaching practices. The results are based on data collected through an online survey among 724 university educators. Depending on the actual use of OER and open teaching practices by the survey respondents, we have categorized them along a scale that goes from "novice" to "expert", and we analyzed the data to evaluate their use of OER and their adoption of open teaching practices, looking for relationships between the two phenomena. The main finding of this paper, which confirms the latest research findings from the open education community, is that a strong relationship exists between the two dimensions: The more an educator uses OER, the more he will probably adopt open teaching practices, and vice versa. These results are discussed with a view to use this virtuous circle between the use of open content and adoption of open teaching as a way to build generalized open education capacity among universities' teaching staff.

Keywords: open educational resources; open teaching practices; higher education

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1. Introduction

In the last decade, the concept of open educational practices (OEP) has raised interest within the open education movement [1]. Initially defined as practices "that are based on a competency-focused, constructivist paradigm of learning and promote a creative and collaborative engagement of learners with digital content, tools and services in the learning process" [2], the concept of OEP has been developing in both research and in daily educational practice [3] towards a broader understanding than teaching with OER [4]. For example, Cronin defines OEP as "a broad descriptor of practices that include the creation, use, and reuse of open educational resources (OER) as well as open pedagogies and open sharing of teaching practices" [3].

The open education community is converging in recognition of the potential of OER as a trigger to implement open pedagogies [5]. Much has been written on the innovation potential that the use of OER could have on the way educators teach, to the point of formalizing the concept of OER-enabled pedagogy, defined as teaching practices that take place "in the context of the 5R permissions (retain, reuse, revise, remix, and redistribute) which are characteristic of OER" [6]. The logic is simple: By replacing a proprietary set of learning materials with one that is openly licensed, educators can create new relationships between their learners and the knowledge they will be working with. When learners are encouraged to develop and meaningfully revise the teaching resources, the relationship between the teacher, the student, and the teaching content is inevitably transformed: knowledge converts from a stable asset (contained in a book, for example) into a fluid process in which students can actively and critically engage. The role of the teacher in this change process is key, since the possible openness level of every educator is deeply connected with their individual attitudes and culture [3], as well as the institutional context, since openness is a social construct where educators define their open practices and at the same time are defined by them [7]. However, the relation between the use of OER and the adoption of open teaching practices has not been studied in enough depth. In particular, research has not yet been able to demonstrate that OER adoption can be considered a gateway towards open pedagogy. This is a complex research problem, connected both with the difficulty of convincing educators to do things differently and with the different teachers' motivations for adopting OER. Some teachers might in fact be attracted to OER because of their potential for social justice, others by their impact on pedagogical innovation, others by both these drivers [8].

The goal of this paper is to contribute to improving the understanding of the correlation between the use of OER and the adoption of open teaching practices within higher education, as well as to investigate whether an inverse relationship also exists, where the use of open pedagogies is influencing the potential adoption of OER.

2. Methodology

The overall research question that has guided our work is the following: Is there a positive relationship between the use of open educational resources and the adoption of open teaching methodologies in the work of university educators? This question has been addressed by analyzing the relationship from two possible angles, resulting in two research subquestions:

RQ1: To which extent does the familiarity with and capacity of using open educational resources influence the adoption of open teaching approaches within the work of university educators?

RQ2: To which extent does the familiarity with and capacity of using open teaching approaches influence the use of open educational resources within the work of university educators?

The results are based on a dataset gathered through an online questionnaire that was answered by 921 university educators from around the globe, with 724 complete and therefore valid responses (78.61%). Respondents came from 36 countries, the following being the most represented: Brazil (245 participants—33.83%), Italy (190—26.24%), Ireland (99—13.67%), and Palestine (57—7.87%). Data was collected during the period June 2016–May 2019 through an online service tool (the service tool is available at https://rd.unir.net/pub/oef/), available in English, French, Italian, Spanish, and Portuguese. The survey was disseminated through multiple means: by activating networks such as the Open Education Consortium and the European Distance and eLearning Network, by presenting the project at relevant conferences such as OER17 or OER18 or the UNESCO Second OER World Congress, and by promoting the existence of the survey through social media. It should be noted that the online questionnaire, which consisted of nine multiple choice questions, did not refer to concepts such as open educational resources or open educational practices, in order to avoid being perceived as an exercise for e-learning or open licensing specialists. In the questionnaire we refer to the use of "licences that makes the content openly available (such as Creative Commons)" to use a language that can be understood by educators without going too specific on the different existing licenses typologies in order to investigate the degree to which educators are open to openly licensed materials. The questionnaire is available in Appendix A.

For the purpose of the present work, we have adopted two clear definitions of OER and open teaching approaches. The OER definition we have used is the very recent one contained in the UNESCO Recommendation on OER: "Open educational resources (OER) are teaching, learning, and research materials in any medium that may be composed of copyrightable materials released under an open license, materials not protected by copyright, materials for which copyright protection has expired, or a combination of the foregoing" [9]. We have based our open teaching definition on the work of Stacey [10] and Reynolds [11]: Open teaching is about encouraging learners to access available online content, fostering co-creation of knowledge by students in collaboration with peers within and outside the university, and encouraging students to contribute to public knowledge resources.

In our understanding, in contrast to the vision that understands open teaching as a further step of the openness journey that follows and enriches the use of OER, high degrees of open teaching can take place without the use of OER [12].

The collected data was analysed through the Open Educators Factory (OEF) framework, an approach that aims to facilitate the understanding of the different and interrelated dimensions of university educators' capacity to adopt OEP. The framework, presented in Table 1, was designed following an extensive literature review and subsequent discussions with a number of experts in the domain of open education [13]. The framework identifies four areas of educators' practice that can be enhanced by open approaches (*Design*, *Content*, *Teaching* and *Assessment*) and grades the ability of educators to adopt open approaches in these areas along three levels, that are represented by the three rows of the table below. Within the present paper, we have focussed on two central areas, which are *Content* and *Teaching*.

Table 1. The Open Educators Factory Framework.

Design	Content	Teaching	Assessment
Open designer	Expert OER user	Open teacher	Open evaluator
Collaborative designer	Familiar with OER	Engaging teacher	Innovative evaluator
Individual designer	New to OER	Traditional teacher	Traditional evaluator

With respect to the use of open content (second column in Table 1), the framework typifies three categories of educators. Starting from the bottom of the table, we have the *New to OER* educators, who do not consider whether the resources they use are openly-licensed and who do not release their content under open licence, the *Familiar with OER* educators, who produce and share their resources under open licences and reuse resources recommended by trusted colleagues, and the *OER experts*, who search for and share resources through social media and repositories and who spread their resources beyond the classroom. In order to place the respondents into one of the three levels, we have used a data from combination of questions 2, 3, 4, 5, and 6, as detailed in Appendix A. The three educator typologies with regard to open teaching are presented in the third column of Table 1 and, starting from the bottom, are the *Traditional teachers*, who adopt conventional lecture-based pedagogy, the *Engaging teachers,* who complement traditional teaching with collaborative strategies and with innovative teaching methods such as the flipped-classroom approach, and the *Open teachers*, who foster students' knowledge co-creation and contribution to public knowledge resources. In order to place the respondents in one of the three levels we have used data obtained from question 7, as detailed in Appendix A.

In order to appreciate the relation between the use of OER and the adoption of teaching practices, we have analyzed the data by distinguishing the three categories of respondents with respect to their scoring in the Content category (*New to OER*, *Familiar with OER*, and *Expert OER user*) and by assessing how each category scored in the Teaching category. Also, we have done the same by taking the three groups of respondents with respect to their scoring in the Teaching category (*Traditional teacher*, *Engaging teacher*, and *Open teacher*) and by assessing how respondents from each category scored in the Content category.

Two limitations of this study must be highlighted. First, the study was not able to consider the differences between the higher education systems and contexts of the country of origin of the survey respondents. This represents a limitation mainly because of the importance of contextual factors in the decision of whether to adopt open content and open pedagogies [3] and prevented us from running countries comparisons. Still, we believe that a common core set of activities exists across the globe regarding what university teachers do and how they do that, especially given the recent globalization trends in higher education [14]. Second, participation in the survey was voluntary, so teachers who are familiar with the use of information and communication technology (ICT) or OER or both would have been more likely to respond. Also, we are aware that quantitative self-reported data may not be sufficient to draw sound conclusions about educators' attitudes to openness and adoption of open approaches [7].

3. Results

The online questionnaire has generated plentiful data: In this paper we present a fraction of the results, focusing on the relation between the adoption of OER and the use of open teaching methods, in line with the research questions presented above.

3.1. Use of Open Teaching Methods among Different Categories of OER Users

First, it is useful to understand how respondents scored in terms of OER adoption. As shown in Figure 1, the studied population is rather strong in OER use, with only 15% of respondents categorized as *New to OER*, 42% categorized as *Familiar with OER*, and 43% categorized as *Expert OER Users*. This distribution is probably due to two things. First, most respondents likely had a vested interest in open education and OER given that 85% were at least familiar with OER. Second, in order to score as either *Familiar* or *Expert OER user*, it was sufficient to respond positively to either question 2, 3, or 4 (presented in Appendix A). As stated before, we selected not to adopt a strict definition of OER, based for example on the well-known 5R paradigm [15] but rather to consider every educator that is working with open content (as described in questions 2, 3, and 4) as belonging to the category *Familiar with OER*.

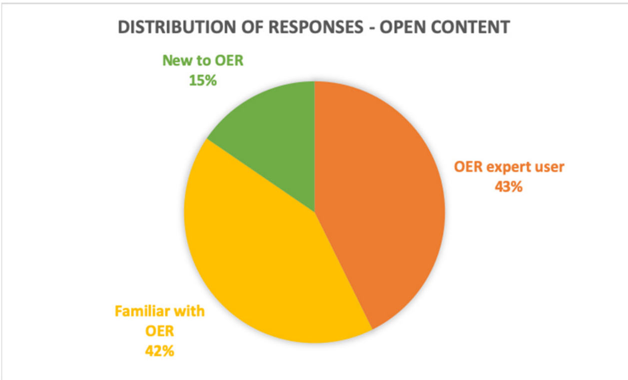

Figure 1. Distribution of respondents with respect to the use of open content.

We then analyzed the relation between the use of OER and open teaching approaches by looking at the actual shares of *Traditional*, *Engaging*, and *Open teachers* among the three different cohorts with respect to OER use, as in Figure 2.

The three graphs above show how the cohorts of *OER experts* (top-left), *Familiar with OER* (top-right), and *New to OER* (bottom) position with respect to open teaching. It suggests a relationship between the use of OER and the adoption of open teaching approaches, in that the share of *Open teachers* increases together with the capacity to use OER. The percentage of *Open teachers* is 40% for the *OER Experts* cohort, 13% for the *Familiar with OER* cohort, and 6% for the *New to OER* cohort. Interestingly, the percentage of *Engaging teachers* that adopt collaborative and engaging methodologies but are not necessarily open in terms of reaching beyond the classroom does not vary significantly among the three cohorts. This could be due to the fact that these engaging strategies are not necessarily based on digital resources, as reflected by one of the possible answers to Question 5: "I use seminars-like strategies, either offline or through restricted online spaces", and therefore the use of OER might not be influencing the decision on whether to adopt those strategies or not. Interestingly, this shows an important pocket of innovation with a high potential in terms of open education, composed of those teachers that are adopting engaging teaching strategies without using OER (between 43% and 49% of respondents), and that due to their openness to innovation and willingness to experiment with new teaching methods could easily become proficient OER users. A final important finding is that, among *OER Expert* teachers, just 11% are using only traditional lecture-based teaching methods: This hints to the fact that investing in OER adoption, most probably due to their inner collaboration and engagement triggering capacity, can have an important impact on updating the teaching style of university educators.

Figure 2. To which extent do educators adopt open teaching approaches? Responses from *OER experts* (top-left), *Familiar to OER* (top-right), *New to OER* (bottom).

3.2. Use of OER among Different Categories of Open Teachers

Distribution of respondents across the three categories related to open teaching practices, presented in Figure 3, was based on the most common modality of teaching reported by participants: 28% use only one-way transmissive teaching methods and qualify therefore as *Traditional teachers*, 48% engage students through offline and online collaborative methods (*Engaging teachers*), while 24% foster co-creation of knowledge by students, working with wikis, blogs, and communities of practice and involve external stakeholders in the teaching process (*Open teachers*).

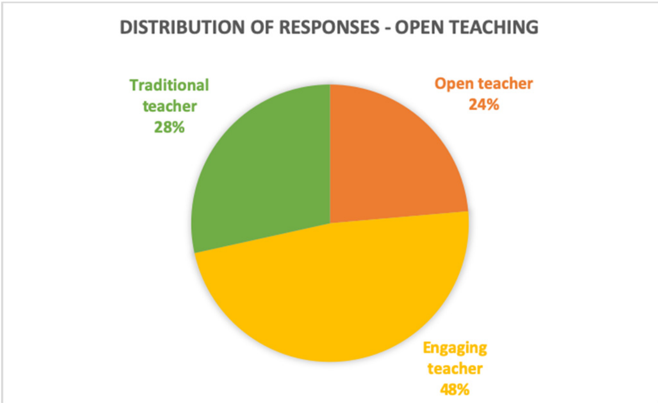

Figure 3. Distribution of respondents with respect to the use of open teaching approaches.

The three graphs of Figure 4 show the extent to which *Open teachers* (top-left), *Engaging teachers* (top-right), and *Traditional teachers* (bottom) qualify in terms of OER adoption.

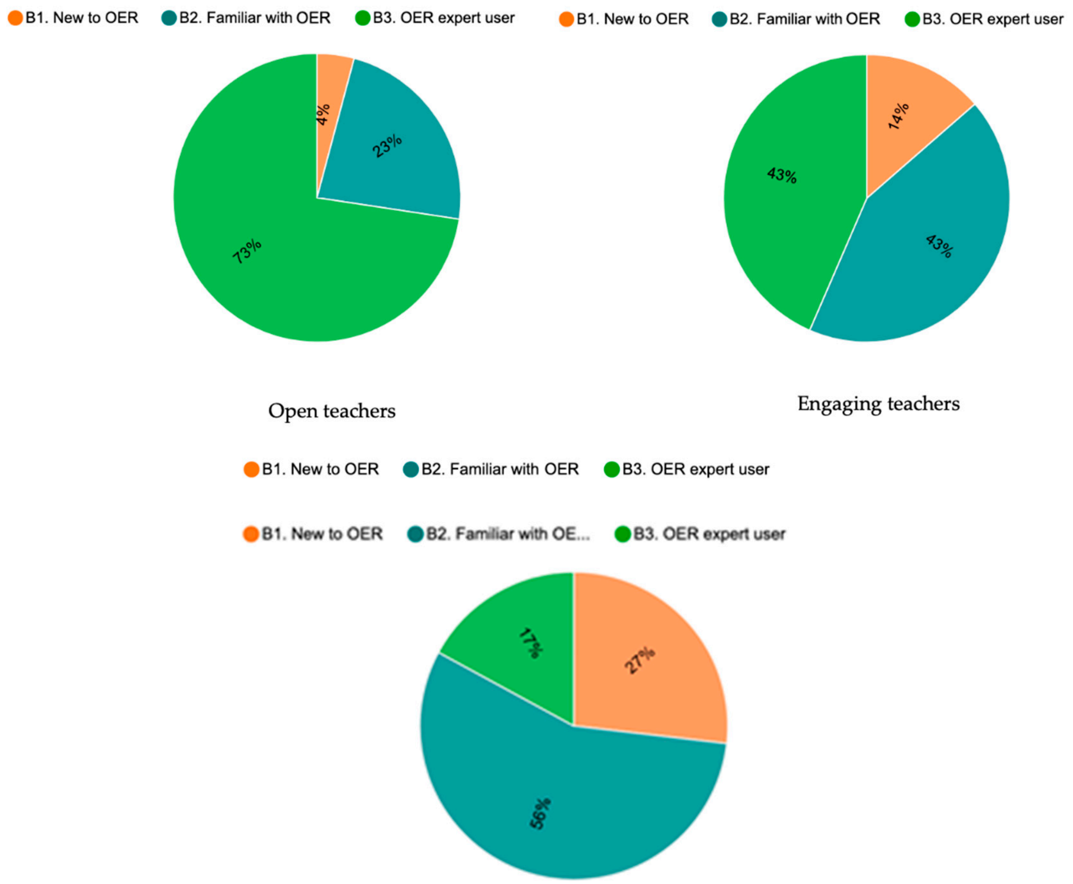

Figure 4. To which extent do educators adopt OER? Responses from *Open teachers* (above), *Engaging teachers* (middle), *Traditional teachers* (below).

Again, in this case, a positive relation emerges among the use of open teaching approaches and the tendency to adopt OER. This is demonstrated by the fact that among *Open teachers*, only 4% qualify as *New to OER*, while 73% are defined as *Expert OER users*. Open teaching approaches based on knowledge co-creation, which are adopted both by *Open* and *Engaging teachers*, normally encourage students to look for content on the open web, and to do so the educators must be able to guide students on where to search and especially on the strategies to use content produced by others. Interestingly, more than half of the *Engaging teachers* cohort are either *Familiar with OER* or *OER Expert users*, showing that the use of open content is strongly embedded within innovative pedagogies even when these are not going beyond the classroom setting. Finally, it is encouraging to see that among traditional educators, defined in the survey as teachers who use mainly frontal transmissive teaching, more than half of the respondents claimed to be at least *Familiar with OER*.

4. Discussion

Using relevant research findings with our results, we to try to deepen the understanding of the observed relational patterns between the use of open content and the adoption of open teaching practices. In contextual terms, it is important to notice that the open education community is increasingly moving towards research approaches that go beyond the analysis of open content adoption towards a broader understanding of the impact of open practices in support of innovative education [16]. However, only a limited number of studies have attempted to measure the proportion of teaching staff that adopt open practices. Further, most of these studies have been solely focusing on OER [17,18], with just a few addressing the use of open teaching methods [3,8].

First, a numerically relevant category of educators that are using OER in combination with open teaching practices has emerged from this study. Data presented in Figures 2 and 4 confirm that the use of open content and the adoption of open teaching tend to mutually reinforce, both at the level of educators that are both *Expert OER users* and *Open teachers* but also at the intermediate levels of educators that are fully open in one of the two dimensions (either content or teaching) and less in the other one. In all these cases, what can be observed is an agency shift from the teacher to the learners, who are considered independent agents within the learning process and are allowed to work independently and especially to learn at their own pace, in their own way and using their own personal networks [19]. In a context where learners have full access to ideas and resources that can shape and support their learning journeys, they deserve to be engaged in social processes of knowledge development instead of just being allowed to use the information presented by the teacher [20].

Second, the results show a relation between the use of OER and the attention to learners' collaboration dynamics. As shown by the possible responses of Question 7 in Appendix A, both *Engaging* and *Open teachers* are in fact using peer-to-peer pedagogies and group assignments over transmissive pedagogies. This finding corroborates the collaborative impact of OEP, intended as both use of open content and open teaching approaches, as concluded by Cronin who notes a relationship between the use of OEP and social learning practices [3]. Importantly, these collaborations can potentially empower students whether they work with OER within their classroom communities (with *Engaging teachers*) or by breaking down the university boundaries (with *Open teachers*), creating and/or curating content and contributing to public knowledge communities [4].

Also, the results show that within a university some educators might be more inclined to adopt open teaching strategies and might be using OER as a logical support for these approaches, while others might be more thoughtful in making sure that the content they use is made available openly, in line with institutional or national copyright legislation, and by doing so they use open resources that can potentially support social learning practices. The coexistence of these categories of educators corroborates the idea that, in order to increase the adoption of OEP within a university, multiple strategies are possible [21,22]. What matters here is that the data confirms that different roads can be taken to create sustainable ecosystems where OER can be used to support high-quality and inclusive education [5].

5. Conclusions

Based on the results presented above, we can conclude that a positive correlation exists between the use of OER, either at a level of familiarity or of high expertise, and the adoption of engaging and open teaching methods. By comparing these results with existing literature in the field [23,24], we can confirm that the combined use of open content and open teaching approaches can allow educators and students to build on the possibilities offered by the open web through collaborative knowledge creation, increased learning socialization, and interactivity and connection with communities outside the university. These results support a recent definition of OEP offered within a set of guidelines for educators by the Joint Research Centre of the European Commission, which understands OEP as teaching and learning practices that not only use OER but are also open to change, adaptations, and collaboration, making the range of different teaching and learning approaches more transparent, shareable, and visible. In this understanding, the use and reuse of OER goes hand in hand with the sharing of inclusive teaching strategies [25]. Finally, by looking at the relation between the use of OER and the adoption of open teaching methods from the point of view of those university leaders that want to increase the use of OEP within their institutions, open content appears as one of the key drivers for teaching innovation, and at the same time we can leverage educators' interest in new ways of teaching in order to foster the use of OER within universities.

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Appendix A Multiple-Choice Questionnaire

(1) How do you design your lectures/courses?

- a) On my own, based on my experience and knowledge, as I have always done. (result: individual designer)
- b) In collaboration with colleagues from my institution. (result: collaborative designer)
- c) In collaboration with colleagues from other institutions, through bilateral contacts. (result: collaborative designer)
- d) I share ideas and drafts about my course through restricted social media (such as subject-related discussion groups) to allow colleagues from other institutions to contribute. (result: open designer)
- e) I share ideas and drafts about my course through open social media (such as twitter, academia.edu, cloudworks), to allow anyone (including students) to contribute. (result: open designer)

(2) To whom do you make available your teaching resources (PPTs, documents)?

- a) To students enrolled in my course, through the university website. (result: New to OER)
- b) To all students of my university, through the university website. (result: Familiar with OER)
- c) I make it openly available to anyone, through the university website. (result: Familiar with OER)
- d) I make it openly available to anyone, through sharing platforms (Slideshare, repositories, etc). (result: OER Expert)
- e) I also promote the content I produce through social media (such as Twitter, Slideshare, Facebook, Wikipedia …). (result: OER Expert)

(3) Under which licence do you release the teaching resources you produce?

- a) I do not apply any licence, I just make it available to through the university website. (New to OER)
- b) Through a restricted licence (all rights reserved). (result: New to OER)
- c) Through a licence that makes it openly available (such as Creative Commons). (result: OER Expert)

(4) Have you ever been using online resources (PPTs, videos, documents, articles) produced by others in your teaching? If so, under which license was this content released?

a) No, do not use online content produced by others in my teaching. (result: New to OER)
b) Yes. I am not worried about the license of these resources, since I used it for educational purposes. (result: Familiar with OER)
c) Yes. I only use resources released under an open licence, such as Creative Commons. (result: OER Expert)

(5) How did you get to know about these resources?

a) I have been searching for them on Google or other search engines. (result: New to OER)
b) Through a colleague from my university. (result: New to OER)
c) Through social media (such as Twitter, Slideshare, Facebook). (result OER Expert)
d) Through OER repositories. (result: Familiar with OER or OER Expert)

(6) Have you ever re-shared resources produced by others after using/adapting them?

a) No, never. (result: New to OER)
b) Yes, among colleagues from my university. (result: New to OER or Familiar with OER)
c) Yes, openly through social media (such as Twitter, Slideshare, Facebook). (result: Familiar with OER or OER Expert)
d) Yes, openly through OER repositories. (result: Familiar with OER or OER Expert)

(7) How do you teach?

a) I use classic, frontal classroom teaching. (result: Traditional Teacher)
b) I use the university Learning Management System (LMS) in support to classroom teaching, to share links and documents. (result: Traditional Teacher or Engaging Teacher)
c) I use seminars-like strategies, either offline or through restricted online spaces (Chats, forums). (result: Engaging Teacher)
d) I use “flipped-classroom” methodologies (using classroom time to discuss content that students have studies at home before the lesson). (result: Engaging Teacher)
e) I encourage my students to search for additional resources on the web and to produce their own knowledge. (result: Open Teacher)
f) I try to foster co-creation of knowledge by students by working with wikis, blogs, communities of practices. (result: Open Teacher)

(8) Do you encourage participation from non-enrolled students in your courser?

a) Yes (result: Open Teacher)
b) No (result: Traditional Teacher or Engaging Teacher)

(9) How do you assess your students?

a) I assess them through tests and classwork. (result: Traditional Evaluator)
b) I am introducing peers-assessment, either offline or through online means. (result: Innovative Evaluator)
c) My students have digital portfolios and are assessed through that. (result: Innovative Evaluator)
d) My students are assessed by online communities of Practices. (result: Open Evaluator)

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Supporting innovation in technology-enhanced learning: a stakeholder-based open approach

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Abstract: This paper explores the concept of innovation in technology-enhanced learning (TEL) and proposes a model to support innovation in the area of TEL. This model has emerged from the HoTEL project, a support action funded by EU's FP7. The paper first provides a brief summary of innovation models emerging from research and then moves to an analysis of the key elements, dynamics and dimensions that need be considered in order to develop a model supporting innovation specific to the TEL domain. The HoTEL innovation support model is then presented as a new way for supporting innovation adoption and mainstreaming within the field. Such a model is based on the concept of open innovation and advocates the direct involvement of all key stakeholders in the innovation process and their active role in considering all the strategic elements (networking, partnerships, support, user engagement, etc.) necessary for meaningful and effective innovation in TEL.

Keywords: technology-enhanced learning; open innovation; stakeholders' involvement; innovation mainstream; networking.

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1 Introduction

In the field of TEL, innovation may frequently start in a classroom or in a community of practice, or may it be the result of the large-scale use of a technology not originally created for educational purposes. The road to success for a TEL innovation to a large extent depends on the possibility of being understood and supported by diverse categories of stakeholders that are not always the same (e.g., industrial investors, school leaders, publishers, policy makers, teacher networks, student associations, consultants, etc.). Not all of these may ultimately influence every kind of TEL innovation with similar leverage, but it is nonetheless important to consider the full spectrum of involved interests in order to select the most crucial representatives of stakeholders to discuss/support the innovation's development. Furthermore, what appears to be a big success in a certain context may not work at all in another context (e.g., country, socio-economic environment, organisation or sector). It is therefore fundamental to identify not only 'what works' but also 'where' and 'under which conditions', and to distinguish between success factors that are relatively 'unique', specific to a context, and others that can more easily be found or reproduced in other contexts.

2 Innovation models and TEL

Understanding innovation as a process provides a better understanding on possible ways in which we apply and manage it. This understanding has evolved over the past decades: early models interpreted innovation as a linear sequence of activities, whereas more recent work attempts to build more complexity and interaction into the innovation arena (http://www.emotools.com/media/upload/files/innovation_models.pdf). Table 1 summarises the features of the different innovation models generated over the past decades.

Table 1 Development of innovation models

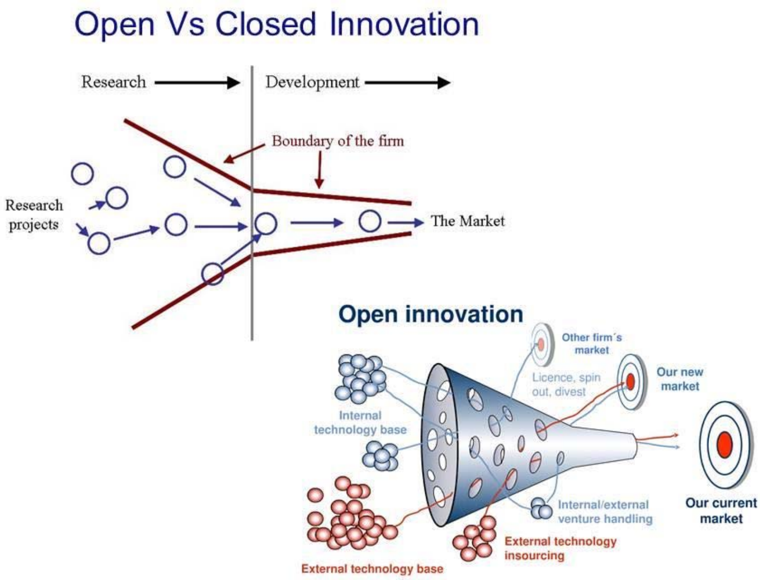
Model	*Generation*	*Characteristic*
Technology push	First	Simple, linear sequential process, emphasis on R&D and science
Market pull	Second	Simple, linear sequential process, emphasis on marketing; the market is the source of new ideas for R&D
Coupling model	Third	Recognising interaction between different elements and feedback loops between them; emphasis on integrating R&D and marketing
Interactive model	Fourth	Combinations of push and pull models, integration within firm; emphasis on external linkages
Network model	Fifth	Emphasis on knowledge accumulation and external linkages; systems integration and extensive networking
Open innovation	Sixth	Internal and external ideas, as well as internal and external paths to market can be combined to advance the development of new technologies

Source: Du Preez and Louw, *A Framework for Managing the Innovation Process* (2008, p.2)

The open innovation model is the best suited for TEL innovations and their adoption, because it supports the simultaneous collaboration of diverse actors, through relational activities that facilitate sharing, expressing, combining and expanding their tacit and explicit knowledge. This participatory open innovation model is also in line with the SECI model of knowledge creation in the TEL context, as described by Nonaka (1995), Nonaka and Toyama (2003), Kamtsiou and Klobucar (2013) and Kamtsiou et al. (2007).

As shown in Figure 1, "open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and [to] expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology" [Chesbrough, (2006), p.1]. Thus, in open innovation, institutions adopt both internal and external ways of using technologies and rely not only on their internal R&D capacity, but also on external sources of knowledge, resources, and decision making and funding power (spin offs, universities, suppliers, other intermediaries, decision makers, users, etc.).

Figure 1 Open vs. closed innovation (see online version for colours)



Source: http://blog.business-model-innovation.com

In contrast, closed innovation implies a situation where, as Chesbrough puts it, "companies generate their own ideas and then develop them, market them, distribute them, service them, finance them and support them on their own" (Chesbrough and Crowther, 2006).

The general idea of open innovation is that a single organisation cannot innovate alone, but must engage with different kinds of actors to gain new ideas, combine resources and sharing risks, in order to remain competitive. This is especially true in the case of TEL, since TEL innovations have a systemic nature (Kamtsiou and Nascimbeni, 2013; Bocconi et al., 2012). Discussing innovation in learning settings implies the need for considering not only innovation processes, but also (and primarily) the significance of the interconnection between actors involved in the processes of innovation. In other words, the complex ecosystem of TEL stakeholders will be considered when defining and supporting TEL innovation. In this respect, a relevant interpretation of innovation for the area of learning is one offered by the Society Driven Innovation study, developed within the framework of the INNO GRIPS Project – Global Review of Innovation Intelligence and Policy Studies (Rigby et al., 2008). The study considers innovation as a systemic process in which societal needs are met through the complex interaction of actors engaged in meeting socially defined needs. According to the study, Society Driven Innovation (SDI) has a broader objective than just the economic goals of competitiveness and growth and embeds the need to meet some social or cultural need, which is defined by society, usually through government policy. Moreover, these actors are operating in different contexts (e.g., academia, industry, educational institutions, professional development, etc.), which are in turn influenced by larger environmental changes, thus making their interaction even more complex.

SDI is largely government, top-down driven, although other forms of bottom-up action may also generate SDI. Particularly in research and development and in public procurement, where innovation criteria are used to stimulate 'lead markets' through the adjustment of market signals (e.g., for renewable energy supplies) and regulations (especially related to social or environmental criteria) [Rigby et al., (2008), p.16]. When the five primary features of SDI are described, its relevance to the world of learning becomes particularly clear:

1 social and cultural objectives are identified by social institutions among whom a substantial consensus exists

2 the objectives are of general and national or even international significance and importance; they often concern the alleviation of social or environmental problems (e.g., disease, climate change

3 the goods or services are often provided by, supported by, or involve lead markets and are facilitated by governments (though this need not be exclusively the case)

4 innovations require a significant structure to ensure effective implementation and/or diffusion

5 innovations have potentially significant structural and large-scale impacts on society (Rigby et al., 2008).

Societal actors may take a variety of roles in supporting the implementation of TEL innovations:

a initiating an action to meet a need (= driving innovation)

b creating the network of actors required to meet the need

c active participation in networks

d passive participation (= endorsing innovation).

This classification is important for defining the possible roles of stakeholders within the HoTEL innovation support model (ISM).

Further exploring the definition of innovation in TEL, in a recent JRC report, ICT enabled innovation for learning refers to "the profoundly new ways of using and creating information and knowledge made possible by the use of ICT (as opposed to using ICT for sustaining or replicating traditional practices). It deals with both formal and informal learning, covering traditional education settings (schools and higher education) and adult education. Last, but not least, this ICT potential for innovation must be realised and accompanied by the necessary pedagogical and institutional change" [Kampylis et al., (2012), p.7]. According to IPTS, "the paradigm underpinning ICT-enabled innovation for learning entails a holistic transformational shift towards connecting learning organisations and processes (i.e., connecting the realities of learners' lives and their experience of school)" [Kampylis et al., (2012), p.8]. In this respect, we can infer that such innovations are radical or disruptive rather than incremental improvements of the existing design.

3 Innovation in TEL: genesis, adoption, scaling up

In the field of technology-enhanced learning, three main genesis models can be noted:

1 Technology and industry-led, in which the availability of a new technology, generally not specifically designed for learning, finds a number of educational or informal learning applications that may lead to large-scale adoption via significant industrial and commercial investment.

2 Research-led, in which learning theories are applied in experimental learning settings which are created and monitored in order to check learning effectiveness, usability and other key features of both generic and learning-specific new technological innovations.

3 Practice-led, spontaneous bottom-up innovation emerging from individuals or communities of teachers and learners that find original ways of using technology to materialise new ideas about learning and teaching, and are able to demonstrate their effectiveness in new contexts of use.

One can argue that a fourth model exists, i.e., policy-led innovation, materialised by the many national and supranational programmes launched since the ‘80s in order to diffuse ICT and its use within classrooms. In our view, these policies provided support to either of the three existing models, or to a combination of them, without truly establishing a different genesis model. Policies may become relevant, furthermore, in the subsequent steps of innovation life cycles, and notably adoption, scaling up and institutional exploitation. Another observation is that each of the three genesis models of TEL innovation carries with it both strengths and weaknesses, and furthermore, the integration of approaches is desirable. For this reason, the approach followed in HoTEL combines/integrates the genesis models of innovation in order to better define the ISM.

The field of TEL is considered to be a diverse and multi-level domain, involving many types of players, working in different cultures and operational contexts, under varying jurisdictions, with differing and sometimes opposite approaches to pedagogy and the task of education. Observing the subject in more depth, the TEL domain is not only varied, but the adoption of TEL in general and ‘products’ in particular is also complex, with many technical and organisational interdependencies. For example, multiple root technologies such as content delivery and assessment need to be integrated with other technologies that are found outside TEL, such as those related to big data, artificial intelligence and the internet. These types of technological innovations, which are produced using the interface of several technologies, are in turn giving birth to new pedagogical innovations and supporting the implementation of new learning and educational practices, such as seamless learning, microlearning, rhisomatic learning, etc. Thus, most TEL innovations are not linear, single rooted or independent, but rather systemic, involving several converging and or competing technologies, as well as complex interactions by many players who have to collaborate in order to align their contributions and develop holistic solutions, rather than simply present the introduction of new standalone products. Hence, these types of systemic innovations have ‘a nature of integrality’ (Kaivo-oja, 2011), as well as a multi-diverse nature, since the envisioned applications generally require different development pathways per involved technology. Different providers of systems, content and services are often mutually dependent and a degree of coherence between them is necessary to transfer TEL innovations to the mainstream. Furthermore, other types of stakeholders have to come to an agreement about what is desired and how it should be provided. When organisations are looking to introduce and manage TEL innovations, they need to take into account the entire ecosystem in which they are operating. The focus is on desirable systemic change, by which we mean changes in business (and learning organisations), learning processes and practices, as well as technological (software, tools and infrastructure) and social changes (e.g., role of learning among developing European citizens, their employability and personal fulfilment).

For systemic innovations to be successful, the "functional logic of the whole *product/service delivery and supply chains* (suppliers, manufactures, distributors, value-added resellers, installers and consumers) may change because of the new innovations" (Kaivo-oja, 2011). In the case of TEL, educators, software developers, brokers and policy makers may also have to be aligned, co-innovate and make changes for the successful adoption of TEL innovations. Most common types of incremental innovations are:

1 technological innovation

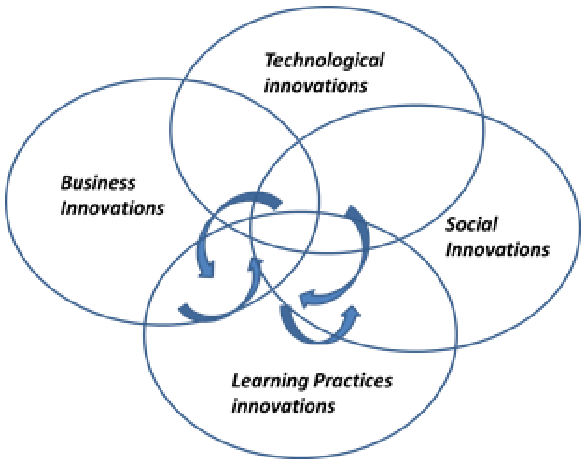
2 business innovation

3 social innovation.

In the case of systemic innovations, these three types are systemically interconnected; thus, systemic changes in one of these three innovation types can also introduce changes or innovations in the other two innovation types (Kaivo-oja, 2011).

In our case, we have added one additional innovation type, 'learning practice innovations', which is specific to TEL innovations.

Figure 2 Synergy field of different forms of TEL innovations (see online version for colours)



Saritas (2011) identifies three drivers for managing systemic innovations:

- the need to gain a rich understanding of existing systems and procedures, their history and possible futures
- the analysis of different stakeholders perspectives and their social relation in the system which can affect and be affected by the process

- the impacts of formal and informal networks and procedures, which can be in favour or in conflict with other systems.

OECD (2008) identifies several models of innovation adoption in learning:

- In the *research-development-dissemination-adoption model*, "there are clear stages to be followed based on the industrial conception of innovation as a technical process. This assumes linear rationality, planning and the division of labour. Some of the evidence-based approaches to educational policy and practice relate to this industrial conception of diffusion".
- In the *epidemiological model*, "innovation is understood to spread in a given population rather as an epidemic, following a cumulative S-shaped logistic curve as growing numbers of people are 'touched'. More recent, naturalist theories of culture see ideas as contagious, not practices. This relates to the discussion of personalization and the warning of widening existing inequalities".
- Individual decisions and their aggregated social effects lie at the core of the "*social-interactionist model* [which stands] in contrast with the epidemiological model, which allows little room for wishes or decisions. This focuses on mechanisms for persuasion, more or less complicated, linked to two key parameters: a) given and received information; b) communications networks".
- "In the *institutionalisation innovation model*, an innovation has a finite duration and, in the best of cases, it leaves traces of its existence. When it is adopted by an institution, it becomes appropriated so that the innovation loses its newness and energy, is absorbed by the institution, and becomes part of a routine. The innovation is firmly institutionalised when it has found its way into legislation requiring new forms of practice".

As analysed above, in the past, many originally promising technologies have been hampered by 'last mile' problems, essentially failing to convince either the actors involved in the supply-delivery value chains or the wider majority of users of their benefits. Technology adoption is about making technology available (*a delivery process*); most importantly, however, it is about people, their expectations and what they imagine and then learn about what a technology can do (*a social process*). Often, user response to new technologies undergoes a stagnation or disillusionment stage (hype cycle) before picking up again. Failing to identify this development at an early stage and dealing with the reasons behind it can have a seriously negative impact on that technology mainstream potential. In reality, technology adoption conforms to more complex patterns and is subject to the influence of very diverse factors. The issue of uncertainties in user responses, the acceptance of emerging technologies and their social implications, are often ignored, and in reality, the assessment of future innovations simply concentrates on technological potential and the supplier's deployment processes.

TEL innovations are more complex, since they need to be fitted to or (innovate/disrupt) current learning practices and pedagogies. Consider, for example, how innovations or 'value propositions' from software designers and platform developers influence and impact the individual contexts of teachers (teaching practices at schools, training needed to adopt the new systems, professional development), or those contexts of schools administrators and IT managers where informed decisions need to be made regarding access, affordability, quality and adaptability to existing organisational processes, or in the case of a ministry of education, which might have a say in how the innovation fits with school curricula, as well as the place and time of adoption.

In addition, the learning practices that are supported or enabled by TEL innovations need to be identified and described. TEL innovators must not only be informed of the current and emerging learning practices supported by TEL, but also they need to understand current analytical frameworks and use them as checklists against the proposed innovations and the respective learning and pedagogical paradigms associated with these innovations. Such analysis of the related learning practices and analytical pedagogical frameworks is intended to lead to improvements in the design of innovations or in the change-management of their adoption. In other cases, they may assist in identifying the assumptions made of existing practices that can be combined with the innovation to ensure its viability.

Formal education is also a high stakes culturally and institutionally conservative activity that serves more than one societal purpose, including learner development and fulfilment, child care, preparation for citizenship, parenthood and retirement and preparation for work and selection for employment. Each of these societal purposes and learning areas demand different approaches and understandings for the learning theorist, as well as for the TEL innovator, and may develop at varying rates or may be found to be diverse in relation to context, location and culture. For example, in the case of TEL innovations, if they span more than one educational system (national education systems), or across more than one sector, (e.g., schools, higher education, professional development) or types (formal, informal), their implementation may need to be adapted for each of these systems. Furthermore, as each educational system may evolve differently in response to wider political, economic and social pressures, innovations may also need to be continuously adapted to these changes.

4 Research methodology: exploring innovation in TEL from multiple perspectives

In order to design an original ISM from a sound understanding of the TEL panorama in technology and pedagogy terms, a number of research activities have been carried out.

Desk research has informed the first part of the work. First, an analysis of the emerging landscape of technologies for learning was run, in order to consider how this would influence learning changes in the next decade, and to detect and explore original ways to use ICT in the field of learning. The analysis covered both generic ICT that are also used for learning and specific technologies and applications designed to support and enhance learning. Desk research analysed available studies in the field of TEL, produced in the frame of FP6, FP7 and other programmes funded by the European Union and by specialised institutions and agencies such as IPTS – Institute for Prospective Technological Studies, IDATE or Gartner Group. In parallel, the extent to which learning theories have contributed to new ways of using ICT for learning in practice was explored, by reviewing and assessing key information, issues and developments in TEL, specifically focusing on socio-political understanding to identify new learning paradigms. We used conceptual modelling to map the learning theories with the TEL practices as well as with ICT practices outside the strict TEL domain. The corpus of current learning theories was investigated via an extensive literature review and a preliminary exploration of their relationships with TEL was conducted. In particular, new learning paradigms enabled by TEL in individuals, higher education, work environments, and informal learning settings were reviewed, looking into related learning theories governing these new paradigms. A focus was set on the changed perception of learning in relation to formal and informal learning, new forms of employment (one-man business and micro-companies), flexicurity and unemployment, etc. By doing so, TEL applicability for different user groups emerged, together with existing gaps, factors of success and failures in emerging learning paradigms. The literature review was twofold:

a wider literature review concerning learning theories in the field of education

b a more focused literature survey of learning theories that have been applied in the TEL context, irrespectively of their use or not in TEL practice, has been conducted.

The scope of these two reviews was to include academic literature, as well as education related research projects.

Based on the outputs of the above desk research activities, the effectiveness, suitability and overall success of a number of learning practices with a particular focus on learning innovation were analysed and classified. To do so the following methods were used:

a qualitative evaluative approaches such as focused observations, questionnaires and interview surveys, discourse analysis, and stakeholder consultations

b identification of success criteria and indicators for benchmarking such as class activity and engagement in TEL, social interactions and construction of meaning, assessment of learning achievements and attainment of learning outcomes

c technology acceptance models.

This practices analysis has allowed reaching an overview of what has been achieved so far and what is known in current practice in terms of the application of existing learning theories in TEL practices, by screening national and EU funded projects, leading TEL communities and networks, field study of representative segment of the entire European TEL community, research publications.

A third research component, an online consultation with more than 130 stakeholders representing higher education, corporate training and individual learning (including policy and decision makers, learners, learning facilitators, technology providers, e-learning providers) was run, focussing on the technologies that are believed to support fundamentally new forms of learning in the three sectors mentioned above. Once the results of the on-line consultation and of desk research were available, 30 interviews were conducted with TEL leaders to study the relationship between the adoption of the identified technologies and the emergence of new forms of learning, thereby validating the findings of the project to date. The online consultation focussed on the key levers that can enhance faster and more effective innovation cycles in TEL. This activity's rationale was to use gathered feedback to help in the definition of the Innovation support model and to inform future research and policy strategies in relation to how effectively reduce the time span of innovation cycles (i.e., the time elapsed between the identification of technologies with some potential to support learning practices, the analysis of the pedagogical implications of their usage, the piloting of such technologies and their adoption).

Finally, an expert's workshop was organised to further validate and integrate the above findings, resulting on some important conclusions on current educational challenges as a starting point to map learning theories, emerging technologies and learning practices. This workshop aimed at providing a framework for brainstorming in order to improve, through a collaborative activity, the HoTEL ISM, centred on how the recent developments in technology areas can affect the ways we will be organising, delivering and managing learning and education in the future. The final endeavour of the workshop was to brainstorm on emerging/disruptive technologies and then map them to learning theories and new learning practices in order to come up with a set of ideas to make the HoTEL ISM more useful and fitting for practice. During the event, the consultation results were discussed and validated: in addition to shedding some light on the recent developments in technology areas and learning practices, the results of the consultation provided interesting insights to be considered in the preparation of recommendations of how to enhance and foster support to innovations in TEL, considering the challenges linked to the specificity of the TEL area, that deals with technology but also with educational values.

5 The HoTEL innovation support model

As briefly discussed above, different methods and steps need to be taken to analyse TEL innovations according to their nature (incremental, disruptive or systemic) and their types (technical – technology push, business – market pull, learning practices – bottom-up, social – social needs pull). Successful innovations also need to take into consideration:

a the integrated design process and the organisational architecture of the institution that adopts the innovation (e.g., for a company, a learning institution such as a university, school or professional organisation

b the design and implementation of the 'product, services [and] practice'

c the design and implementation of new technologies (Du Preez and Louw, 2008).

Many good ideas or even pilot products in TEL, whether arising from a technology push, practices (market pull) or research, often fail to be successfully adopted and mainstreamed. Being such a complex domain, it is safe to argue that the majority of TEL innovations will require the sharing of ideas, contributions and the collaboration of efforts arising from research, technology and practitioners, including software and learning solutions developers. For this reason, the main result of this preliminary analysis is that the HoTEL ISM must, first and foremost, be able to involve stakeholders (and different stakeholders, according to the innovations analysed); the innovation process must not be considered as linear and must be open to measuring the 'potential' and 'success' of innovation in different ways.

Five 'structuring assumptions' are the basis of the HoTEL ISM:

1. Recognition of the need to identify and analyse the diversity of innovation paths, along with the innovation channels, starting points, contexts, expected outcomes, success criteria and in general, every single step and factor of the support model and the setting.
2. Recognition of the existing difficulty in measuring ‘success’ within a TEL innovation setting. How is success defined? Do we use pedagogical, technological, social, economic or other criteria to determine what can be considered a success?
3. Embedded flexibility and adaptability of the support model is required in order to match different stages of innovation development and different contexts and innovation paths. The support model must take the various key factors from every context, stakeholder and user and integrate them within the innovation so that a unique experience is produced. This unique experience will then feed every actor in the setting (i.e., higher education, workplace learning, and informal learning in networks), including the model and the innovation, creating a full and iterative cycle.
4. The core concept in the support model is that of a ‘multi-stakeholder ecosystem’ (with different stakeholder representatives according to the nature of the proposed innovation) that analyses and eventually tests the proposed innovation using a multi-perspective approach and identifies all the strengths and weaknesses from each relevant stakeholder’s perspective. This test may be bottom-up (practical, on the ground, with real users and in a real context) or it may be top-down/theoretical (expert-based – using a deep-thinking test bench developed by experts and qualified users).
5. The model needs to provide for context-sensitivity analysis and propose action for distinguishing transferable from non-transferable success factors according to a well-defined set of criteria.

The research and experts consultations presented above suggest that innovations, in order to be meaningful, accepted and adopted, need to tackle/present the intention to solve significant challenges and to comply with the social/economic/organisational priorities of the specific educational context being addressed. In other words, to be considered meaningful and deserving the attention of decision makers at the public and private level, innovations need to:

- be relevant to some extent in the emerging technological landscape.
- indicate an impact on existing learning practices/theories or demonstrate the potential to contribute to new learning practices.
- contribute to meeting the contingent political, social and economic priorities in the context addressed and/or at the EU level.

In line with this reasoning, a recent IPTS study (Kampylis et al., 2013) – based on case studies that have already achieved a significant degree of scale and impact – identifies four principles that differentiate the strategic effectiveness of different innovation initiatives. These principles have been also adopted by the HoTEL ISM.

- Multiple pathways for innovating and scaling: this principle refers to the awareness that there is no single recipe for innovation and that there is no one size fits all solution to innovation: each case may have its own features and route to scalability and mainstreaming
- Ecological diversity of innovations foster scalability: the more 'innovation sites' involved, the bigger the potential for scalability.
- Leadership for strategic alignment as a necessary condition for scalability: the need for strong coordination, as ecological diversity and multiple pathways can deliver in-depth contributions but can also be a risk in terms of effectiveness.
- Foster multi-level, system-wide connectivity and strategic partnerships: according to the results of the study, public-private partnerships emerging as a result of bottom-up initiatives help to mobilise resources, increase the problem solving and innovative capacity of the project and solicit both tangible and intangible support.

In relation to the wider field of learning with the support of technologies, the recently published *Beyond Prototypes* report (TEL, 2014) focuses on enabling innovation in TEL and pays special attention to the UK context. The main conclusion of the report is that "the work involved in successful TEL innovation can be characterised as 'bricolage'. This is a productive and creative innovation process that involves bringing together and adapting technologies and pedagogies, experimentation to generate further insights and a willingness to engage with local communities and practices" [TEL, (2014), p.6]. The HoTEL experience fully confirms this view. Furthermore, similarly to HoTEL, the report sets as a starting point the consideration that TEL is a complex system in which communities, technologies, learning practices and pedagogy interact. Recommending the need for meaningful innovation in TEL (with long-term objectives and making sure that the adopted innovations have as scope a positive impact on educational change), the report outlines the key role played by the context in which the innovation is to be introduced and highlights the importance of the implementation process to ensure the success of the innovation.

The desk and field research run by HoTEL, as well as the engagement of real innovators and the practical piloting conducted throughout the project have confirmed the initial view of HoTEL, that is, by using a metaphor, that innovation in TEL is a constellation, and that the primary need is to connect the stars to have innovations that can be applied to the mainstream. As a result, the ISM proposed by HoTEL is not composed of prescriptive actions, but rather of a set of adaptable three phases, which can be implemented through a set of eight practical steps (see Figure 3). The philosophy of the ISM is in line with the i-teams model produced by NESTA for the Bloomberg Philanthropies (http://www.nesta.org.uk/project/i-teams), since it provides room for local partnerships and for customised support.

Therefore, and according to the information presented in Figures 3 and 4, the general conceptualisation of the ISM is composed of the following three phases:

1 A discovery phase, where an innovation is discovered and described in a structured format, so that different innovations can be compared with one another; added value is provided by connecting with learning theories, and by supporting the innovation leader in context exploration and in stakeholder (including main 'influencers') identification.

2 An analysis phase, where the innovation is analysed from a full multi-stakeholder perspective through a number of flexible protocols with macro categories of analysis such as:

   a sectors/context of innovation
   b impact of innovation
   c stakeholders involved in innovation
   d process of the development of innovation
   e serendipitous elements in innovation
   f the unique nature of innovation
   g innovative elements in innovation, etc.

3 A transfer and support phase, aimed at supporting an innovation to either be transferred to another context or to be further developed and scaled within the same context. A number of matching exercises need to be conducted, e.g., mapping stakeholders from the originating context to the new context, isolating critical success factors for the innovation and transferring them to the new context, etc.

These three phases are articulated through eight practical steps, which represent the HoTEL 'innovation support process', which is graphically illustrated in Figure 4.

Figure 3 The main elements of the HoTEL ISM (see online version for colours)

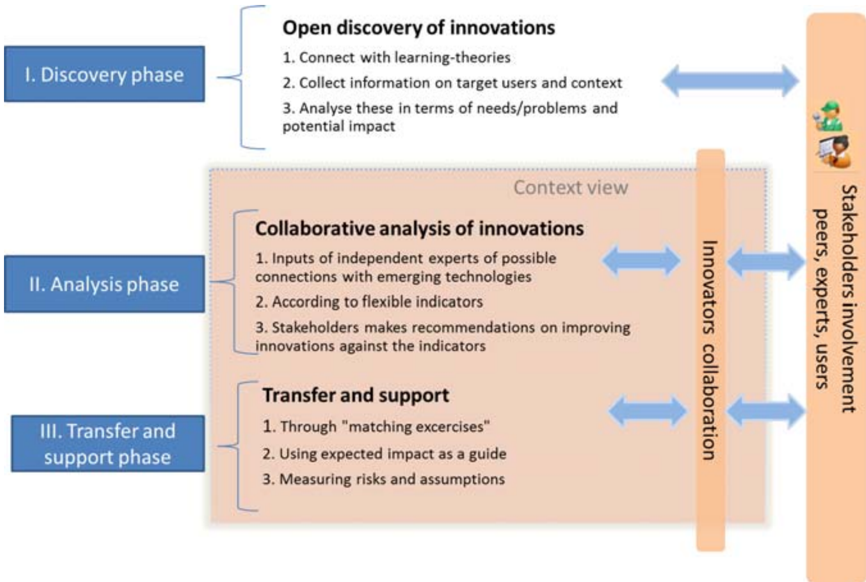
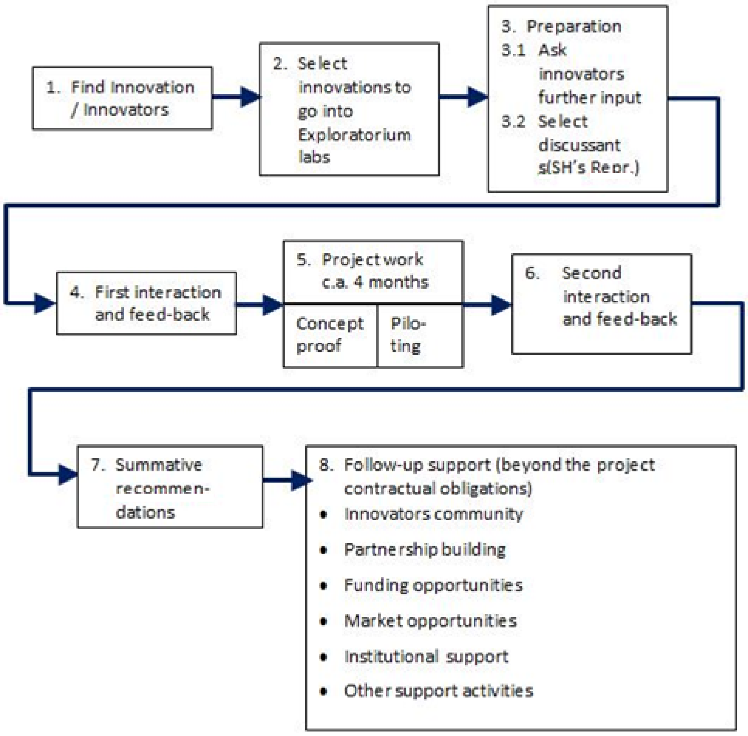


Figure 4 HoTEL operational steps for the support of innovation adoption (see online version for colours)



As part of the discovery phase and in particular, as part of the selection phase, the following set of dimensions has been used to rate innovations. These dimensions were inspired in the framework defined by IPTS (Kampylis et al., 2012):

1 Type of innovation addressed (product, service, process).

2 The nature of the innovation, from the introduction of some new elements (incremental), to a relevant number of innovative elements (radical), to a profound and comprehensive change (disruptive).

3 Life cycle stage of the innovation (development, pilot, scale, mainstream). This describes the stages of development, ranging from limited, experimental application (pilot), to wider up-take (scale), to consolidated use (mainstreaming).

4 Territorial level addressed (local, regional/national, EU).

5 Target groups – from a specific group (single actors) to a diverse set of actors (multiple actors), up to a variety of stakeholders (wide range of actors).

6 The potential impact of the innovation.

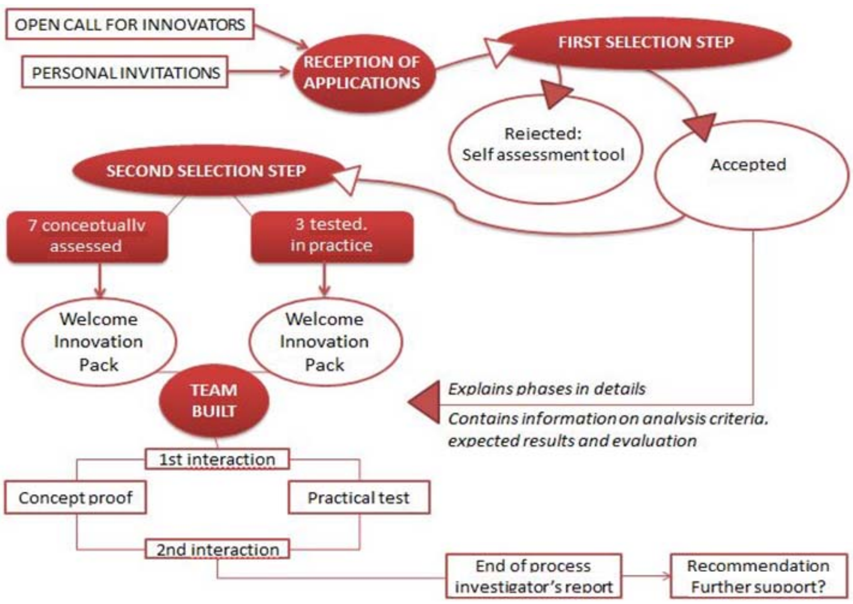
7 Stakeholders to be activated to support the innovation's implementation.

In terms of analysis and supporting the innovation (phases 2 and 3), there are two key interaction activities related to innovators, which are described below.

- *First interaction: self-assessment*. Each innovator is invited to participate in a self-assessment exercise, providing detailed information on the innovation's character, the value proposition/ innovative aspects of the innovation, the strategic objectives of the innovators' development plan, an analysis (SWOT) of the objectives outlined, a development plan in terms of R&D and marketing and promotion and pricing. As part of this development, innovators are encouraged to include measurement indicators from a common pool as suggested by the ISM (available in D4.4.1), so as to be able to compare and contrast the effectiveness of implementation. These include: number of beneficiaries, profile of beneficiaries, learning user performance per user and target group (before and after the innovation), user interaction per user and target group (before and after the innovator), as well as other indicators such as user reputation, level of disruption and technological improvement.
- *Second interaction: reporting, reviewing, support and implementation*. At the end of the innovation-testing period, innovators are asked to report on their progress, i.e., discuss the changes implemented in qualitative terms and report their performance against the success indicators established by the reviewers. Following this, the same teams of reviewers who initially reviewed the innovation will re-analyse the innovation using the same procedure as noted above (i.e., an individual review followed by a conciliation meeting). The aim of this review will be to detect whether the innovations have made progress in terms of improving their adoption potential. According to the results of the second interaction, a group of recommendations can be generated to help the innovators in their goal of improving this adoption potential.

The representation below clarifies the process of supporting innovation through the implementation of the different ISM phases: discovery (as identification, selection), analysis (as analysis) and support and transfer (as support).

Figure 5 Innovation 'processing stages' (see online version for colours)



The above process can be narratively described as follows:

1. An open call for innovators was launched in Spring 2013 to gather applications from innovators in TEL for three ‘learning exploratorium laboratories’ (labs). Personal invitations to apply were also sent at the initiative of the single labs, either in parallel or if needed (i.e., when the collected applications were not judged as being appropriate).
2. To check the relevance of the applications against the aims of the project, a transparent procedure was carried out, engaging experts from each lab and using a grid to assess the practice’s innovativeness, applicability and state of development.
3. Once the selection process was complete, applicants were informed of the results and received:
   a. in case of selection, information and instructions on how to move forward (through the welcome pack and personal briefings)
   b. in case of exclusion, a self-assessment tool to support them in reconsidering their innovation and/or how to present it more effectively.
4. Each lab worked with theoretical and practical testing. Through theoretical testing, innovations were conceptually assessed; through the practical testing, practices were practically tested by the lab.
5. The innovators worked together with the HoTEL team via personal contacts (virtual and face to face); innovations were analysed and supported by a set of tools and actions.
6. At the end of the process, innovators were asked to assess their experience with HoTEL, both in terms of the processes they had to work with and in terms of the impact of these processes on their innovations. The validation input provided by innovators was crucial for the final definition of the ISM.

The labs worked on a set of protocols that were common to all of them, but which could be flexibly adapted, depending on the features of the labs and of the innovators they worked with. The standard process implied the following actions:

- the in-depth description and analysis of the innovations as carried out by innovators themselves; this was facilitated by completing a self-assessment tool, in which they had to describe their innovation in detail, its expected impact and the support they expected from HoTEL.
- a review of the completed self-assessment tools by external experts (each lab had its own experts) and the provision of feedback, suggestions and recommendations regarding:
  1. how to better describe the innovation
  2. how to better ground the innovation in the technological and pedagogical context of reference
  3. how to speed up the path of innovation as wished-for by the innovator (for example, from an idea to a prototype).

- upgrading of the innovation by the innovators, based on the recommendations of reviewers and the feedback received from relevant stakeholders (including potential users) via ad-hoc organised events (for concept proof validation and/or practical testing).
- a new review round by external experts to provide a final assessment of the innovation upgrade process.
- validation by innovators of the innovation support process.

6 Innovative aspects of the ISM

With respect to existing ways for supporting innovation in the field of TEL, the HoTEL ISM is innovative in a number of ways.

First, it represents a ‘bridge’ between innovation drivers and innovation supporters. The ISM has in fact been designed in such a way that it is able to combine bottom-up innovation (coming from single grassroots innovators or groups thereof addressing societal needs, or market needs, or consumer needs) and top-down innovation (coming from institutions and addressing societal needs), and can therefore be used by ‘innovation supporting agencies’ or policy makers to discover innovative TEL practices and products, and to accompany them towards replication and/or mainstreaming.

Second, the HoTEL ISM is fully open. Consistent with the open innovation approaches presented above, the ISM recognises the need for interaction between internal and external actors and between practice and research (through, for example, the phase where learning theories and pedagogical approaches are included). As a result of this openness, the model can ‘learn from experience’, as it did during the HoTEL piloting process and can therefore be constantly improved.

Third, the HoTEL ISM highlights the key role played by stakeholders in the innovation process. ISM stakeholders are not only expected to ‘comment’ or ‘validate’ results, but are also considered to be the true ‘engine’ of the process: the stakeholder ecosystem is key in the implementation of the HoTEL model, where top-down and bottom-up innovation co-exist, given that the TEL landscape is populated not only by single, grassroots innovators but also by market and institutional forces, and where more than often, innovation is a societal need. The stakeholders identified include four broad categories of participants involved in the running of the learning exploratorium labs: ‘TEL innovators’ of any background who will propose ‘innovations’ (ideas, research results, teaching practices) that they wish to test through the HoTEL labs, and is aimed at receiving support for exploitation; ‘lab managers’ who lead and take an active part in lab activities; ‘innovation experts’ who bring approaches and expertise from within and outside TEL; ‘TEL and innovation stakeholders’ who observe, comment and validate the innovation cycle that will be tested in the labs.

If we consider the genesis of innovation as presented above, we can already gain a better understanding of how important the involvement of different stakeholders in enhancing an innovation becomes. In Table 2, the three learning areas covered by HoTEL through its exploratorium labs are matched with the three genesis models of innovation in TEL.

Table 2 Genesis models of TEL innovation in the three areas covered by HoTEL

	Higher education	*Learning at work*	*Professional networks*
Technology and industry-led	□	■	■
Research-led	■	□	□
Practice-led	■	■	■

It is evident that each area implies the need for involving different stakeholders in order to guarantee the successful implementation of the innovation, these being: innovation in higher education; (generally) research and practice-led (■); the support of stakeholders representing the TEL industry (□) will be necessary to support innovation adoption and scaling. In the case of corporate training (learning at work), as innovations usually arise from industry, the support of stakeholders representing the research field, as well as that of practitioners, will be needed. Finally, concerning professional networks – being at the crossroads between industry and the world of practitioners, these networks usually generate innovations that are either technology and industry-led or practice-led and will therefore need to seek the support of research stakeholders.

7 Conclusions: lessons learned and the future of the HoTEL ISM

During the HoTEL lifecycle, the ISM was continuously enhanced according to the feedback received from the labs. However, a number of improvements are nonetheless envisaged for future versions of the model:

- Practical examples should be added, particularly those that have local relevance; these cases should be familiar to participants, since they appear to be a valuable vehicle for allowing the autonomous self-directed application of the ISM analytical tools.
- Consideration of language as a barrier should not be neglected and a translation of any type of information might be considered.
- Keeping complexity moderate by breaking down complex topics in well-defined and clearly understandable nuggets will further support participation opportunities, as well as autonomous self-directed application. Furthermore, a shared understanding among the participants of what ‘success’ and ‘impact’ mean did not exist. One of the major difficulties of innovation development within an educational setting was to properly define ‘success’. These criteria have proven to be dependent on the context, the objectives and the target-group being addressed, among other direct and indirect variables. Similarly, the same challenge has arisen for assessing the potential impact of an innovation. The set of dimensions that can be considered for analysing the innovative impact on the target-group, whether individually or in general, and/or on the working and learning environment, for example, makes it difficult to strictly assess the potential impact of a given innovation.
- Although all areas are important to the successful development of a product or service, some interventions need to take place sooner than others. Hence, it is important to analyse and define priorities. In order to facilitate this process, a design

mind-set must be implemented within the innovator's team, aimed towards overcoming external barriers. The design process starts with the formulation of questions and problems based on a deep understanding of human needs, both practical and aesthetic; thus, the relevance of this mind-set to the early stage of the innovation's development emerges.

- It may be useful to specifically target the model to the different stage of the innovation, or to develop more than one sub-model, tailored to innovations at different stages of development. While innovations in an intermediate stage of development found the model extremely useful and fitting their needs, innovations that were still in a conceptual phase (either in terms of service provision or of research and development) found the process to be less useful, as a service concept had not yet been developed and because they were seeking a process by which to arrive at a service concept, rather than a process by which to improve an already existing service-concept. Similarly, innovations in a mature phase of development also found the process less useful. In this case, the reason was because they had already dealt with the problems that are tackled by the HOTEL ISM. They were instead looking for new areas to explore and to evaluate long-term strategies, among others, rather than make incremental improvements on their current activities.
- Stakeholders involvement must be continuous and continuously supported. The first interaction between the innovator and stakeholders is very important and certainly influences all processes; thus, interaction and communication between them is important in order to address the stakeholders' specific requirements and to understand what motivates them. Breakdowns in communication between actors are a frequent cause of problems and can in fact lead to moment of discontinuity in the support process.

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Sustainable ICT, Education and Learning

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The Innovation Cycle for Sustainable ICT Education

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Abstract. Usually, the cycle of innovation is sold as a great progress in Education. However, in Education, the cycle of innovation does not exist as we might expect. Innovation is cyclical by itself. Each step of the structure can be modified, improved and complemented without waiting for a whole process that shows logic in other areas (engineering, logistics, and psychology, for instance) but that, in education, seems to be a luxury. This position paper shows why and how to perform a dynamic innovation cycle that enhances learning and teaching experiences, Worldwide, including North-North, North-South and South-South approaches, supported by initiatives by UNESCO, the International Council of Distance Education, Open Education Consortium, the European Commission and others.

1 Innovation Cycle and the Sustainable Development Goals

Our common ground is education. This is stated by the sustainable development goals of the United Nations (SDG). It is the objective 4: quality education.

But the objective 4 is closely linked to other objectives, as the number 2, on eradication of hunger, or number 3 on health, or 8 on decent work and the 16, about peace. Education lives across society as a whole. And education requires innovation. Normally, the innovation is structured as a cycle consisting of 3 pillars: evaluation, quality and training. Personally, I think that there may be more. Each pillar will affect teachers, students, and staff support and management. In addition, innovation itself focuses on the educational system and the educational methodology [1].

1.1 What Innovation Means

In short, what Innovation means? Why someone new at the leading post needs to re-modify everything from scratch? Why when a blue guy follows a red one, or the other way around, education is always losing something good? Is that difficult to understand that something can be saved from burning to the ground? [2, 3].

Selective innovation over specific steps of methodology, assessment, training, content authoring or any other links of the chain, is a breakthrough. Simple, effective, encouraging [4]. It means the missing link. We call it transgenic learning (#transgeniclearning) because it actually follows the same process, metaphorically speaking:

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out of a chain of parts, one specific part is taken, modified, and put back on the chain. To make it better, or faster, or cheaper, or more personalised, or localized, etc.

What we stand for is that the timely application of selective changes might mean a World, and it takes just a moment in the design of a lesson plan. The school teacher of the university professor is entitled to do so, without waiting for an overall regulation.

And nowadays, the real key, the golden rice of Education, that effective move that any docent can make on their own, is to combine regular academic programmes with informal learning. To integrate Open Educational Resources, MOOCs, SPOCs, Learning Objects and so many pieces of knowledge uploaded out there (we call it Internet), into their classroom. The challenge is to select the quality content. But the integration part should be easy. Formal and informal integrated, not that difficult and a huge breakthrough in Education.

2 What Is Transgenic Learning?

Genetically Modified Organisms (GMO) is a controversial technique to produce new life or food based on the artificial modification of DNA [5, 6]. Induced by an external disruption, a significant change happens, as if it might be part of the natural evolution of a species. In doing so, adaptation is forced into the natural course, so that an additional feature is provided to that species: from a stronger plant against stormy weather or a plague, to a vitamin embedded into a cereal that does not contain it by default, through the modification of a human protein. This external intervention is conflictive from a number of approaches: ethical, scientific, Societal and economic, to name a few. However, the possibility exists; and if smartly applied, it provides the human being with a new resource for progress.

Indeed, genetically modified organisms (GMOs) are those organisms in which the genetic material has been modified through modern technology to produce a new organism or the same one with a modified set of properties [7]. For example, to remove something that does not work or may work better, it is later modified and it is finally reinserted. It is a simple process: choose something that you want to modify, because it does not work, or because we want it to adapt somehow, modified it and reinsert it.

You can choose one that does not work well, which is not well suited, which can be improved, which can be complemented. We can choose, modify it, and reinsert it in the cycle. And all this, without waiting for a semester or a whole year [7, 8]. Innovation can be done immediately. Although there is no support to a lack of planning or an improvisation, a teacher (at school or university, everywhere) should not stand by the imposition of a cycle that is not the reality of their educational context, in the classroom. Innovation should serve as a healthy and continuous process of regeneration and progress.

3 A Significant Breakthrough in Education

Education, as a whole, nowadays, requires a disruptive boost [9, 10]. If we teach and learn in the same way that we did for the last 20 centuries; if we use the very same academic structures that 10 centuries ago; if we stress some methodologies from the early XX century; and if we use resources from before the rise of Internet; if all this happens, we will miss every single possibility that the last 20 years bring to the table. We will miss new, adapted, personalized ways to learn and to teach; to be more efficient, to get a better performance; to enjoy more the experience as a user; and to improve the competence and skill acquisition. Furthermore, we need to break this slow evolution in Education. The youngsters, the technicians, the mass media, the entertainment industry, all of them are far advanced from any practical implementation in the classrooms, from kinder garden to the University.

Open Educational Resources, MOOCs, Virtual Reality, Augmented Reality, Emotional Intelligence, Personalized Learning, Analytics and so many resources, services and approaches to complement, enhanced and evolve Education, as it is now [11, 12]. We need a radical innovation, to design a new paradigm, to complement the existing ones, to evolve with the actual users of the system (students, teachers, professors, tutors, parents) and not always far behind from them. We need a GMO concept into Learning and teaching, a transgenic approach to Education. Something that makes things evolve quicker and more adapted into a very specific and practical objective. And this is a complex challenge. Compulsory. Needed. Urgent. But a challenge, yet.

And out of this challenge, the most difficult part is to find the right integration between informal ways of learning, teaching and using daily services, with formal courses and academic degrees; the smart combination of resources inside-outside the classroom; the update of accredited content with enriched, additional information outside the official syllabus that can fit into the same slot of educational competences [13, 14].

4 The Role of ICT in Educational Innovation

Teachers are in revolution. They claim an active role in new ways of learning and teaching. Usually, through the use of ICT in the classroom, wherever that classroom is, face-to-face or online. They claim, fight for and push for means, time and capacity decision in the innovation cycle in Education. They can be disruptive through the use of Open Educational Resources (OER), live analysis of learner data and, of course, ICT tools in the classroom and long list of activities and services [15].

Literally, this revolution is happening everywhere. We count parallel events in Sidney, Ljubljana, Buenos Aires, Beijing, London, Salamanca, Visakhapatnam, Paris, Toronto, Tallin, Bogotá, and a long list of places. Thousands of school and university teachers want to do better, perform better, support better. They are committed and determined. This is an overall force that requires global awareness and action, National policies, regional contributions, peer-to-peer interaction and a key role from every character in the setting: from learners to administrative staff, principals, tutors, parents and sympathizers. And, of course, from the teachers.

In this context, ICT can be the secret ingredient to facilitate that healthy revolution. From a basic use to an advanced tool creation, teachers can integrate communication, interaction, assessment, innovation, content and any other element of any educational cycle. This revolution is very much alive and kicking, and it will bring a real change in Education.

5 OER as a Means to Boost Education

Which seems clear is that we need an agreement. In OER many issues are at stake yet: accreditation, credit recognition, access, etc. All of them emerge from practice, from the community of practice, from the actual users (i.e. students, teachers, professors, management staff, etc.) We all are very committed to provide an open environment, with the various interpretations of what "open" means. We discuss, design activities, organize congresses, create content, give lectures, write documents about educational policy, review papers, work with Governments and regional departments, publish books and share out thoughts with blog-posts like this one, to name a few actions. Furthermore, we all look for a pro-active, fruitful, interesting and intellectually spicy environment that supports learning, competence building, and integration, along with personal and group development [10].

However, open means also controversy. Nobody argues against the good-willing approach to the various pillars of openness: access, content, data, research results, licensing, policy and technology. However, it seems that open quite often means unregulated. And unregulated might mean whatever. And this should not be the case when we deal with OER. We, the community, must be sure that content, access, technology and the other pillars provide the user with the best quality and, above all, with a minimum threshold for quality.

This approach would require a list of requirements and metrics to meet by every OER to ensure that threshold, based on an agreement amongst the various stakeholders. We need to normalize that approach, to make it sensible, reachable and useful.

Furthermore, we need to get an agreement to make the user feel safe and inside a quality framework, every time that this very user takes an OER. OER must be a seal for quality content and quality education and the OER community can reach a consensus about this basic right.

5.1 MOOCs, as an Example of Innovative OER, Applied

Informal learning and social interaction are receiving increasing attention in current eLearning campuses and platforms. Massive Open Online Courses (MOOCs) are no exception [16]. In plain online campuses, students now have a wide range of options for social actions and group collaborations at their disposal: post/answer questions in forums, start their own activities, create their own sites, wikis, invite colleagues, comment on someone else's job, score jobs made by others, incorporate external materials to their knowledge repository, fill in questionnaires, participate in WebRTC sessions with teachers, et cetera. Small Private Online Course (SPOCs) and locally deployed Learning Management Systems (LMS) already allow almost endless possibilities in humble environments. These can grow exponentially in an x/c MOOC setting which can potentially manage thousands of learner accounts around common learning material.

5.2 Open Licensing, Proprietary Content, as an Innovative Breakthrough

Nowadays, one key discussion point is about open licensing [12, 17]. The bottom line is that resources created out of public funding should be open and free. This funding comes from tax payers for the greater good and no one could make business or restrict access to these outcomes. This means, for instance, that professors of public universities, being civil servants, develop resources and provide them to the community openly. They keep the intellectual property, but not the exploitation rights or the ownership.

On the other side, when private funding is used to create resources, it depends on the author and-or owner the way to use them and to put them in the market. They can be open or free or universal or nothing at all or a combination of these. This owner has no obligation to make them available to the community as if they were supported by public funding. There is a claim from a section of the OER movement that everything should be open and free ever, no matter who is financially supporting the resource or the educational process. However, a balance should be reached to guarantee the exploitation rights and the sustainability of the creations, when they might come from various sources. Public funding means public resources; but private funding means the need to find an agreement about service and access with the owner.

6 Conclusions

There are more parts of this cycle of innovation, such as content, licenses or the exploitation, for example. In theory, the cycle of innovation runs like a clockwork: turns and turns inside out and outside in trying to understand and improve. Sometimes, to give more laps will not a real good and it does not make any progress. Other times, giving turns is like a clock based on a Nautilus shell, as a Fibonacci series, where you get more knowledge and better application after each iteration. However, this is not true.

They have sold us something that is not accurate. Engineers, entrepreneurs and bureaucrats wanted to parameterize a process useful for them. However, it does not provide an additional value to the educational community, if it is not properly contextualised. If we apply the spirit of the full cycle of evaluation we should be using semesters or full years to check whether the measures are useful or not. And so long seems eternal at ICT in Education, where everything changes from one month to the next one.

The reality is quite different: there is no cycle of innovation in education. We must break it and innovate now, without waiting, hungry for change and improvement. Innovation must be cyclic by itself. And a form of innovation is through “Transgenic learning". It is a metaphor, a simile, only a provocative title to explain an equal transformative reality but much less conflictive than the original term.

In education, the key innovation that will mark an era, the transgenic learning, the disruptive innovation, right now, is the combination of formal education with informal education: How to integrate educational resources outside the official programme with those very programmes. How to take advantage of a permanent connection of a student so that they can learn and practice anywhere at any time. How to use free educational resources as a significant part of the official curricula in primary education, secondary education, high school, University, vocational education, etc.

Albert Einstein said that "The definition of insanity is to do the same thing over and over again and to expect a different result". There is no need to use an industrial cycle of innovation in the educational innovation cycle, which has a very specific profile and needs. We must break the inertia, we must innovate in education, and we must do it now.

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Villar-Onrubia, Daniel	Coventry University. Principal Project Lead, Disruptive Media Learning Lab	United Kingdom
Zhang, Jingjing	Beijing Normal University. Centre for Big Data on Technology-Mediated Education	China

Sources: University of Edinburgh OER Policy and UNISA 2014 OER Strategy

Table of Content

A few definitions

“Open education encompasses resources, tools and practices that employ a framework of open sharing to improve educational access and effectiveness worldwide.”
(Open Education Consortium)[1]

“By 'open access' to the literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself.”
(Berlin Declaration, 2003)[2]

“Open Educational Resources (OER) are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge.”
(Atkins, Brown, & Hammond, 2007)[3]

“Digitised materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research. OER includes learning content, software tools to develop, use, and distribute content, and implementation resources such as open licences.”
(OECD, 2007)[4]

"Open educational resources should be freely shared through open licences which facilitate use, revision, translation, improvement and sharing by anyone. Resources should be published in formats that facilitate both use and editing, and that accommodate a diversity of technical platforms. Whenever possible, they should also be available in formats that are accessible to people with disabilities and people who do not yet have access to the Internet."
(CTOE, 2007)[5]

“The open education (OE) movement is based on a set of intuitions shared by a remarkably wide range of academics: that knowledge should be free and open to use and reuse; that collaboration should be easier, not harder; that people should receive credit and judos for

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[1] Open Education Consortium. Retrieved June 5th, 2016, from http://www.oeconsortium.org/about-oec/
[2] Berlin Declaration (2003). *The* Berlin Declaration *on Open Access to Knowledge in the Sciences and Humanities. Retrieved June 7th, 2016, from* https://openaccess.mpg.de/Berlin-Declaration
[3] Atkins, D.E., Brown, J.S. & Hammond, A.L. (2007). A Review of the Open Educational Resources (OER) Movement: Achievements, Challenges, and New Opportunities. Report to The William and Flora Hewlett Foundation. p. 4. Retrieved November the 29th, 2016, from http://www.hewlett.org/uploads/files/ReviewoftheOERMovement.pdf
[4] OECD. (2007). Giving knowledge for free. The emergence of Open Educational Resources. Ed: Organization for Economic Co-Operation and Development. Retrieved November 29th, 2016, from https://www.oecd.org/dataoecd/35/7/38654317.pdf
[5] Declaration, C. T. O. E. (2007). Cape Town Open Education Declaration: Unlocking the promise of open educational resources. Retrieved May 14th, 2016, from http://www.capetowndeclaration.org/

contributing to education and research; and that concepts and ideas are linked in unusual and surprising ways and not in the simple linear forms that today's textbooks present."
(Baraniuk, 2008)[6]

"Open Educational Practices (OEP) are defined as practices which support the production, use and reuse of high quality open educational resources (OER) through institutional policies, which promote innovative pedagogical models, and respect and empower learners as co-producers on their lifelong learning path. OEP address the whole OER governance community: policy makers, managers, administrators, educational professionals and learners."
(ICDE, 2011)[7]

"Open Educational Resources (OER) are materials used to support education that may be freely accessed, reused, modified and shared by anyone."
(Downes, 2011)[8]

"Teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions."
(Unesco, 2012)[9]

"The shift to the open model of education entails changes much more profound than simply amending the legal status of a particular educational resource (…) The values and practices associated with being "open" are coming to the fore."
(McAndrew & Farrow, 2013)[10]

"Openness has a long history in higher education. Its foundations lie in one of altruism and the belief that education is a public good. It has undergone many interpretations and adaptations, moving from a model which had open entry to study as its primary focus to one that emphasises openly available content and resources. This change has largely been a result of the digital and network revolution."
(Weller, 2014)[11]

"Openness is a set of interconnected structural elements that provide the framework supporting education."
(Wiley, 2014)[12]

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[6] Baraniuk, R. G. (2008). Challenges and opportunities for the open education movement: A Connexions case study. Opening up education: The collective advancement of education through open technology, open content, and open knowledge, 229-246.

[7] International Council for Open and Distance Education (ICDE) (2011). Definition of Open Educational Practices. Retrieved October 17th, 2016, from www.icde.org/en/resources/open_educational_quality_inititiative/definition_of_open_educational_practices/

[8] Downes, S. (2011). Open Educational Resources: A Definition. Retrieved November the 29th, 2016, from http://halfanhour.blogspot.be/2011/07/open-educational-resources-definition.html

[9] UNESCO. (2012). 2012 Paris OER Declaration. Retrieved May 14th, 2016, from http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/Events/English_Paris_OER_Declaration.pdf

[10] McAndrew, Patrick and Farrow, Robert (2013). Open education research: from the practical to the theoretical. In: McGreal, Rory; Kinuthia, Wanjira and Marshall, Stewart eds. Open Educational Resources: Innovation, Research and Practice. Vancouver, Canada: Commonwealth of Learning and Athabasca University, pp. 65–78.

[11] Weller, M. (2014). *Battle for Open: How openness won and why it doesn't feel like victory* (p. 232). Ubiquity Press.

[12] Wiley, D., (2014), *The Open Education Infrastructure, and Why We Must Build It*. Retrieved March 12th, 2017 from http://opencontent.org/blog/archives/3410

1. Introduction: Context of this Policy and Inner Relations

Online learning elicits additional competences from traditional, face-to-face education. Online learners require an additional determination for exploration, retrieval and categorization of data. Online learners also, as Internet users, must be active; they buy things, read things, combine things, and do not let others make decisions on their behalf. The online lecturer, professor or tutor, must break the *fourth wall* represented by the device to interact, encourage, evaluate and coach their students. In this context, Open Education becomes the real means of access to and interaction with every type of user. Open data, open resources, open policies, open licensing, open technology, open authoring and open results, are part of the open education strategy from a Higher Education institution. They facilitate and support the right and duty to education that every person has, from informal learning to academic degrees, vocational training or simply curiosity. Open Education is an instrument for equity, access, inclusion and excellence, with the aim to foster a more balanced and fairer society.

At UNIR, we believe in providing students and professors with a quality environment for learning and teaching, with the implementation of advanced technologies and up-to-date equipment. In this context, Open Education becomes a key part of the university's strategy to combine Open, Universal and Free content (OUF) with proprietary services, and to find a balance between economic profit and social benefit. This Open Education policy depicts the approach and specific services that UNIR meets and will deploy until 2020, so that more and more resources and services are open to every learner and professor, along with the process and strategy to be followed.

As a private, for-profit university, UNIR aims at providing its students with high quality resources and a superior learning experience, along with the accreditation of the right competences. This is part of the business model. Furthermore, UNIR provides reliable faculty, coaching, courses, assessment and believes in giving students the best environment for achieving their objectives. UNIR also gives students confidence in themselves and boasts of an extremely low drop-out rate (<5%). In this context, Open Education has proven to be a corner stone for success, since UNIR integrates the best resources, services, data and networks available worldwide, along with their own sources.

2. Purpose of this Policy

This policy outlines the vision of the Universidad Internacional de la Rioja (UNIR) towards Open Education (OE) in every form: Open Educational Resources (OER), Data, Research results, Policy, Licencing, Technology and Content authoring. It provides an action plan to reach this vision by 2020 and provides a set of guidelines for the adoption of OE in the university's teaching practices. Since UNIR is an online university this policy concentrates on digital contexts. However, this policy well could be applied to physical resources like textbooks or manuals on paper, also.

With the present policy, UNIR wants to encourage staff and students to use, create and publish OE resources and services to enhance the quality of the student experience, enhance the provision of learning opportunities for all, and improve teaching practices. At the same time, UNIR also aims to contribute to "a vast pool of educational resources on the Internet, open and free for all to use…creating a world where each and every person on earth can access and contribute to the sum of all human knowledge".[13] In addition, the policy outlines how UNIR will contribute to research in the field of OER and Open Education within Spain and internationally.

3. Potential Impact of the Policy

Globally, many universities are increasingly sharing their educational resources under open licences to promote a positive learning experience to prospective students. Open sharing of UNIR content will most certainly solicit significant publicity and interest and, as such, will function as a major marketing platform for UNIR as a university of choice. This will have the potential to promote the university's reputation as a major knowledge producer and distribution hub for higher education. From Education, to Social Science, Medicine and Engineering, the implications are that OE cannot be considered as supplementary, but rather as integral to the learning experience. In this case, OERs must be integrated into mainstream institutional processes if UNIR wishes to harness the true potential of OE in the institution's transformation process. Open Education also holds the potential to become economically and practically sustainable.

Access to information requires a rethinking of the teaching-learning process of future professionals in education, i.e., teachers, pedagogues, etc. It is no longer enough to know; now it is necessary to know how to do in a learning oriented towards the acquisition of skills and competence achievement. In this process, digital literacy, which has both cognitive and technical dimensions, plays a crucial role. These dimensions include:

a) Having the variety of skills required to find, understand, evaluate, create, and communicate digital information in a wide variety of formats

b) Being able to use various technologies adequately and effectively to search for and retrieve information, interpret search results, and judge the quality of retrieved information

c) Understanding the relationships between technology, lifelong learning, personal intimacy and proper information management

d) Using these skills and appropriate technologies to communicate and collaborate with peers, colleagues, family, and sometimes the general public

e) Using these skills to actively participate in civil society and contribute to a vibrant, informed and committed community

Access to Open Educational Resources (OER), data and services is of paramount importance in education, e.g., the training of lecturers and tutors, so that they are able to adequately train future teachers and pedagogues. In addition, given the current development of active pedagogies and digital technology, OER have direct impact on related educational research, instructional design, personalization of learning, analytics of learning, feedback and other elements of the educational process.

[13] Cape Town Declaration (2007). Cape Town Open Education Declaration: Unlocking the Promise of Open Educational Resources. Retrieved from: www.capetowndeclaration.org/read-the-declaration

4. Background

Open Education Resources (OER) are digital resources that are used in the context of teaching and learning (e.g., course material, images, video, multimedia resources, assessment items, etc.), which have been released by the copyright holder under an open licence (e.g., Creative Commons), permitting their use or re-purposing (re-use, revision, remixing, redistribution) by others.

The use, creation and publication of OER are consistent with the University's Mission Statement, which includes "a special sensitivity to attend to those people that cannot attend presence lectures and to those who can, but prefer to utilize innovative resources to improve their education, supported by emergent technologies". It is also in line with the University's aims "to facilitate access to higher education degrees to any person with the proper qualifications, with no limitation on distance, time, place, culture or social context."[14]

From an international view, the right to provide inclusive and quality education for all and promoting lifelong learning is the core of Sustainable Development Goal #4 by the United Nations, which is implemented through the global education agenda (Education 2030) signed as Incheon Declaration and Framework for action in 2015[15]. In this declaration, the access to OER is referred along the full text, such as in articles 22, 43, 45 and 79.

5. Current Structure and Resources at UNIR

UNIR has implemented a number of tools and resources focused on Open Education: from digital repositories to video-casts, as well as social networks and blogs.

As digital OER repositories UNIR provides UNIR Library and Re-UNIR. UNIR Library works as a digital service that provides access to students, teachers and tutors to over twenty bibliographical data bases, e-books, science articles, and papers. Re-UNIR is an institutional repository where teachers, researchers, students can publish their work and search for Master`s theses, conference papers, etc. It also contains most of the research outcomes from the university.

Indeed, the media production at UNIR (http://tv.unir.net) provides video-cast resources, lectures, presentations and open classes. UNIR creates over 1,300 lessons per week that are made available through that very video repository: 20% of these are open with no registration, 20% are open but require registration, and 60% are available to UNIR students and faculty only. With the present policy, UNIR aims to provide a general framework to make all these open activities sustainable and cohesive over the long-term. Moreover, UNIR also includes scientific publications, video interviews with teachers and researchers and a variety of content that provides valuable information for students. UNIR students and faculty use these features as powerful tools to search for materials, clarify their doubts, and reinforce their knowledge, open new ways to creativity and to have a more direct relationship with the academic staff.

[14] Retrieved from http://www.unir.net/universidad-online/mision-valores/, February 23rd, 2017
[15] UNESCO (2015). Education 2030 Incheon Declaration and Framework for Action Towards inclusive and equitable quality education and lifelong. Retrieved from http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/ED/ED_new/pdf/FFA-ENG-27Oct15.pdf, April, the 4th, 2017

This digital resource is supported by the YouTube channel of UNIR Universidad and the UNIR Research Dissemination channel, with more than 20,000 subscribers. YouTube bridges the gap with students and the general public and supports a diversity of end-users and global recognition.

In addition, UNIR hosts an open access journal (International Journal of Interactive Multimedia and Artificial Intelligence), runs its own open publications like the proceedings of UNESCO-UNIR ICT and Education International Congress 2016, Social4All Methodology for making web applications accessible and has been contributing to NMC Horizon Report Higher Education since 2013 as experts to the report, also leading the Spanish version.

Furthermore, the presence in social networks is becoming a good opportunity to share events, information, resources and more. With over 14,500 followers, UNIR's Twitter profile works along 1,300 followers of UNIR Research, and shows a really active profile on promoting open educational resources, open class, and conferences.

Finally, most of the faculty keep blogs about their research activities, their learning or teaching experiences in classes, their best practices and their presence in science congress and conferences. It means a way of sharing their knowledge and engaging the students by creating a discussion hub and a comprehensive repository of valuable educational content.

With these resources UNIR covers a wide range of materials to open up a good amount of knowledge to the society, general public, academic staff, and every potential learner worldwide.

6. Strategic Priorities of the Policy

The present policy is structured along the five priorities listed below, which give UNIR the opportunity to engage with the issue of Open Education and OER without committing to a one-size-fits-all approach or rushing in without proper research and planning. Once approaches and solutions have been finalized, they will become operational through specific implementation plans and the development and implementation of relevant actions and guidelines. They all look for the highest quality and the same successful metrics than any other educational material, no matter the channel, format or means. The following priorities are meant to be developed in parallel, and not in sequence.

Priority 1: Increase the Amount of UNIR Resources Released as OER

Objective by 2020: UNIR will gradually increase the amount of current educational resources released as OER, up to 40% of the total broadcast by text and video.

How to reach Priority 1: UNIR will implement an open policy to release learning resources, lessons, video-casts, open classes and other educational material, incrementally, every academic year, from various faculties, scientific fields and degrees. Whether or not OER are used or published in a school or service will ultimately be a decision for the rector and the exec board. Where use, creation and publication are to be restricted, schools and services are encouraged to identify and communicate a rationale for restriction. The University reserves the right to remove resources that do not comply with its policies, and/or request removal of resources from external repositories/sites.

Priority 2: Integrate Existing OER as Appropriate into UNIR Courses
Objective by 2020: UNIR will increase the use and re-use of existing OER within UNIR courses to the level that 60% of course materials are comprised of OER, and utilized as part of the teaching-learning process. **How to reach Priority 2**: UNIR teaching staff will be trained online and through seminars on how to identify, evaluate, adapt and share relevant OER within their teaching activities. Online open resources, after a quality check, will be combined with academic, proprietary materials, so that students, authors and lecturers are encouraged to integrate both approaches into a successful learning flow. Other OER repositories will be integrated for a bi-directional relation, so that OER can be freely shared. Cross capacity-building actions will be put in place through courses, open classes and workshops dedicated to Open Education and OER.

Priority 3: Support the Creation of OER as Academic Resources
Objective by 2020: at least 20% of all UNIR learning material produced by faculty will be created and distributed under open licences. UNIR teaching staff will be trained in Open Education and equipped with knowledge, skills and technologies to produce OER. **How to reach Priority 3**: The university will encourage faculty and students to create and publish OER to enhance the quality of the student experience, provided that the resources are fit-for-purpose and relevant. Whether or not OER are used or published in a school or service will ultimately be a decision for the rector and the executive board. Where use, creation and publication are to be restricted, schools and services are encouraged to identify and communicate a rationale for restriction. The university reserves the right to remove resources that do not comply with its policies, and/or request removal of resources from external repositories/sites.

Priority 4: Develop an Open Access Approach for UNIR Research Data
Objective by 2020: Over 80% of UNIR research data, and all of those that are not restricted by privacy issues, will be made available with open licences and promoted through relevant open access umbrella repositories. **How to reach Priority 4**: UNIR faculty will be trained through online resources and through face-to-face seminars on how to select the appropriate open access licences for their research work, including data sets and data results. UNIR repository for open research data will be connected to existing umbrella key national and international repositories with open research data.

Priority 5: Contribute to the Awareness of Open Education into Society and the Academic Community at Large
Objective by 2020: UNIR will boost the dissemination, awareness and support to Open Education through the university's departments and services, with a special stress on reaching out to the general public, the academic community and a variety of stakeholders: from policy makers, to regular citizens, through school teachers and content providers.

How to reach Priority 5: UNIR will promote its Open Education policy and carry out specific activities to raise awareness. UNIR will also expand the publication policy in Open Access journals and repositories and Open Source repositories for scientific outcomes and on-going investigation, though social networks, journals, university magazine, newsletters, video channels and blogs.

7. Recommendations for UNIR Faculty Related to Open Education

The following recommendations for faculty are put forward by the present policy:

- It is the responsibility of staff and students to ensure that they have the necessary knowledge and rights to publish an OER and that all such resources published comply with all relevant policies (i.e., copyright, IPR, accessibility)
- Staff and students are advised to publish OER using a Creative Commons attribution licence (e.g., CC-BY), when the have the rights to do so. Other Creative Commons licences (e.g., to add a non-commercial use or share-alike element) may be used if the creators feel this is necessary or appropriate for their particular resource, or to comply with the licence of any third party content used in the resource
- Written and interactive digital teaching resources should be published in an appropriate repository or public access website in order to maximize discovery and use by others, or must be linked or federated from the university repository to other repositories. Where OER have been created as part of an externally funded activity, any storage and/or repository locations mandated as a condition of the funding should be used. Where possible, OER will be released in editable and open formats
- Audio/video-based OER teaching resources should be published at the University's multimedia repository
- Faculty and students are encouraged to collect data where possible on usage of their OER
- Where students are producing OER as part of their programme of study or within a faculty-directed project, these guidelines should be followed and OER should be checked by a member of staff before publication

8. Engagement of Students into the Open Education Policy

University learning has changed in the past years. We are in the so-called conceptual society, in which students are required to be able to interpret complex relationships, find creative solutions and to develop their emotional intelligence and self-directed learning as they engage with content, and with their peers and instructors. Students must be effective communicators and producers; collaborative workers; skilled consumers and processors of information. They must be able to develop meta-cognition, be digitally literate and trained to synthesize diverse ideas. The age of analogue textbooks and closed information has already passed. Now it is necessary to know and access open resources that are constantly being updated. Also, policies of open access to scientific knowledge have progressed remarkably. Evidence of this is the infinite number of open digital repositories in universities and research centres. Faced with this scenario, university students should not be limited to static and closed sources of knowledge; they should know how to search, select, evaluate, and use resources appropriately and ideally, create new and valuable resources. For this, it is essential to have specific training that will enable students to carry out these operations and to know the licences under which these resources can be used, such as Creative Commons, in order to use them in a responsible manner.

9. Relation to Other Stakeholders, Practitioners and Facilitators

The present policy must be seen as a way of contribution to the international eLearning and Open Education community, with a number of leading networks and institutions, such as:

- UNESCO, which remains connected to UNIR thanks to the UNESCO Chair on eLearning held by Prof. Daniel Burgos
- ICDE, the oldest international association in the field of distance education, which remains connected to UNIR thanks to the ICDE Chair in OER, held by Prof. Daniel Burgos
- Open Education Consortium, the broader international association with a specific focus on Open Education (former Open Courseware Consortium)
- EDEN, the European Distance and eLearning Network, with assistant Dr. Fabio Nascimbeni, as Board Member
- Other networks: Open Distance and Learning Australian Association (ODLAA), Brazilian Distance Learning Association (ABED), Spanish eLearning Association (TELSpain), Red eLearning Latam (REALM), European Network for Technology-enhanced, Adaptive and Online Education (ENTEL), European Association for Technology-enhanced Learning (EATEL), Red de Recursos Educativos Abiertos y Educación Abierta en Español (REANET), Technology Enhanced Learning European Advanced Research Consortium (TELEARC), etc.

10. Sustainability, Networking and Dissemination of the Open Education Policy

UNIR finds the combination of sustainability, networking and dissemination as crucial to a completely successful OER policy. Sustainability, networking and dissemination are key activities that have to work together with the same goal: to provide support and collaboration of all the stake holders in the open activities.

Anderson & McGreal's (2012) basic model for the provision of post-secondary educational services on distance education institutions included the following: content services, interaction services, credentialing services, support service and technological services need to work together as complementary and integrated areas. This coordination can assure the sustainability of the system.

UNIR is going to foster the collaborative relationship with their national and international partners in order to evaluate the correct implementation of this policy. With the support of the UNESCO Chair on eLearning and the ICDE Chair on Open Education Resources (http://research.unir.net/unesco), UNIR has access to the latest policies currently in place worldwide, the best practices, and the most well-known experts in the field. Among UNIR's partners there are also a variety of institutions who work in association with UNIR in European projects in which UNIR will found a network to learn from, and to ask for support if it is needed.

With regards to the dissemination of scientific knowledge, UNIR develops its Science Dissemination Unit (UCC+i), supervised by the Vice-rectorate for Transfer Knowledge and Technology (http://transfer.unir.net) and certified by the Spanish Foundation for Science and Technology (FECYT). The mission of this unit is to disseminate research outcomes to the general public through mass media, social networks and innovative media formats. The production of news, reports, and audio-visual resources is part of its core description, so it will be an excellent support for the sustainability of this Policy.

Acknowledgements

UNIR iTED (Research Institute for Innovation and Technology in Education, http://ited.unir.net) has been in charge of the design, core redaction and editing process of this policy. UNIR thanks this institute for its determination and energy to pull together a vast variety of sources and people towards a common goal for the benefit of the educational community.

Furthermore, the following institutions, departments, faculties and external reviewers have provided a decisive support to the redaction of this Open Education policy and to the agreement towards an actual implementation. UNIR expresses the sincerest thanks to all of them:

Departments at UNIR

- Rectorate
- Vice-rectorate for Knowledge Transfer & Technology
- Vice-rectorate for Doctorate
- Vice-rectorate for Educational Development and Innovation
- Vice-rectorate for Faculty
- Vice-rectorate for Research
- Vice-rectorate for Students and Quality
- School of Engineering and Technology
- Faculty of Social Sciences
- Faculty of Education
- Scientific Dissemination Unit (UCC+i)

Institutional relations

- Unesco. UNITWIN/UNESCO Chairs Programme
- Unesco. Institute for Information Technologies in Education
- University for Peace (United Nations)
- European Commision. Joint Research Centre Seville
- Internacional Council for Open and Distance Education. ICDE
- Unesco Chair on eLearning at UNIR
- ICDE Chair in Open Educational Resources at UNIR
- Telefónica-UNIR Chair in Digital Society and Education
- AENOR-UNIR Chair of Standards and Certification

External review

- Athabasca University
- Beijing Normal University. Centre for Big Data on Technology-Mediated Education
- Coventry University. Disruptive Media Learning Lab
- Instituto Tecnológico de Buenos Aires
- Mediterranean Universities Union. UniMed
- New Media Consortium
- Open and Distance Learning Australian Association. ODLAA
- Open Education Consortium
- Open Education Foundation
- Open Universiteit Nederland
- The University of the South Pacific
- Universidad de La Laguna
- Universidad de Salamanca
- Universidade de São Paulo. Escola Politécnica
- Université Caddi Ayad
- Université Ibn Zhor

13 Bacsich, P., Nascimbeni, F., Atenas, J., Aceto, S. & Burgos, D. (2017) Member States case studies: Policies for Opening Up Education in Europe. Seville, Spain: Joint Research Centre. European Commission

Member States case studies: policies for opening up education

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Draft Final Report

Authors: Paul Bacsich, Fabio Nascimbeni, Javiera Atenas, Stefania Aceto, Daniel Burgos

Table of Contents

Abstract

The present report presents the results of the study *Member States case studies: policies for opening up education*, run by the Universidad Internacional de la Rioja (UNIR) on behalf of the Joint Research Centre (JRC) Seville of the European Commission.

The study, which is part of the project *Policies for Opening Up Education* (OpenEdu Policies)[1], aims to provide evidence-based recommendations to policy makers at Member State and European level to foster open education in Europe. The work has covered the following 22 countries: Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia, Sweden, and United Kingdom.

The report presents, for each country, a contextualised overview of the state of play of open education in the country, followed by a summary of the interview (or in two cases, interviews) run with national policy makers and/or experts from that specific country. Then an analysis of the desk research and of the interview results is presented, followed by a set of recommendations for future open education policies at the EU and at the MS level, derived from the statements made by the interviewees.

[1] https://ec.europa.eu/jrc/en/open-education

Executive Summary

Innovation in Education and Training is at the core of the European strategy, as stated by the *Europe 2020* strategy[2], by the *Rethinking Education* Communication[3] and more recently by the Communication *Opening up Education: Innovative teaching and learning for all through new technologies and Open Educational Resources*[4]. All these policies aim to stimulate open and flexible learning in order to provide the skills needed in the 21st century economy and society, and give relevance to innovative ways of learning and teaching through ICT, stressing that embedding ICT and OER in education will increase both efficiency and fairness of education and training in Europe.

In order to achieve these ambitious goals, **effective open education policies are needed**. Taking into account the different understandings that exist of the concept of "open education" across European Member States and recognising the different approaches in place, in 2016 the Joint Research Centre (JRC) Seville of the European Commission commissioned a Study called *Member States case studies: policies for opening up education*, aimed at facilitating the understanding of what policies actually are in place across the EU, what kind of open education policies are needed and how best to formulate them.

The study, which was run by the Universidad Internacional de la Rioja (UNIR), is part of the project *Policies for Opening Up Education* (OpenEdu Policies)[5], and covered the following 22 countries, all[6] Member States of the EU: Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia, Sweden, and United Kingdom.

In order to reach this goal, the study team has been working to:

- Identify and analyse, through desk research, national-level policies aiming at opening up education
- Explore, through a number of interviews with policy-makers and experts, perceptions on what national and EU policies are needed and of possible barriers and enablers to national and EU policies on open education;
- Analyse the results of desk and field research, spotting issues faced by decision-makers when planning policies on opening up education, and propose recommendations for future open education policies.

The study has identified and analysed policies from 14 countries of the EU (Croatia, Cyprus, Czech Republic, Estonia, Germany, Germany, Greece, Ireland, Italy, Lithuania, Netherlands, Poland, Romania, Slovakia, and UK). In the cases of Germany and the UK, two policies have been selected and analysed for each country. The selected policies range across all educational sectors (school, higher education, VET and adult learning).

[2] http://ec.europa.eu/europe2020/index_en.htm

[3] https://ec.europa.eu/digital-agenda/en/news/communication-rethinking-education

[4] https://ec.europa.eu/education/policy/strategic-framework/education-technology_en

[5] https://ec.europa.eu/jrc/en/open-education

[6] We are of course aware that there is OER activity and indeed policy work in some non-EU European countries in the European Higher Education Area of which Norway and Switzerland are the most obvious examples – for other examples see http://education.okfn.org/world/ – but non-EU European countries were not in scope for this study

Based on the study results, we identified that **four types of policies involving opening up education** are present at the moment across the EU:

- Policies focusing specifically on opening up education through the promotion of OER and OEP (e.g. Germany, UK/Scotland, Netherlands, UK/England);
- Policies relating to general ICT for learning with some open education component (e.g. Cyprus, Ireland, Italy, Lithuania, Poland);
- Comprehensive strategic educational policies with some open education component (e.g. Croatia, Czech Republic, Estonia);
- Polices from National Open Government Plans with some open education component (e.g. Greece, Romania, Slovakia).

The identified policies have been analysed using the **OpenEdu framework** produced by JRC[7] that identifies six core dimensions of open education (Access, Content, Pedagogy, Recognition, Collaboration and Research) and four transversal dimensions (Strategy, Technology, Quality, Leadership). The great majority of the policies analysed target a number of these openness dimensions, including in many case some of the transversal dimensions, showing that the understanding of open education by the majority of European policy makers – even though not by their totality – goes much beyond OER and open content. Interestingly, the Collaboration dimension was quoted as very important in a number of interviews (for instance from Finland, Italy, Romania and Scotland), showing a certain degree of "maturity" in the understanding of what open education is about.

Policy **impact** was a focus of the study. In general terms most of the policies are too recent to have had much evidence-based impact; in addition some countries like Germany and Netherlands had substantial activity before there was a relevant policy in place and it is hard yet to disentangle the effect of the policy from the general volume of activity. In each case, when evidence-based impact was reported, this is recorded in the interview reports.

Another major interest of the study were the main barriers that can prevent open education policies (or, for countries where there is no policy, open education initiatives) from fully succeeding, as well as the potential enablers for open education, since understanding the barriers and enablers can help policy-makers who are both actually running policies and planning future initiatives aiming at opening up education. The main **barriers** identified by the interviewees are: low ICT-readiness, low policy priority assigned to open education, fragmentation of initiatives, lack of institutional support, resistance to cultural change, lack of awareness about open education, low open education capacity within the teaching population and the absence of an open licenses national recognition scheme. The main **enablers** for open education to thrive, in the eyes of the interviewees, are: a clear policy priority assigned to open education, awareness-raising on open education targeting leaders and educators, capacity building for educators and other stakeholders on open education, measures empowering educators, online platforms and grassroots communities.

In terms of **relations between the national and EU level**, most Member States interviewed made mention of EU aspects and of these, all considered that their policies are in line with EU policies. Among those who did make mention, there appears to be a reasonably good understanding of open education in Austria, Cyprus, Denmark (especially, including Open Science), Germany (very positively and thoroughly), Italy (at least for schools), Netherlands, and UK/Scotland. However, even if most of the

[7] Inamorato dos Santos, A., Punie, Y., Castaño-Muñoz, J. (2016) *Opening up Education: A Support Framework for Higher Education Institutions*. JRC Science for Policy Report, EUR 27938 EN; doi:10.2791/293408

interviews stated that coherence exists between their national policy and EU policies in the field, few countries, with the notable exception of Italy, mentioned any of the specific key EU documents on open education, and no commentary was offered on whether they felt that EU programmes such as Erasmus+ are having an impact on open education at the national level. We can conclude that the European Commission's work in this area needs far more thorough dissemination, and that this would motivate MS representatives to make more visible their activities.

Finally, the various lessons learned and recommendations suggested by interviewees in the country reports have been analysed and grouped in a way informed by the dimensions of the OpenEdu framework, but extended to including the usual dimensions of EU action such as research, dissemination, and funding.

1. Introduction to the study

The goal of the study *Member States case studies: policies for opening up education* was to provide evidence-based recommendations to policy makers at Member State and EU level to foster open education in Europe.

In order to reach this goal, the study team has been working to:

- Identify and analyse, through desk research, national-level policies aiming at opening-up education
- Explore, through a number of interviews with policy makers and experts, perceptions on what national and EU policies are needed and of possible barriers and enablers to national and EU policies on open education;
- Analyse the results of desk and field research, spotting issues faced by decision makers when planning policies on opening up education, and propose some recommendations for future open education policies.

The study covers the following 22 countries of the European Union: Austria (AT), Bulgaria (BG), Croatia (HR), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), Germany (DE), Greece (EL), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Netherlands (NL), Poland (PL), Romania (RO), Slovakia (SK), Sweden (SE), and United Kingdom (UK).

This deliverable integrates all the results of the study, and contains:

- For each country, a summary of the interview (in a few cases, two interviews), preceded by relevant overview information on the country found during desk research and discussions with experts
- An analysis of the desk research and of the interview results
- A set of draft recommendations for future open education policies at the EU and at the Member State level.

The study has identified 16 policies from 14 countries, presented in the table:

Country	**Name of policy**	**Sector**	**Relevance**	**Status**
Croatia	Strategy of Education, Science and Technology	All sectors	National	Ongoing
Cyprus	Digital Strategy for Cyprus (Measure 16 eEducation)	School education	National	Ongoing
Czech Republic	Strategy for Education Policy until 2020	School and Adult Ed	National	Ongoing
Estonia	Estonian Lifelong Learning Strategy 2020	School and Higher Ed	National	Ongoing
Germany	Advancement through Education: Open Universities 2011-2020	Higher education Adult Ed	National	Ongoing
Germany	Mainstreaming OER	School and Higher Ed	National & Regional	Ongoing
Greece	3rd National Action Plan on Open Government 2016-2018	All sectors	National	Ongoing
Ireland	National Forum for the Advancement of Teaching and Learning in Higher Education	Higher Education	National	Ongoing
Italy	Plan for digital School	School Education	National	Ongoing
Lithuania	Activity Plan for ICT Implementation in General and Vocational Education for 2014–2016	School Education and VET	National	Closed
Netherlands	HO2025, de waarde(n) van weten	Higher education	National	Ongoing
Poland	OP KED – Operational Program for Knowledge Education Development	All sectors	National	Ongoing
Romania	Virtual School Library and Open Educational Resources	School Education	National	Ongoing
Slovakia	OER in the Open Government Partnership Action Plan of the Slovak Republic 2015	School Education	National	Ongoing
UK (England)	Higher Education Funding Council national OER programmes 2009-15	Higher Education	Regional	Closed
UK (Scotland)	Open Educational Practices in Scotland (OEPS)	Higher Education	Regional	Ongoing

Interviews have been carried out in 20 countries out of 22[8]: in the cases of countries where we have not been able to identify a relevant policy, the interview focused on the reasons for the absence of such a policy and on the general state of the art of open education in the country.

Although the original aim was to interview representatives from the national authorities, in some cases – mainly due to the low rate of response by such stakeholders – we interviewed experts or consultants that were knowledgeable about the policy under study (in the cases where the interview was focussing on a specific policy) or about the state of the art of open education in the country (in the case where the interview was focussing on the general developments at national level). The list of interviewed persons is presented in Annex 1.

[8] To date, it has not yet been possible to organise an interview with representatives from Bulgaria and Luxembourg, despite a number of attempts

2. Methodology

2.1 Study activities

The following activities have been carried out:

- **Desk research**: review of existing reports (see Chapter 9 for a list of references), contact and interaction with experts (see Annex 2 for the experts list), further research for each country in order to select the most relevant policy (in those cases where there were several) or justify their absence
- **Field research**: identification of one or more potential interviewee per MS and conduction of online interviews with a reference person involved in the design, implementation, or assessment of the policies identified (or in few cases senior experts, e.g. in universities, with an in-depth knowledge of such policies)
- **Results integration**: analysis of desk and field research results, further search for information (when needed), drafting of recommendations.

2.2 Approach to policies selection

We have been look for "*public policies set up at a large scale and supported either at national or regional government level*".

The working definition of "open education" for this study was the one presented in the OpenEdu study of the JRC-EAC: *"Open education is as a way of carrying out education, often using digital technologies. Its aim is to widen access and participation to everyone by removing barriers and making learning accessible, abundant, and customisable for all. It offers multiple ways of teaching and learning, building and sharing knowledge. It also provides a variety of access routes to formal and non-formal education, and connects the two".* In line with this definition, the policies that we have selected for analysis will have some of the following characteristics: they aim to widen access and participation to education, they promote multiple ways of teaching and learning, they explore access routes to formal and non-formal education, and connect the two, or they support recognition of non-formal and informal learning.

In terms of **priority**, we have select: first, policies fostering Open Educational Content (OER) and Open Educational Practices (OEP); second, policies for ICT in education, which contain elements of openness; third, policies for Lifelong Learning with elements of Recognition of Prior Learning and fourth, policies for Open Access and Open Government, when they affect education.

In terms of **timescale and maturity**, we have been looking for policies actually running (started a maximum of 3-5 years ago), for policies that are not running any more (as it is interesting to understand the reason for their closure), and for policies that have not started yet but are presented in an approved policy document.

We have been able to find and analyse policies in each of the 22 analysed countries. For the cases where we could not find a policy fitting the above description, we have explained this in the respective country paragraph, as even the lack of policy is relevant to the frame of the study, and we have provided an overview of what we found to prove that there is no policy as the study defines it. For a few countries that have more than one interesting policy (such as Germany or the UK), we have selected more than one policy.

2.3 Approach to the interviews

In designing and carrying out the interviews the following considerations have been taken into account. First, Open Education policies, whatever their scope, are to be considered in relation to wider educational and socio-economic policy aims. Second, initiatives at the local level (none were actually used in this final report) often respond to context-specific needs but might be able, if they were effective and successful, to scale up at the sector or geographical level if they respond effectively to wider educational and socio-economic priorities. Third, the level of autonomy/centralisation of E&T systems strongly influences the dynamics and features of decision-making, implementation and evaluation. Fourth, the political actors involved in the process tend to strongly influence the policy cycle evolution based on their own, personal "vision of the world". Last, the stakeholders (trade unions, students' associations, etc.) and beneficiaries (teachers, students) addressed often play a key role in determining the success or lack of success of the policy.

During the interviews, the UNIR team has been looking for the following perceptions from policy-makers about:

- Current initiatives and plans for future initiatives
- Challenges and barriers encountered in existing policies
- Key enablers for implementation, the actors involved and the role played by beneficiaries and stakeholders in enhancing the effectiveness (or not) of the policy
- Actual and potential role of European policies and funding schemes
- Feasibility of inter-country policies (e.g. between Germany and Austria; Netherlands and Flanders, etc.) that foster open education.
- Relationship between national policies and EU frameworks
- Unexpected developments associated with the implementation of the policy
- Lessons learnt from implementation and evaluation of the policy.

2.4 Approach to integration and drafting of recommendations

As from the Tender Specifications, "*case studies will look into the details of what policies are needed and how best to formulate them*". Therefore, the aim of the recommendations contained in the present report is to provide suggestions, based on evidence, on policies and measures aiming to opening up education as well as to provide recommendations on how to best design and implement such policies in order to guarantee their effectiveness.

Recommendations-building has been a concrete and pragmatic exercise based on the findings emerging from the analysis of actual policies and especially from the critical analysis of issues emerging during the interviews. Further, the identified policies have been analysed following the dimensions of the OpenEdu framework produced by JRC[9], to allow an appreciation of the richness of open education approaches beyond the promotion of OER.

[9] Inamorato dos Santos, A., Punie, Y., Castaño-Muñoz, J. (2016) Opening up Education: A Support Framework for Higher Education Institutions. JRC Science for Policy Report, EUR 27938 EN; doi:10.2791/293408

3. Country analysis, with summary of the interviews

3.1 Austria (AT)

Open education in the country

Austria is a small but federal country with a population of around 8,5 million. It has some activity in ICT in schools and in Higher Education, in particular with distance learning being delivered from Danube University Krems[10] and some other providers, though most are blended rather than fully online[11]. However, the country is not particularly active in OER or MOOCs. On the other hand, Open Access development is substantial – the OpenDOAR portal reports[12] 28 Open Access repositories from Austria.

The overall context for education reform is set by the *National Reform Programme* document[13] of 2015. It cites EU recommendations to work on "recognition of migrants' qualifications" and at the schools level, to

> Improve educational outcomes in particular for disadvantaged young people including those with a migrant background, by enhancing early childhood education and reducing the negative effects of early tracking.

and at university level, to:

> Further improve strategic planning in higher education and enhance measures to reduce dropouts.

The *OECD Review of Policies to Improve the Effectiveness of Resource Use in Schools* reported in 2015 on Austria[14], but made no mention of OER, open education or MOOCs. The ENIC-NARIC 2015 report[15] *Higher Education in Austria* similarly makes no mention of such features but does contain material on distance education, noting in a specific section (3.2.7) on distance learning that (p.29)

> The use of new media is of central significance in this connection. The University of Linz, for example, has been offering law studies with multimedia support as a distance-learning programme since the winter semester of 2001.

It also makes specific reference (p. 11) to DU Krems:

> The University for Continuing Education Krems (Danube University Krems) is a university facility of a special kind, having its own legal basis (Act on the Danube University Krems), adopted in 1994. It is a corporation under public law with far-reaching self-administration and serves the goal of post-graduate training and further training.

and notes cross-border activity with the FernUniversität[16] in Germany.

There is relevant policy-driven activity in ICT in schools (efit21) and relevant policy formulation under way for the university sector.

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[10] http://www.donau-uni.ac.at/en/

[11] But see the University of Salzburg offering at http://salzburg.unigis.net

[12] http://www.opendoar.org/find.php?cID=15&title=Austria

[13] http://ec.europa.eu/europe2020/pdf/csr2015/nrp2015_austria_en.pdf

[14] https://www.oecd.org/edu/school/2016%2006%2014%20OECD_Country%20Background%20Report%20AT%20FINAL.pdf

[15] http://wissenschaft.bmwfw.gv.at/fileadmin/user_upload/wissenschaft/naric/The_Austrian_System_of_Higher_Education2015_engl.pdf

[16] https://www.fernuni-hagen.de/regionalzentren/ausland.shtml

efit21 – digitale Bildung (digital education for schools)

The policy-driven activity with a focus on ICT in schools originates from the Federal Ministry for Education[17] (Bundesministerium für Bildung, BMB). The policy started in 2012 and is called *Efit21 – digitale Bildung* (digital education).

This policy[18] puts the focus on the integration and use of new information and communication technologies in Austrian education facilities. In doing so, the following goals are being pursued.

- Through the use of ICT, the quality of teaching and learning should be increased in a targeted manner
- Young and adult people should be taught the necessary digital competences for personal, professional and social success
- ICT training in schools should impart labour-market-relevant skills and education- or job-related e-skills
- The use of ICT in educational administration should improve efficiency and promote sustainable modern organization
- The further integration of society should be facilitated. In more detail it proposes that barriers to the use of ICT should be removed in order to make their potential accessible to all persons, and thus improve the overall social integration and participation

In the event, due it seems to reorganisations in the Ministry, it was not possible to find a relevant person to talk "on the record" about this policy.

ICT in higher education

Fortunately, conversations with experts had indicated that the Federal Ministry for Science and Research wished to set up a framework that encourages higher education institutions to develop their own materials and make them available to all students. An interview was organised with the relevant person.

Person interviewed

Dr. Helga Posset, Federal Ministry for Science, Research and Economy

Interview results

Vision on open education in the country, role of the Ministry

The vision of open education from the point of the Federal Ministry for Science, Research and Economy[19] is somehow embedded in the social dimension of Higher Education, meaning that open education is mainly seen as a way to increase higher education access and participation. A number of departments within the Ministry are connected with open education, dealing with public universities[20], private universities[21], and universities of applied sciences[22], or focusing on teaching, in particular digitalisation, blended learning and OER.

[17] https://www.bmb.gv.at

[18] http://www.efit21.at/en/

[19] http://www.en.bmwfw.gv.at/Seiten/default.aspx – it is a new Ministry – http://www.en.bmwfw.gv.at/Ministry/Seiten/TheMinistry.aspx

[20] http://wissenschaft.bmwfw.gv.at/home/science-higher-education/universities/

[21] http://wissenschaft.bmwfw.gv.at/home/science-higher-education/private-universities/

Policy design and involved stakeholders

At the moment a new strategy to increase access and participation in higher education is under preparation within the Ministry, and this contains one part on ICT and open education.

This strategy, which resulted from a consultation that took place from February to December 2016, should be made public in spring 2017 as a White Paper, then funding might be allocated to it. Independently from the possibility of having funds allocated to the strategy, the Ministry will implement a number of measures that have emerged as important from the consultation, such as services for student information, student counselling, curriculum design, problematic target groups identification and support.

A first implementation workshop (called Bologna Day, 23 March 2017 at University of Linz) will be organised with a number of higher education stakeholders to plan detailed activities, set priorities, raise awareness and mainstream higher education social dimension. This will include an international peer learning activity[23] where they have invited representatives from other countries that are preparing similar strategies.

Expected challenges and enablers

A first expected challenge is fragmentation. There are quite a few open education initiatives in Austrian universities that work in their context, but there is nothing that works on a national scale, since the national context is quite composite[24] and with a lot of players involved. To reach a larger scale, more funding and possibly a survey on the status quo would be needed.

Capacity of professors will also be a challenge: training of trainers would be needed, and to do so better institutional and inter-institutional coordination would help, since it is not always clear who is in charge of supporting professors when it comes to OER and open education.

Relation between the policy and the EU-level developments

The unit in charge of open education within the Ministry follows the initiatives at the EU level, trying to guarantee a certain coherence between the actions at the national level and the ones at the EU level.

Lessons learnt and recommendations for future open education policies

First, to properly set up a policy in the field of open education a lot of desk research is needed, since a lot of things are happening nationally and internationally.

Second, it is important to look into who is doing what in your country and who do you have to bring together in order to facilitate decisions and to understand the areas that you have to focus on.

Third, policy-makers must be open to different visions when they are planning visions and measures, involving stakeholders and daring to be a bit visionary.

[22] http://wissenschaft.bmwfw.gv.at/home/science-higher-education/universities-of-applied-sciences/

[23] This is one of the few situations where cross-border activity has been flagged in the interviews

[24] It is not clear whether the speaker felt that Austria is more “composite” than other countries of similar size. True, there are three types of HE provider (university, polytechnic and private) but that is not unusual; in addition, at least in theory the Bundesland structure (the nine states) is not relevant to universities and there is only one national language.

3.2 Bulgaria (BG)

Open education in the country

Bulgaria (population around 7 million) is rarely studied by EU projects in the open education area and there is a very limited list of contacts in the country with knowledge of open education and ICT in education. Desk research, including perusal of earlier reports or sections (usually very short) in overview reports has not revealed any relevant recent policies.

The Eurydice report *Modernisation of Higher Education in Europe* 2014[25] commented:

> With the help of European funding, Bulgaria was able to put in place a number of initiatives to support distance learning in higher education. For instance, within the project Raising qualification of academic teachers (2008-2011), more than 250 academic teachers were trained on the use of e-learning and distance learning methods in their specific discipline. Furthermore, a project entitled Development of electronic forms of distance learning in higher education is being implemented during 2013-2014.

However, this last project was quite small in scale (see below). Nevertheless, for this or other reasons, distance learning activity is now recorded in standard portals[26] – in particular Varna Free University "Chernorizets Hrabar" (a private university[27] founded in 1991) is recorded as offering two online Bachelor programmes in Business and Computer Science respectively, and there are several blended learning offerings including from D.A. Tsenov Academy of Economics[28], an established public institution founded in 1936.[29]

OER repositories or related activity are not recorded by either POERUP[30] or the OER World Map[31] – Bulgaria does not have a country champion for the World Map.

There is little activity in MOOCs. However, The first Bulgarian MOOC was registered in the Open Education Europa portal in the second half of the 2015, but it was noted that this "is more than 3 years after the majority of the other EU countries" in a useful in-country analytic report on MOOCs[32] from a researcher at Burgas Free University[33] (another private university).

The OpenDOAR portal records[34] a respectable 8 Open Access repositories in Bulgaria.

There were active ICT for education initiatives in schools in the last decade and several university and virtual schools initiatives, such as the Bulgarian Virtual University[35] launched around 2002[36] and then First Bulgarian Online School[37] launched around 2005. Nothing is known about recent developments of these entities.

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25 http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/165en.pdf – and repeated in other reports including *Adult Education and Open Education Resources* (European Parliament, 2015, p. 132, http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf)

26 Search for "Bulgaria" at http://www.distancelearningportal.com

27 http://vfu.bg/en/about_us/

28 http://www.mastersportal.eu/studies/54560/financial-management.html and https://www.uni-svishtov.bg/?page=page&id=184

29 https://www.uni-svishtov.bg/?page=page&id=184

30 http://poerup.referata.com/wiki/Open_Education_Initiatives_-_by_country – information collected up to mid 2014

31 https://oerworldmap.org/country/bg

32 "THE EUROPEAN INITIATIVE FOR MASSIVE OPEN ONLINE COURSES /MOOCS/ AND THE CHALLENGES FOR ITS IMPLEMENTATION IN BULGARIA", *Business Research*, 2016, http://www.bposoki.bg/uploads/posts/zeleva_en.pdf

33 http://www.bfu.bg/en/za-bsu

34 http://www.opendoar.org/find.php?cID=34&title=Bulgaria

35 http://www.virtualschoolsandcolleges.eu/index.php/Bulgarian_Virtual_University

Bulgaria faces many challenges in education. The *Education and Training Monitor 2015* country report[38] states that:

> It still needs to improve the overall quality and efficiency of its school education system and the capacity of higher education to respond to labour market needs. Access to education for disadvantaged children, in particular Roma, is an ongoing challenge. The quality of VET in Bulgaria is insufficient, including in terms of its integration in the general education system. The rate of adult participation in learning is among the lowest of the EU.

Various measures are under way, suggests the report. In particular (p. 6):

> In 2014, Bulgaria adopted its 2014-2020 strategy for the effective implementation of ICT in education and science. The first phase of the strategy (e-learning) was launched in May 2015. The strategy aims to create a unified system for ICT use in schools, higher education and science.

Development of electronic forms of distance learning in higher education

The material is paraphrased from the web page[39].

> A closing meeting of the project *Development of Electronic Forms for Distance Learning and Setting up a Virtual Library* at Todor Kableshkov University of Transport, Sofia was held in October, 2014. The project was developed as one project within the Operational Programme BG051PO001-4.3.04 *Development of Electronic Forms of Distance Learning in Higher Education*. The project funding amounted to BGN 530.995,[40] financed by a grant under Operational Programme *Human Resources Development 2007 – 2013*, co-funded by the European Social Fund. The project implementation period was 24 months.
>
> The project objective was to promote the lifelong learning process via development of electronic forms of distance learning at the university as an opportunity to improve professional skills and competences without prolonged absence from work. 32 lecturers and experts participated in the project. A number of activities, the overall purpose of which was to develop and modernize Lifelong Learning Centre, were carried out during the project implementation.

Recent Higher Education reform measures

The aforementioned *Country Report* states (p. 8):

> In February 2015, Bulgaria's National Assembly approved the strategy for the development of higher education and accompanying action plan. The strategy identifies specific problematic areas relating to the quality and compatibility of the Bulgarian higher education with other European higher education systems. The strategy provides a SWOT analysis of the Bulgarian higher education system and flags up a number of shortcomings, which include: an imbalance between university autonomy and state control; outdated syllabuses and curricula; a 'supply and demand' mismatch between higher education and labour market needs; a low level of research output in some universities; insufficient outgoing and poor incoming mobility of students and university teachers.
>
> In May 2015, the Ministry of Education and Science published a draft amendment of the Higher Education Act, proposing a number of changes including the identification of priority professional fields and protected specialisations (i.e. specialisations which are important for socioeconomic development but not very attractive for applicants).

[36] http://www.bvu-bg.eu/index.php?Clip=proekt&lng=eng

[37] http://www.virtualschoolsandcolleges.eu/index.php/First_Bulgarian_School and http://bulgarian-online-school.com/?lang=en

[38] http://ec.europa.eu/dgs/education_culture/repository/education/tools/docs/2015/monitor2015-bulgaria_en.pdf

[39] https://old.vtu.bg/en/index.php?track=491

[40] Probably around €271.695

None of these have a explicit link to ICT in higher education. On the other hand, further down page 8 the *Country Report* states (our emphasis):

> Bulgaria has implemented a number of projects using funding from the European Social Fund (Human Resource Development Operational Programme). These include the *System for qualification and career development of the academic staff in higher education institutions* project, aimed at further development of the existing system for the qualification and career development of academic staff, providing continuing education in key fields like foreign language and using information and communication technology in the training process;

Thus there are some policy hooks to link to ICT and open education, if the country wishes to.

3.3 Croatia (HR)

Open education in the country

Like Bulgaria, Croatia (population 4,25 million) is rarely studied by EU projects. There was a burst of education reform activity around ten years ago and some of the more recent initiatives are described in a national report[41] from 2011. Unlike its neighbour Slovenia, there does not seem to be any specific open education policy, nor is there any specific ICT in education policy.

There is no distance learning programme[42] for Croatia listed on the Distance Learning portal.

OER repositories or related activity is not recorded by either POERUP[43] or the OER World Map[44] – Croatia does not have a country champion for the World Map.

There is little known about activity in MOOCs. A Croatian academic recorded in her 2016 report[45] that "there is not much Open Educational Resources in Croatia and is only one MOOC course on Croatian language".

On the other hand, OpenDOAR portal records[46] a substantial 21 Open Access repositories in Croatia.

More generally, there is a new policy on *lifelong learning* to focus on, Nove boje znanja – Strategy of Education, Science and Technology.

Policy/initiative overview	
Policy title	**Nove boje znanja** **Strategy of Education, Science and Technology**
Policy URL	https://vlada.gov.hr/highlights-15141/archives/strategy-of-education-science-and-technology-nove-boje-znanja/17784
Description of the policy	Main goals of the Strategy are: • Quality education available to everybody under equal conditions. • Lifelong learning as a principle on which the entire education is based. • Curriculum reform in pre-tertiary education. • In the higher education, studying programs will be enhanced and the foundations of the Bologna reform will be consistently implemented • Securing preconditions for the increased participation of adult citizens in the lifelong learning processes.

[41] http://www.erisee.org/downloads/2013/2/b/2011%20NATIONAL%20REPORT%20OF%20THE%20REPUBLIC%20OF%20CROATIA%20-%20Contribution%20to%20the%20report%20on%20ET2020%202011%20ENG.pdf

[42] http://www.distancelearningportal.com

[43] http://poerup.referata.com/wiki/Open_Education_Initiatives_-_by_country – information collected up to mid 2014

[44] https://oerworldmap.org/country/hr

[45] "Advantages and Limitations of Usage of Open Educational Resources in Small Countries", *International Journal of Research in Education and Science* Vol. 2, Issue 1, Winter 2016 – https://oerknowledgecloud.org/sites/oerknowledgecloud.org/files/5000123134-5000259500-1-PB.pdf

[46] http://www.opendoar.org/find.php?cID=34&title=Bulgaria

	The Strategy is said to emphasise also the importance of using information and communication technologies in educational process, fostering the implementation of e-learning, other modern methods of teaching based on ICT and development of open educational resources.
Policy institution	Inter-ministerial committee
Policy date	2014
Policy status	Current
Language	English (for summary document)
Policy jurisdiction	National
E&T sectors	School education, Higher education, VET, Adult learning
Dimension of impact	Core dimensions □ Access □ Content □ Pedagogy □ Recognition ☑ Collaboration □ Research Transversal dimensions ☑ Strategy □ Technology ☑ Quality □ Leadership

Person interviewed

Sandra Kučina Softić, Head of E-Learning Centre at SRCE and the E-learning Office of the University of Zagreb

Interview results

Vision on open education in the country, role of the Ministry

Over the last few years there has a frequent succession of Governments in the country, yet it can be considered that there is some understanding at Ministerial level, because there is a vision that education must be accessible and available for everyone. Also, there is an understanding and a commitment to open the resources produced with public funds.

Policy design and involved stakeholders

The policy was designed to improve the educational systems and to enhance its quality. The main stakeholders are the higher educational institutions[47] (8 Croatian public universities), the council of rectors and the academic libraries.

Policy dimensions and areas of action

The main dimensions are related to the change of the educational system by modernising education, in particular by shifting from a teacher-centred approach to a student-centred one.

[47] http://www.studyincroatia.hr/studying-in-croatia/croatian-higher-education-system

The main objectives are to commit to the provision of lifelong learning across the country and to deploy of blended learning approaches and e-learning platforms across the HE sector.

Policy implementation and impact to date

So far, the HE sector has e-learning platforms and in ICT the provision is quite extended. Also after the implementation of the Bologna Process, measures have been implemented towards enabling mechanism to improve the quality of education and to measure the learning outcomes. Furthermore, the adoption of OER and repositories is now becoming a trend[48] in the country.

Key barriers and enablers during implementation

The main barriers in the HE sector can be understood as the lack of awareness about open education and Open Educational Resources, also, the lack of awareness and understanding about copyright[49] and open licenses.

In relation with the challenges, there is still some reluctance amongst academics towards sharing the resources they produce, and this might be a consequence of the barriers described.

To overcome these challenges, some guidance notes and training have been produced to train academics and educators about copyright and open licenses.

Relation between the policy and the EU-level developments

It can be considered that the Croatian policy is in line with other education policies across the EU in relation with modernisation of the educational system.

Lessons learnt and recommendations for future open education policies

In relation to **recommendations**, it is key to fix the current copyright issues across Europe, as it is sometimes quite difficult to share materials across countries, because national legislations operate differently and there are not clear common grounds in relation to the use of open licenses.

Also it is **recommended** that all the teaching and learning resources and research outcomes must be openly published.

Finally, it is **recommended** that the EU provides support for initiatives from EU countries to develop open educational platforms and resources for migrants and refugees, to support them learning the language of their host countries, to become integrated into society and to gain access to the educational system.

[48] There are 21 repositories listed in the standard OpenDOAR database – http://www.opendoar.org/find.php?cID=55&title=Croatia

[49] In confirmation, the Creative Commons Croatia page is several years out of date – https://wiki.creativecommons.org/wiki/Croatia

3.4 Cyprus (CY)

Open education in the country

Cyprus (population 0,84 million[50]) has not been studied much by EU projects in terms of its open education activity. It is better known to experts for its distance learning activities.

OER repositories or related activity is not recorded by either POERUP[51] or the OER World Map[52] – Cyprus does not have a country champion for the World Map. However, there is some OER activity, as the interview demonstrates.

The Open University of Cyprus[53] is involved in MOOC activities[54] and the University of Nicosia (a private university) offers a MOOC[55] on Digital Currency.

OpenDOAR portal records[56] 4 Open Access repositories in Cyprus, a substantial number considering the small population.

As noted by the *Education and Training 2016 Monitor Report*[57], early school leaving has declined steadily in Cyprus in recent years and the tertiary education attainment rate is one of the highest in the EU. However, at the same time Cyprus faces one of the lowest employability rates of recent graduates in the EU and an unsatisfactory performance in basic skills by students and young adults alike. The country also features one of the lowest participation rates in VET in the EU, but recent reforms and new initiatives in this area include gradually expanding the VET offer.

In terms of open education, there are a number of institutional initiatives –especially at the (public) Open University of Cyprus[58] and the (private) University of Nicosia[59], both active in online learning – but there is not a specific national policy.

On the other hand, Objective 4 – Education and Learning of the 2012 *Digital Strategy for Cyprus*[60] aims to promote digital education as a dynamic tool aiming at the upgrade, the enrichment and the reform of the Cypriot educational process. Within this objective, Measure 16 – eEducation has a list of objectives, most of which are either prerequisites or aspects of opening up education through ICT. This was taken as the focus for the interview.

[50] In the zone controlled by the Republic of Cyprus – http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/732265957BAC953AC225798300406903?OpenDocument&sub=2&sel=1&e=&print

[51] http://poerup.referata.com/wiki/Open_Education_Initiatives_-_by_country – information collected up to mid 2014

[52] https://oerworldmap.org/country/cy – however note that Eastern Mediterranean University in the Turkish-occupied zone is a member of the Open Education Consortium – http://www.oeconsortium.org/members/view/549/ – although assigned to Turkey not Cyprus

[53] http://www.ouc.ac.cy/web/guest/home

[54] http://www.ouc.ac.cy/web/guest/dsdp/news/archive/15451?doAsUserId=wnqgtvlehimbtp%3F_bs_bookmarks_azfilter%3DY*&

[55] http://digitalcurrency.unic.ac.cy/free-introductory-mooc/

[56] http://www.opendoar.org/find.php?cID=57&title=Cyprus

[57] https://ec.europa.eu/education/sites/education/files/monitor2016-cy_en.pdf

[58] http://www.ouc.ac.cy/web/guest/university/genika

[59] https://www.unic.ac.cy/DL

[60] http://www.mcw.gov.cy/mcw/dec/digital_cyprus/ict.nsf/3700071379D1C658C2257A6F00376A80/$file/Digital%20Strategy%20for%20Cyprus-Executive%20summary.pdf.

Policy/initiative overview	
Policy title	**Digital Strategy for Cyprus (Measure 16 eEducation)**
Policy URL	http://www.mcw.gov.cy/mcw/dec/digital_cyprus/ict.nsf/3700071379D1C658C2257A6F00376A80/$file/Digital%20Strategy%20for%20Cyprus
Description of the policy	The strategy targets the country's digital development, and includes a specific objective on Education and Learning: to promote digital education by using ICT as a dynamic tool aiming at the upgrade, the enrichment and the reform of the educational process. The objectives related to education deal with ICT infrastructure, content, applications, and teacher training.
Policy institution	Ministry of Transport, Communications and Works
Policy date	2012
Policy status	Current
Language	English (for summary)
Policy jurisdiction	National
E&T sector	School education
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy □ Recognition □ Collaboration □ Research Transversal dimensions □ Strategy ☑ Technology ☑ Quality □ Leadership

Person interviewed

Anastasia Economou, Head of the Educational Technology Department, Pedagogical Institute, Ministry of Education and Culture

Interview results

Vision on open education in the country, role of the Ministry

The understanding of the Ministry in relation to open education is quite broad, and includes both the learners' and the teachers' perspectives. The Ministry understands open education not just as open resources, but as a set of practices that – combined with certain platforms – can support and promote collaboration between educational institutions, educators, learners and parents raising awareness of the potential of open education. Also, at Ministerial level there is a strong commitment in opening up not just teaching and learning but also cultural heritage, therefore a partnership with Europeana[61] has been established.

[61] http://www.europeana.eu

Policy design and involved stakeholders

The role of the Ministry is to support and raise awareness in relation to open education, promoting collaboration at national and international level (starting with the European Council) as well as opportunities for the development of open education initiatives at school and at higher education level and involving the cultural heritage sector. Also, and going beyond the policy, opening up access to research, teaching and learning materials and digitised access to the Cypriot heritage are key elements for the Ministry.

Policy dimensions and areas of action

The main dimensions of the policy are related with improving connectivity in the educational sector (16.1-.2 -.9), increasing the number of computers in each school in order to achieve one PC per student (16.3); developing digital educational content for the majority of primary and secondary schools (16.7) and upgrading the infrastructure of the public tertiary education sector. Three projects have been approved regarding the three[62] State Universities: the University of Cyprus, the Cyprus University of Technology and the Open University of Cyprus, which aim to upgrade and develop the technological infrastructure that will provide the tools for integrated, automated and quality services for students, academic and administrative personnel (16.13).

Policy implementation and impact to date

At Higher Education level, two interesting projects with involvement of Cypriots institutions are Photodentro[63], a portal to share educational resources amongst universities, developed in partnership with Greek stakeholders, and Open Discovery Space[64], a EU project aimed at sharing resources and collaborating in Open Educational projects. Also, thanks to the policy the Cyprus Pedagogical Institute[65] has adopted Creative Commons as default licences for all the materials they produce.

Key barriers and enablers during implementation

Some of the barriers mentioned are related to the cultural change needed among educational stakeholders to embrace openness in teaching and learning, and to the gradualness with which the policy has been implemented. However, in this case it is important to consider that Cyprus was badly affected by the economic crisis in the last years and therefore the government has had other more important priorities. However, the economic crisis can be also perceived as an enabler, as sharing of resources was useful to support teachers and students when other means were not available: thus open education was widely promoted as a mean to overcome economic factors that could negatively affect education.

A major enabler is the coherence of the policy with the *National Reform Programme of Cyprus EU2020*[66], under point 5 "Education", in which guideline 8 refers to "Developing a skilled workforce responding to labour market needs, promoting job quality and lifelong learning" and guideline 9 to "Improving the performance of education and training systems at all levels and increasing participation in tertiary education". Also, point 6 "Digital Society" aims at "Optimising support for research,

[62] http://www.highereducation.ac.cy/en/che-introduction.html – for a more thorough but older document see http://www.kysats.ac.cy/archeia/pdf/highereducation-vivliaraki.pdf

[63] http://photodentro.edu.gr/aggregator

[64] http://opendiscoveryspace.eu/consortium

[65] http://www.pi.ac.cy/pi/index.php?lang=en

[66] http://ec.europa.eu/europe2020/pdf/nrp/nrp_cyprus_en.pdf

development and innovation, strengthening the knowledge triangle and unleashing the potential of the digital economy”.

Relation between the policy and the EU-level developments

Cypriot policies are fully in line with EU development, agendas, strategies and commitments. However, it would be helpful if there were a means to share agendas and strategies in relation with lifelong learning, digital literacies and development around open education initiatives.

3.5 Czech Republic (CZ)

Open education in the country

Czech Republic (population 10,5 million) has not been studied much by EU projects in terms of its open education activity.

Nor is much known recently of activities in distance learning. The Distance Learning portal[67] records just one DL course and that from a US-accredited university in Prague; yet older reports, from the last decade[68], indicate considerable activity at a range of higher education institutions.

More generally, in the lifelong learning domain the "Third Age University" network seems to be active in lifelong learning at several universities.[69] Charles University states[70] that "Lifelong learning has a rich tradition at Czech universities, and its importance and potential are growing all the time to meet the challenges of the modern world" – it offers several programmes

Although there is no official government policy specifically on open education, the *RVP Metodicky Port*al is a well-known educational portal[71] collecting Czech Open Educational Resources (OER) targeting teachers. It is an initiative funded by the Czech Republic and initially by the European Social Fund, and is run as part of a research project by the Institute of Education in Prague and the National Institute of Vocational Education. The project aims to provide "systematic support for teachers in teaching methodology and didactics, development of learning communities" and more "effective ways of learning".

Apart from this, there are a growing number of free of charge or OER materials produced by NGOs, state institutions, individual teachers etc., collected by EDUin. Further, the Alliance for Open Education[72] runs a web site[73] dedicated to open education in the Czech Republic, that shows that there is a far greater level of OER activity in the Czech Republic than recorded on international OER databases such as the OER World Map[74] or the earlier (2014) POERUP database[75] – but this is a two-way process as the Alliance for Open Education is the Czech country champion for the OER World Map. There is some MOOC activity; for example Masaryk University offers free online courses.[76]

In terms of Open Access, the OpenDOAR portal records[77] 16 Open Access repositories. As concerns Open government policies, The *Action Plan of the Czech Republic Open Government Partnership for 2016 to 2018*[78], proposed by the Ministry for Human Rights, Equal Opportunities and Legislation, does not mention applications to education in general, but mentions creating national strategy to open access to scientific information. The creation of a strategy is now in progress.

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67 http://www.distancelearningportal.com

68 Such as the Re.ViCa report from February 2009 – http://www.virtualschoolsandcolleges.eu/index.php/Virtual_Initiatives_in_Czech_Republic

69 Such as the University of West Bohemia – http://www.zcu.cz/en/media/about/index.html

70 http://www.cuni.cz/UKEN-4.html

71 http://rvp.cz

72 http://otevrenevzdelavani.cz

73 http://otevrenevzdelavani.cz/otevrene-zdroje/

74 https://oerworldmap.org/country/cz

75 http://poerup.referata.com/wiki/Open_Education_Initiatives_-_by_country

76 http://pozitivni-zpravy.cz/tag/moocs/ and http://pozitivni-zpravy.cz/masarykova-univerzita-spustila-elektronicke-kurzy-pro-verejnost/

77 http://www.opendoar.org/find.php?cID=58&title=Czech%20Republic

78 http://www.opengovpartnership.org/sites/default/files/Czech_ActionPlan2016-18_0.pdf

In 2013, the Czech Ministry of Education in cooperation with non-profit, academic and commercial sectors carried out a nationwide public debate on future educational priorities. Its conclusions formed the basis for Strategy for Education Policy of the Czech Republic until 2020, adopted in July 2014, an important document that will serve as a general basis for policy-making in the Czech Republic in the coming years. This is the policy selected for interview.

Overview of the selected policy	
Policy title	**Strategie vzdělávací politiky české republiky do roku 2020** **Strategy for Education Policy of the Czech Republic 2020**
Policy URL	http://www.vzdelavani2020.cz/images_obsah/dokumenty/strategy_web_en.pdf
Description	The policy is, in line with the Education & Training 2020 strategic framework, based on the concept of lifelong learning aiming at contributing to the achievement of the main goals of education: personal development contributing to improving the quality of human life, maintenance and development of culture as a system of shared values, development of active citizenship creating conditions for a socially cohesive society and democratic governance, and preparation for employment. The priority points are: • Non-discriminatory approach to digital education resources • Development of digital skills and computational thinking of pupils • Development of digital skills and computational thinking of teachers • Development and modification of school infrastructure to facilitate digital education • Support for the development and distribution of innovations.
Institution	Ministry of Education, Youth and Sports, in collaboration with the National Institute for Education
Policy date	2014
Status	Current
Language	English
Jurisdiction	National
E&T sectors	School education, Adult Education
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy ☐ Recognition ☐ Collaboration ☐ Research Transversal dimensions ☐ Strategy ☑ Technology ☐ Quality ☐ Leadership

Person interviewed

Tamara Kovacova, EDUpoint programme, EDUin (Advising institution to the Ministry of Education)

Interview results

Vision on open education in the country, role of the Ministry

Open education is mentioned in some of the strategic documents (national strategy to digital education 2020, national strategy to digital literacy 2020), but implementation of these documents has been very slow. The level of implementation capability (including personnel) on the side of the Ministry is underestimated. Without systemic Ministry support the implementation of both strategies is threatened. Currently the Ministry has very limited capacities and tools for any awareness-raising campaign.

Policy design and involved stakeholders

The Strategy for Education Policy of the Czech Republic 2020 was designed to comply with the EU recommendations for enhancing education in EU Member States. The policy derives from the 2015 strategy for digital literacy, targeting education for 16+ in the Czech Republic 2015-2020 (Strategie digitální gramotnosti ČR na období 2015 až 202079) published[80] by the Ministry of Social Welfare: this mentions open materials as key resources for training on digital literacies. In line with this, the policy mentions, under point 3.2, the importance to "Create an open area for lifelong learning, including recognition of the results of non-formal and informal learning". An important stakeholder involved in the policy is EDUin[81], an NGO that provides support to policy makers in implementing the open education aspects of the policies and promotes, develops and create Open Educational Resources and programmes.

Another strategy targeting schools is *Strategy for digital education 2020*[82] where opening up materials for education is point 1.

Policy dimensions and areas of action

The main dimensions of action of the policy in relation to open education are related with lifelong learning and involve the development of tools for teachers to share resources such as the Metodicky portal[83], and the sustainability support of projects in different areas of action – schools, universities, further education and lifelong learning – to develop competencies of workers.

Policy implementation and impact to date

As this policy is still rather recent and its implementation is in the early stages, its impact is difficult to measure. However it is remarkable that, to support these policies, an official decision has been made to transversally adopt Creative Commons licenses, as a mean for openness in education, for publications and digital resources the Czech Republic[84].

[79] http://www.vzdelavani2020.cz/images_obsah/dokumenty/strategie/digistrategie.pdf

[80] http://www.mpsv.cz/files/clanky/21499/Strategie_DG.pdf

[81] http://www.eduin.cz

[82] http://www.msmt.cz/file/34429/

[83] http://rvp.cz

[84] There are very low ambitions – as example http://clanky.rvp.cz/wp-content/upload/prilohy/21071/kriteria_kvality_digitalnich_vzdelavacich_zdroju.pdf

Key barriers and enablers during implementation

The main barrier observed is the lack of a dedicated team to promote, support and advocate for open and digital education at the ministerial level, as such a team would enable policy implementation in a more effective way.

Relation between the policy and the EU-level developments

Czech policies are in line with the recommendations of the EU as far as promoting the development of innovative and digital skills, including open education, is concerned.

Lessons learnt and recommendations for future open education policies

The lessons learned are not yet clear, as the policy is still in an early stage of development, however these are related to the involvement of different stakeholders to ensure that the implementation is effective and covers all the aspects and areas of the initiative. Without sufficient people at the ministry level it is impossible to implement such a policy. Furthermore, even official documents are rather weak and with low ambitions in terms of opening up education and promotion of the need for creating OER. Similarly, the draft Strategy for Open Access to scientific information[85] has very low ambitions as well as few documents that are outputs of the projects done using European funds[86].

In terms of **recommendations** for future open education policies, it would be **helpful** to be able to have resources developed by EU stakeholders that define and clarify open education and its associated concepts. In fact, even if the core principles are there, the concept is not yet widely spread, and therefore even when in principle aspects of openness are present in policies and projects, these are not clearly stated and not easily identifiable in official documents.

Finally, to ensure that openness-related good practices are known and shared, the EU should **monitor** that all the documentation, agendas, polices and their outcomes such as guides, materials and resources produced with EU funding are published under open licenses. The biggest help would be if Europe would state that everything that is done from EU funds has to have a CC BY licence.

[85] Kritéria kvality digitálních vzdělávacích zdrojů podpořených z veřejných rozpočtů (Criteria for quality of digital educational resources supported from public budgets) Version 1.0, July 2016 – http://clanky.rvp.cz/wp-content/upload/prilohy/21071/kriteria_kvality_digitalnich_vzdelavacich_zdroju.pdf

[86] Perusal of the OpenDOAR results for Czech Republic is interesting – while 16 repositories are listed at http://www.opendoar.org/find.php?cID=58&title=Czech%20Republic the individual repository descriptions are hedged with caveats on availability and coverage

3.6 Denmark (DK)

Open education in the country

The population of Denmark is around 5,7 million. This makes it similar in population to Finland (5,4 million), Scotland (5,3 million), Norway (5,1 million) and Ireland (4,6 million) – but it has rather different approaches to flexible, distance and open education from these other countries.

No relevant policies in Denmark emerged from desk research, either for schools or higher education, for OER, MOOCs, open learning, distance education, or general ICT-supported education. However, experts indicated (though without specific examples) that the institutions in Denmark are generally including digitalisation and ICT-supported education in their strategies – even if one paper argues that there is vagueness in such activities[87]. Certainly no public examples of recent e-learning strategies (in English) were found, even though several leading universities[88] had overall strategies published in English.

Furthermore, open education has a long tradition in Denmark (as in Finland – see later), in the traditional sense of "open and distance learning". Even though there is now no Open University in Denmark (the Jutland Open University was closed in 1995), the Danish Association of Open Universities was formed as a "prolongation" of that approach. Currently there are claimed to be 29 study programmes at university level in distance or blended learning, though with only just over 1000 students in total – far less than, for example, in Scotland or Ireland.

Unusually nowadays for EU Member States, there are no private universities at all[89] in Denmark. (These are *sometimes* a source of innovative approaches, in *some* countries.)

There are some other factors possibly not conducive to open education, in either the traditional or modern (OER-oriented, sense), in higher education. There is an apparent oversupply of higher education: the government recently cut around 3600 places[90] in higher education institutions, claiming that too many graduates were entering non-graduate employment roles. Opinions in Denmark vary[91] on the wisdom of this approach to "dimensioning": a fuller description of this "cap on student intake" is given below thanks to one of our experts. There were also further significant HE budget cuts in 2016.[92]

MOOC activity is also quite low by European standards. In contrast, Open Access activity is substantial with the OpenDOAR portal reporting[93] 12 Open Access repositories.

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[87] "In Denmark, at least, university IT-strategies tend to be quite vague about the goals to be reached; and criteria for determining success often are not clearly defined. It is generally recognized that there is a long way to go before the ideals of the national strategy for ICT in education have been implemented." (http://forskning.ruc.dk/site/files/57184128/Adopting_Elearning_in_Higher_Education_sh_ah.pdf, 2010)

[88] Including Aarhus, Aalborg and Copenhagen – though with little or nothing on open, online, OER etc

[89] Though there is the occasional flurry of interest (http://www.universityworldnews.com/article.php?story=20100123090613452) and Danish universities now charge fees to non-EU students, with some exceptions (http://studyindenmark.dk/study-options/tuition-fees-scholarships)

[90] https://lifeinaalborg.wordpress.com/2014/11/04/danish-institutes-of-higher-education-to-see-significant-cuts-in-student-places-from-next-academic-year/

[91] See for example http://monitor.icef.com/2014/10/danish-reforms-will-impact-domestic-international-students/ and https://www.nafsa.org/_/File/_/ie_marapr15_looking_further.pdf

[92] http://www.universityworldnews.com/article.php?story=20160418210735400

[93] http://www.opendoar.org/find.php?cID=59&title=Denmark

The Danish Technological Institute[94] used to be active in e-learning with support from the government but it now has a private research and development role and is not active in education. The government used to provide funding for EMU, which was the main public portal for educational content in Denmark. It was provided by UNI·C and used to provide several portals with OER content.

It is not clear what the level of interest in such matters is in the Ministry. Some experts feel that it is low: consistent with such a view, Denmark has not updated its *2013-14 Action Plan for OGP* and it does not mention applications to education[95] – there is a section on Open Data, but the Open Data is not oriented to use in, or support of, learning processes.

One expert claimed that the current government view is that second-chance education should focus on basic skills, not HE – but of course second-chance education can use open education methods.[96]

Cap on Student Intake model[97]

- There can be no question that the main challenge facing higher education in Denmark today, as well as most of Europe, is ensuring the relevance of higher education so that students are equipped with the skills and competences needed on the labour market.
- In Denmark, we see an increasing mismatch with some areas of the labour market having a shortage of skilled applicants while in other fields graduates still find it hard to find relevant employment.
- There is therefore an overall need to create a stronger match between the skills graduates obtain as part of their education and the qualifications required by the labour market.
- To meet this overarching challenge there are different related challenges that also need to be addressed. Therefore, a model to adjust student intake has been introduced to higher education programmes.
- The aim is to encourage intake away from programmes with systematic and significant unemployment to programmes with better job opportunities.
- The total extent of the model encompasses approximately 3600 places at Bachelor level and 2300 at Master's level.
- The unemployment trend of each study programme is monitored closely and the underlying model is calculated annually so that "new" programmes associated with systematic and significant unemployment can be identified.

[94] http://www.dti.dk

[95] http://www.opengovpartnership.org/files/denmarkopen-government-action-plan-2013-2014eng1-sidedprintpdf

[96] See Adult Education and Open Educational Resources, European Parliament, 2015 – http://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL_STU(2015)563397

[97] For some public background see https://ec.europa.eu/education/compendium/plan-cap-student-intake_en and more generally http://www3.weforum.org/docs/GAC/2014/WEF_GAC_Employment_MatchingSkillsLabourMarket_Report_2014.pdf

Person interviewed

Line Bækgaard-Fuldmægtig, Danish Agency for Higher Education

Interview results

Vision on open education in the country, role of the Ministry

From the Ministry point of view, open education is embedded into a broader plan related to education digitisation. The aim of the government is to modernise higher education by providing access to digital resources both at research and at teaching and learning level.

Even if Denmark does not have a policy of open education or ICT in education, there is an explicit commitment from the Government, the Ministry, its agencies and from the HE sector to modernise the university system and indeed the whole educational sector. Under this frame, the role of the Ministry in relation to open education, as part of its digitisation agenda, includes (as one of several examples) that of promoting the development of MOOCs to train educators across all educational sectors, from pre-school to post-secondary level. The initiative is left to higher education institutions (universities and others) that are developing institutional open education projects and initiatives, such as the OER portal[98] developed by the VIA University College.

Another interesting open education initiative is the *Consolidation Act on Open Education*[99], focussing on adult vocational education, which purposes can be understood as to promote the availability of a wide range of vocational training programmes for the adult population and to design training programmes, adults' practical opportunities for combining education and an affiliation with the labour market. There is great focus on digital skills when it comes to continuing and further education.

At university level, the Ministry of Higher Education and Science promotes and support open access and open science via the Open Access policy[100] for public-sector research.

Open education state of the art

Denmark's commitment with open education is part of the country digitisation and modernisation agenda which aims at democratising access to education, including the provision of opportunities for adults and for those living in remote zones to access higher education, since online and blended learning courses can facilitate access to those who traditionally do not consider enrolling in higher education programmes.

Up to date, and considering that the Danish university system is quite accessible since EU and Danish students are exempted from fees, there has been a large uptake of digital resources for teaching and learning and for research; and training is being constantly provided for educators. Also, Danish universities are producing MOOCs to widen their educational offer, for example, the Technical University of Denmark[101] and University of Copenhagen[102] have a large offer on MOOCs both in English and Danish.

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[98] http://openvia.dk

[99] http://www.au.dk/fileadmin/www.au.dk/Regelsamlingen/2015/Bekendtgoerelse_af_lov_om_aaben_uddannelse-da-en_gb-C__1_.pdf – see the subsection at the end of this interview transcript

[100] http://ufm.dk/en/research-and-innovation/councils-and-commissions/the-danish-council-for-independent-research/open-access-policy?searchterm=open%0Aaccess

[101] https://www.mooc-list.com/university-entity/technical-university-denmark-dtu

[102] https://www.class-central.com/university/ucph

Key barriers and enablers during implementation

As Denmark does not holds a specific policy in regard to open education, the challenges observed are in relation with the digitisation agenda, and are mainly related with the reluctance of certain groups of educators in embracing change and adopting a digital culture for teaching and learning.

Relation between the policy and the EU-level developments

As far as digitalisation in general terms is concerned, Denmark is in line with the Digital Agendas of the European Union; at the higher education level, and in relation with providing open access to research papers and research data, Denmark complies with the Open Science principles for research and innovation according with the guidelines of the European Commission.

Supplement: Consolidation Act on Open Education

Purpose (Clause 1)[103]

(1) The purpose of the Act is to promote the availability of a wide range of vocational training programmes for the adult population.

(2) In designing training programmes, adults' practical opportunities for combining education and an affiliation with the labour market must be taken into consideration, either by

1) Organisation on a part-time basis for employed persons, including employed persons who receive State Educational Support for Adults (SVU) or compensation for participation in vocational post-secondary adult and continuing education, or by

2) Organisation on a full-time basis for employed persons, including employed persons who receive State Educational Support for Adults (SVU) or compensation for participation in vocational post-secondary adult and continuing education.

(3) The educational activities must lie within the scope of the Danish Ministry of Education or the Danish Ministry of Higher Education and Science.

Area and organisation (Clause 2)

(1) Open education is defined as vocational 1) part-time training programmes, 2) full-time training programmes offered on a part-time basis, 3) single subject courses, 4) courses in specific fields, 5) short courses and 6) tailored courses.

Caveat: Note that open education *may* be offered as distance learning. However, this does not apply to short courses pursuant to subsection 1, item 5 (above), unless the Minister of Education or the Minister for Higher Education and Science decides otherwise.

[103] Text extracted from http://www.au.dk/fileadmin/www.au.dk/Regelsamlingen/2015/Bekendtgoerelse_af_lov_om_aaben_uddannelse-da-en_gb-C__1_.pdf

3.7 Estonia (EE)

Open Education in the country

Estonia (population 1,3 million) is the northernmost of the three Baltic States and with the smallest population (Lithuania is 2,9 million and Latvia 2 million.)

The POERUP database (2014) reports no open education activity except for Tallinn University (which was a member of EMMA[104]); the OER World Map records the Koolielu[105] OER portal, managed by the Estonian Information Technology Foundation for Education (HITSA) and offering OER for primary and secondary education.

On the other hand, Open Access activity is substantial relative to the population: the OpenDOAR portal reports[106] 6 Open Access repositories.

There does not appear to be any national policy specifically for open education or OER. The *Open Government National Action Plan*[107] for 2016-18 has, under Commitment 4: "Development of social and ICT know-how taking into account the opportunities of the information society and e-state", an Action 4.1 "Defining participatory democracy and development of digital competence in school education"; however the details (pp. 25-26) show an orientation mainly to the participatory democracy aspects.

On the other hand, the country Lifelong Learning Strategy presented below contains important elements aiming at opening up education. It is a document that guides the most important developments in the area of education and was selected as the policy document for the basis of the interview.

Overview of the selected policy	
Policy title	**Eesti elukestva õppe strateegia 2020** **Estonian Lifelong Learning Strategy 2020**
Policy URL	https://www.hm.ee/sites/default/files/estonian_lifelong_strategy.pdf
Description	The general goal of the Lifelong Learning Strategy is to provide all people in Estonia with learning opportunities that are tailored to their needs and capabilities throughout their whole lifespan, in order for them to maximize opportunities for dignified self-actualization within society, in their work as well as in their family life. Strategic Measure 4.2 states "the availability of digital learning resources will be ensured, including e-textbooks, interactive exercises, open educational resources, teachers' guides, and web-based assessment tools."
Institution	Ministry of Education and Research
Policy date	2014
Status	Current
Language	English
Jurisdiction	National
E&T sectors	School education, Higher education

[104] http://htk.tlu.ee/htk/new-project-emma-started-2/

[105] https://koolielu.ee

[106] http://www.opendoar.org/find.php?cID=68&title=Estonia

[107] http://www.opengovpartnership.org/sites/default/files/Estonia_NAP3_2016.pdf

Overview of the selected policy	
Dimension of impact	Core dimensions ☑ Access ☑ Content □ Pedagogy □ Recognition □ Collaboration ☑ Research Transversal dimensions □ Strategy ☑ Technology ☑ Quality □ Leadership

Persons interviewed

- Ene Koitla, Head, Innovation Centre, Estonian Information Technology Foundation for Education
- Inga Kõue, Head of Content Development, Estonian Information Technology Foundation for Education

Interview results

Vision on open education in the country, role of the Ministry

The main vision of open education in Estonia has a focus on lifelong learning towards enhancing the skills and competences of teachers, by producing training courses for school teachers, as the Ministry has a plan to support them to embrace digital technologies called "digital focus"[108]. Also, the policy supports the provision of platforms for teachers to share content such as e-koolikott[109], Koolielu[110] and innovatsioonikeskus[111], and have designed guidelines and recommendations for the creation of OER.

Policy design and involved stakeholders

Apart from the Ministry of Education, also schools and universities were involved, together with two foundations that support open education development in the country: Estonian Information Technology Foundation for Education[112] and Innova Estonia[113]. These are involved in providing training towards changing the teaching and learning culture in the country, including the development of a curriculum of digital competences for students and teachers.

Policy dimensions and areas of action

The main areas of action of the policy are focused in the development of a digital culture at national level, promoting resources, guidelines, training and curricula to

[108] https://www.hm.ee/en/activities/digital-focus
[109] https://e-koolikott.ee
[110] https://koolielu.ee – mentioned in the introduction
[111] http://www.innovatsioonikeskus.ee/en/digital-teaching-resources
[112] https://www.hitsa.ee/en
[113] http://eng.innovaestonia.ee

develop digital skills that can be useful in the future for students and teachers by embracing new technologies and acquiring new digital competencies.

Policy implementation and impact to date

Through the Estonian Information Technology Foundation for Education, teachers are being trained in digital competences across the country and online platforms are been built to support the sharing and creation of resources, while guidance and support is being provided to teachers and students to effective use this platforms. Also, universities are encouraged to adopt an open approach to sharing of resources and to include digital literacies in the curriculum.

Key barriers and enablers during implementation

One considerable barrier is the lack of ICT devices for schools, students and teachers, together – especially in countryside areas – with poor access to Wi-Fi and connectivity. But also, a significant barrier is the yet dominant traditional approach to teaching and learning: it was noted that the preferred teaching material in the country are printed textbooks and that the teachers lack the ability to use and adopt new digital technologies. Also, amongst the barriers mentioned, the reluctance of the parents in supporting the use of electronic devices for teaching and learning has been a concern, therefore training and support for parents towards understanding how their children with use technologies has been also included in the actions of the policy.

In relation with the enablers, the support of the government has been key, supporting and promoting digital technologies, developing platforms to share open educational resources and providing training and guidance across the educational sector benefitting students and teachers.

Relation between the policy and the EU-level developments

The policy is related with EU policies in relation to the general aim of developing an open and digital culture amongst educators.

Lessons learnt and recommendations for future open education policies

Amongst the lessons learnt it is important to consider, when developing digital skills in schools and when adopting the use of digital devices with children, the concerns of the parents and provide guidance and support to this group to ensure the effective use of these resources.

Also, it is important to consider that these digital skills need to prepare students for higher education as it can be an effective way to democratise and to widening access to universities.

Finally, it is **recommended** that the EU could provide Member States not only with a framework of competencies and skills, but with guidance and resources to develop these skills, also by providing accredited MOOCs for teachers’ training and more funds for the development of open education.

3.8 Finland (FI)

Open education in the country

Finland has a population of 5,4 million. This makes it similar in population to Denmark (5,7 million), Scotland (5,3 million), Norway (5,1 million) and Ireland (4,6 million). Finland has a long tradition of openness yet there is no single national policy which specifically mentions OER or open education. Nor are there many signs of OER activity and it is noteworthy that the OER World Map[114] does not have a Finland country champion. Experts we consulted claim that the current government is seen as less supportive of such developments than was the case in the past. This is interesting because there is a long history of "open education" in Finland, and thus this section is considerably longer than the norm in order to elucidate that apparent dichotomy.

Open Education in the ODL sense

"Open Education" was a phrase originally used in the ODL (Open and Distance Learning) and Lifelong Learning movements of the 1980s and 1990s. Indeed the *Finnish Universities Act*[115] 558/2009, still current, states (Chapter 1 Section 2 Paragraph 1) that "the universities must promote lifelong learning", as well as "interact with the surrounding society and promote the impact of research findings and artistic activities on society". All of this gives great scope to Finnish universities to engage also in the modern version of open education. However, Chapter 2 Section 7 Paragraph 1 states that "the universities *may* also provide continuing professional education and open university education" (our emphasis) – and the word "may" allows for a degree of optionality as to the depth of their commitment.

The *Council for Lifelong Learning* is an expert body within the Ministry of Education and Culture considering issues relating to cooperation between education and working life as well as the conditions for lifelong learning and developing adult education. The Council comprises 14 members and their deputy members, and they possess diverse expertise in the areas of education, the labour market and research. At the moment the Council accepts that there is no specific Lifelong Learning strategy for Finland, but the Council is looking for a new kind of Lifelong Learning strategy, which should include possibilities to prolong and improve people's working careers. Education, labour and innovation policies have to function as one entity.

The Ministry of Education and Culture has established a process to review the Finnish Higher Education System[116] in order to analyse its strengths and weaknesses and identify proposals to improve the higher education system and strengthen Finland's innovation system. This may in time lead to a policy. In 2015 the Ministry published, in English, a consultative document ("Green Paper")[117] entitled *Towards a future proof system for higher education and research in Finland*.

The paper implies that despite the "must" and perhaps encouraged by the "may" in the legislation) Finland starts nowadays from a low base in lifelong learning. The phrase is used only 11 times in the above report, mostly in connection with other countries, and there is the strong conclusion (p. 44) that (our italics):

> Almost none of the universities indicated that equal participation, *support of lifelong learning*, the support of strong students and a focus on Master and PhD programmes are important in their educational strategy development.

[114] https://oerworldmap.org/country/fi

[115] Unofficial English translation – http://www.finlex.fi/en/laki/kaannokset/2009/en20090558.pdf

[116] http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2015/liitteet/okm11.pdf

[117] https://julkaisut.valtioneuvosto.fi/handle/10024/75119

Furthermore (p.92),

> The International Panel noted that no-one raised any issue about lifelong learning and continuing adult education; indeed, remarkably, the topic did not emerge during the discussion except in response to prompting.

Thus not surprisingly, Finland's two OGP plans[118] do not mention open education – indeed they hardly mention education at all.

Open University and Virtual University

On the other hand there appears to be much longer-term policy continuity in higher education in Finland than in many other Member States. The Finnish Open University is a decentralised system whereby most Finnish universities offer flexible learning courses to adults, many now via online methods. It has its origins in the early 1970s and has been in existence in its current form for at least 20 years. Open University courses are open to all, regardless of age and educational background. The quality and standard of teaching is equivalent to teaching in the faculties/departments of each host university. On the national level the system serves around 80.000 students per year, with thousands of study modules and study units in hundreds of subjects. After taking a certain number (60 ECTS) of courses an Open University student is entitled, outside the normal entrance examination system, to apply for entry into university as a regular degree student. The Open University does not itself grant degrees; however, courses are part of university degree programmes and may therefore be incorporated into a university degree if the student applies and is admitted to university studies later. Open University courses are provided in cooperation with departments and faculties of universities, but in addition, many of the courses are organised in cooperation with adult education organisations: summer universities, folk high schools and adult education centres.

Separately from the Finnish Open University, the Finnish Virtual University[119] was set up in the last decade via a series of government-funded initiatives. This had considerably more focus on online learning. There was also a Finnish Online University of Applied Sciences[120].

Open Education initiatives in the "modern" sense

There have been publicly-funded OER programmes for a number of years.

- Avoimet oppimateriaalit ry[121] (the Finnish Association for Open Educational Resources) was founded in September 2012. Its main purpose is to increase the recognition and adoption of open educational resources in Finland. So far the biggest push of the association has been the *Vapaa matikka* series of grade 10-12 mathematics textbooks. The association is a strong advocate of Creative Commons licensing. The primary working method of the association has been hackathon organizing – as of July 2014, there have been 14 Vapaa matikka hackathons. Some previously written books have also been licensed under a CC license in partnership with the association.
- The Code ABC project[122] is largely volunteer-run but now is part-supported by the Finnish National Board of Education (now Finnish National Agency for Education)[123] and also had some EU funds. It is a grassroots initiative by teachers and

[118] http://www.opengovpartnership.org/country/finland/action-plan
[119] http://www.virtualschoolsandcolleges.eu/index.php/Finnish_Virtual_University
[120] http://www.virtualschoolsandcolleges.eu/index.php/Finnish_Online_University_of_Applied_Sciences
[121] http://avoimetoppimateriaalit.fi/in-english/
[122] http://koodiaapinen.fi/en/
[123] http://www.oph.fi/english/education/overview_of_the_education_system

educational researchers, aimed to provide a free-of-charge and tailored MOOC for Finnish primary school teachers on coding. The new national curriculum framework for primary education in Finland (from 2016 onwards) states that programming (or coding) is part of all education. The initiative also provides an open library of content (openly licensed under CC BY).

- A few Higher Education Institutions were interested in OCW (now Open Education Consortium) but now only one[124] is a member. It is felt that now the focus is more on MOOCs[125] such as at University of Jyväskylä[126] and Turku AMK[127].
- Metropolia University of Applied Sciences, the Finnish Innovation Fund Sitra and others are offering a multidisciplinary course (MOOC) on climate change[128] – *Climate Now* – that was launched in 2016. The course aims to offer every HEI student in Finland the opportunity to learn the basics about climate change and increase understanding of how climate change relates to the graduate's own field of study.
- The Finnish Broadcasting Corporation (YLE) offers free-of-charge educational and informative content through YLE Learning Online[129]. YLE Teacher's TV is also active as a section in YLE Learning Online[130] even if an earlier site[131] is not now available.
- Internetix is a portal of Otava Folk High School[132] for conducting courses of upper secondary education[133]
- As expected, Finnish universities are active in Open Access repositories, with 16 reported by OpenDOAR.[134]

However, some seem now to be not active:

- EDU21 was documented in earlier reports as a portal set up and maintained by the Finnish National Board of Education but no trace can now be found[135]
- Le Mill was also a well-known OER site, which seems now not to have government funding: its former site[136] is not operational.

International databases also mention the OpenScout[137] project, which was an EU-funded project that finished in 2012, but the web site is still active.

Finally for completeness, the OpenDOAR portal reports[138] 16 Open Access repositories in Finland.

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[124] Helsinki Metropolia University of Applied Sciences – http://www.metropolia.fi/en/ – this is documented in OER World Map and POERUP

[125] Informal communication, but confirmed by https://eadtu.eu/images/publicaties/Finland-Comparing_Institutional_MOOC_strategies.pdf p.5

[126] https://www.avoin.jyu.fi/en/study/studies/MOOC_success_factors

[127] https://www.mooc-list.com/countries/finland – see http://www.tuas.fi/en/

[128] http://www.climatenow.fi/story.html

[129] http://yle.fi/aihe/oppiminen

[130] http://yle.fi/aihe/oppiminen/opettajalle

[131] http://opettaja.tv

[132] http://www.otavanopisto.fi/in_english

[133] http://opinnot.internetix.fi/fi/structure/etusivu

[134] http://www.opendoar.org/find.php?cID=73&title=Finland

[135] Perhaps it was confused with the edu21.dk portal in Denmark

[136] http://www.lemill.net

[137] http://learn.openscout.net

[138] http://www.opendoar.org/find.php?cID=73&title=Finland

Swedish-language education

It should be remembered that Finland has two official languages, Finnish and Swedish. The *Universities Act*[139] 558/2009 makes it clear in Chapter 2 Section 12 Paragraph 1 that:

> Åbo Akademi University, Hanken School of Economics, the University of Helsinki, the University of Art and Design, Sibelius Academy, the Theatre Academy and Aalto University [140] shall be responsible for educating a sufficient number of persons proficient in Swedish for the needs of the country.

In more detail, Section 11 Paragraph 1 states:

> The languages of instruction and examination in the University of Helsinki, the Academy of Fine Arts, Sibelius Academy and the Theatre Academy shall be Finnish and *Swedish*. The language of instruction and examination in Aalto University shall be governed by the provisions on the language of instruction and examination of its constituent Schools in Section 9 of the Universities Act of 1997 (645/1997). The language of instruction and examination of Åbo Akademi University, Hanken School of Economics, and the Swedish School of Social Science of the University of Helsinki shall be *Swedish*. The language of instruction in other universities shall be Finnish.

As one example, the Open University at Åbo Akademi University[141] educates about 3000 students per year and delivers about 23.000 credits (ECTS) per year, spread across 300 courses, of which around 1/3 are online courses.

In terms of OER, Vetamix[142] is an online learning resource provided by the Swedish department of YLE (the national broadcasting company) in collaboration with the Finnish National Agency for Education and the Swedish Cultural Foundation in Finland[143].

Person interviewed

Ilmari Hyvönen, Senior advisor, Ministry of Education and Culture, Department of Higher Education and Science Policy

Interview results

Vision on open education in the country, role of the Ministry

In Finland there is no policy with the explicit title of "open education", despite the long tradition of open learning in the country since the 1970s and online learning since the late 1990s. The main reason for this is that openness in its broad sense is somehow embedded in ordinary higher education policy in Finland and the connected objectives of equity and flexibility have in general been achieved. Another reason for the absence of this is that in recent times the government has had other priorities, and budget cuts to contend with.

[139] Unofficial English translation – http://www.finlex.fi/en/laki/kaannokset/2009/en20090558.pdf

[140] Åbo Akademi University (http://www.abo.fi/public/en); Hanken School of Economics (https://www.hanken.fi/en), University of Helsinki (https://www.helsinki.fi/en); University of Art and Design is now part of Aalto University (http://www.aalto.fi/en/); Sibelius Academy (Music) and the Theatre Academy are now part of the University of the Arts Helsinki (https://www.uniarts.fi/en)

[141] http://www.abo.fi/student/en/openuniversity

[142] https://svenska.yle.fi/vetamix

[143] http://www.kulturfonden.fi/in-english/

On the other hand, Finland has a policy on Open Science[144] continuing until 2018 and most probably being extended, promoting the openness of research publications, data, methods: this programme is somehow connected to open education.

If we consider openness in its broad sense including recognition and access to learning for everybody, we can say that all Finnish universities are adopting open approaches. At the same time, a number of universities are providing MOOCs free of charge, charging a fee only at the end of the course for certification.

In the present phase, the Ministry of Education and Culture is working to increase an important dimension of openness, which is the one of institutional collaboration, so that courses by one university can be used by other institutions. The Ministry intends to do that by rewarding with funding the universities that cooperate: in 2016 a general call for funding (€25 million) was launched, where they will fund university consortia. Further, since 2016, public funding to universities is based not only on ECTS taken in the university students are enrolled in but also on ECTS taken in other universities.

Another priority is to improve interoperability of information and management systems of universities so that students can take courses from any university of the country by using a single system. The Ministry is working on this and has developed a shared identity management solution and an ECTS single platform for every student.

Involved stakeholders in open education

In terms of open licensing and OER, there is a number of civil society organisations that promote openness; at the moment the movement is stronger in the Open Science field, but it will be extended to education also most probably. There have been discussions and seminars on MOOCs and OER but this has not yet been brought to a policy: we can say that an underlying discussion has been run in the country for some time, involving universities, trade unions and civil society stakeholders.

Key barriers and enablers during implementation

In the Finnish style of openness, which is now based on cooperation among institutions, the main challenge is that independent institutions which want to work together have to modify and harmonise their timelines and priorities: to change this takes a lot of time and commitment by the single institutions.

Second, in order to foster cooperation, management processes related to students of other universities should be further simplified in terms of information availability, interoperability and credits recognition. Institutions perceive a value in this “open economy” approach, for example since a few years ago universities of applied sciences open all their summer courses for students from other universities.

Third, open licensing of teaching materials is a challenge since the norm is that content belongs to the teachers: to change that, the national teachers’ contract should be changed –this is a rather “touchy subject”.

Fourth, teachers’ capacity in working with open approaches should be enhanced, while in Open Science there are important capacity developments to undertake.

Relation between the policy and the EU-level developments

The Finnish Ministry of Education actively participates in European activities such as the work of the ET2020 Expert Working Groups, *even if the openness part of the work has not really started*.

[144] http://openscience.fi

One suggestion for European institutions is that they could promote European open standards for education data, allowing institutions from different countries to understand what is being done in other countries in terms of curricula etc.

Lessons learnt and recommendations for future open education policies

The basic steps for opening up education in Finland were taken long time ago, and now that open education is somehow part of the system, universities are normally taking open approaches into account.

For cases like Finland, we recommend that the focus should be on collaboration among institutions: universities need to see the value of this cooperation and the Ministry needs to reward these cooperations, also working on practical issues such as interoperability and information sharing.

This will help "institutionalizing" openness: one of the biggest problems with the Finnish Virtual University was in fact that it was added up to the normal institutional processes and this created problems.

3.9 Germany (DE)

Open education in the country

Germany is a federal state with a population of nearly 81 million. For governance purposes it is divided into 16 federal states that are collectively referred to as *Bundesländer*.

Each federal state is almost fully responsible for educational matters, both for schools and higher education.

The populations of the Bundesländer span almost the full range of Member State populations, from North Rhine-Westphalia (17,6 million) and Bavaria (12,5 million) to Saarland (994.000) and Bremen[145] (655.000).

Germany has been intensively studied in respect of OER and open education in the last few years by EU-funded and other projects. There was a POERUP country report[146] and tabular supplement[147] in 2014. There were more recent studies in 2015 by ADOERUP (for the European Parliament)[148] and Oerup![149] (covering the province of Baden-Württemberg). In 2016 the OER Map project published the OER Atlas[150] covering Germany and other German-speaking countries/regions.

The move to open education

Until recently Germany had raised objections[151] to the idea of OER, but in past two years the attitude in general has changed and some national policies have been enacted.

In November 2013, OER was a topic in the CDU/CSU–SPD coalition agreement, with the assertion that *free digital teaching material must be strengthened by the state and the federal states*. The basis for this is an educational and research friendly copyright law and an open-access-policy, stating that the access to textbooks for schools and teaching materials for universities should be – as much as possible – free and the usage of free licenses and formats should be strengthened.

So, despite the fact that OER was not seen as an issue expected to become a policy priority in the near future, some actions in that field have occurred. Because of encouragement from teachers, educational institutions and non-profit organisations, a hearing took place in November 2012 between the *Federal Ministry of Education and Research* (BMBF) and the *Standing Committee of the German Ministers of Education and Cultural Affairs* (KMK) about the issues of OER and especially the copyright problems of digitising parts of textbooks for the classroom.

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[145] In full, *Freie Hansestadt Bremen* (Free Hanseatic City of Bremen), sometimes also called *Land Bremen* – this is mentioned as it comes up later in examples

[146] http://poerup.referata.com/wiki/Germany

[147] http://poerup.referata.com/wiki/File:Open_Education_Initiatives_in_Germany.pdf

[148] http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf, pp.120-124

[149] http://www.oerup.eu/fileadmin/_oerup/dokumente/need_analysis_report_MFG_Germany1.pdf

[150] http://open-educational-resources.de/oer-atlas-2016-download/

[151] "Germany was the only country who responded that the OER issue is not expected to become a policy priority in the near future. They also stated that they do not consider a lack of learning material in digital format (especially in English) to be one of the major problems in education; therefore, the potential benefit of OER in Germany is not highly rated." OPEN EDUCATIONAL RESOURCES: ANALYSIS OF RESPONSES TO THE OECD COUNTRY QUESTIONNAIRE, EDU Working Paper 76, 2012, p. 8 – http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=EDU/WKP(2012)13&docLanguage=En

This resulted in an agreement between KMK, the publishers of educational media (Verband Bildungsmedien) and the collecting societies on rules for the digitalization and photo copying of content from textbooks for the classroom (*Digitale Schulbücher, einscannen und kopieren in der Schule*[152]).

In August 2013 the Federal Ministry of Education and Research (BMBF) launched three surveys to determine their policy in the different aspects concerning OER:

- Outline of OER in Germany (*Freie Bildungsmedien*)
- Judicial matters about Open Content and Copyright (*Open-Content und Urheberrecht*)
- OER and Metadata (*Metadaten für Open Educational Resources*).

Another policy of the BMBF is finding scenarios for the usage of copyright protected material in education and research till 2020 – *Ein wissenschafts- und innovationsfreundliches Urheberrecht für die digitale Wissensgesellschaft*[153].

Open Access

The Federal Ministry of Education and Research started in September 2016 an Open Access Strategy for scientific publications to be distributed via the internet, either in an online open access journal, on a web site or in a so-called *repository*.

A key action of the new BMBF strategy is the introduction of an open access clause for all projects funded by the BMBF. Scientific articles from BMBF-funded projects should either be published directly under an open access model or should be placed in an appropriate document server after an embargo period.

In addition, the BMBF will support the Länder, universities and research institutions with a national competence and networking site to develop their Open Access activities. BMBF is also funding, in a competition, innovative ideas that will help to anchor the new publication formats at universities and research institutions.

Even now the OpenDOAR portal reports[154] an impressive 193 Open Access repositories, more than two per million population.

"Open Universities"

In parallel and not yet closely connected, Germany has been investing in ICT in higher education activities. The first policy presented below, Advancement through Education: Open Universities, is a competition programme that follows the 2008 qualification initiative Advancement through Education which aimed to enhance educational opportunities for everyone in different stages of learning and to improve citizens' employment prospects.

The second policy presented is the core OER policy, Mainstreaming OER.

[152] http://www.schulbuchkopie.de/VBM_Schulbuchkopie_Ansicht.pdf

[153] https://www.bmbf.de/files/Abschlussbericht_strategischer_Dialog_wissfreundl_Urheberrecht.pdf

[154] http://www.opendoar.org/find.php?cID=81&title=Germany

Germany – "Open Universities" initiative

Overview of the selected policy	
Policy title	**Advancement through Education: Open Universities 2011-2020**
Policy URL	http://www.wettbewerb-offene-hochschulen-bmbf.de
Description	The Federal Ministry of Education and Research (BMBF) is currently funding in the first nationwide contest 26 projects and in the second round of the competition 47 projects from universities and university networks, to develop open study programmes for working adults and other target groups to a) secure the supply of skilled workers permanently, b) improve the permeability between vocational and academic education, c) ensure a more rapid transfer of knowledge into practice and d) support the profile of the universities in the field of lifelong learning. The projects are based on a variety of formats, including part-time courses, sandwich courses, study modules and certificate offers. The first round started in 2011 and the second in 2014. The first round projects come to an end in September 2017. A second funding period of the second round is scheduled to start in February 2018.
Institution	Federal Ministry of Education and Research (BMBF)
Policy date	2011
Status	Current
Language	German
Jurisdiction	National
E&T sectors	Higher education (including vocational HE), Adult learning
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy ☐ Recognition ☑ Collaboration ☐ Research Transversal dimensions ☑ Strategy ☐ Technology ☐ Quality ☐ Leadership

Person interviewed

Ida Stamm, Senior Consultant, VDI/VDE Innovation, Technik GmbH on behalf of BMBF

Interview results

Vision on open education in the country, role of the Ministry

The Federal Ministry of Education[155] understands open education as a means to widening participation for new target groups that normally do not enrol into university programmes straight after leaving school. Also, open education is understood as a route to effectively develop skills towards improving the competencies of workers, and therefore towards achieving the development of a highly skilled workforce. In this sense the role of the Fachhochschulen[156] (Universities of Applied Sciences) is key, since they offer part-time courses aiming at opening access to education to adult learners.

Policy design and involved stakeholders

The policy responds to the need of democratising access to higher education programmes for people who normally do not have a chance to access it, whether because their vocational studies did not allow access to HEIs, or because previously there was not enough of an offer of part-time and blended learning options. The policy has been designed by the Central Government and by the Federal States, by agreeing both on the implementation of the policy and on its funding scheme. To ensure the quality and consistency of the policy, its plan has been assessed and improved by international experts from German-speaking countries. The key stakeholders of the policy are the German Central Government, the Ministry of Education and its agencies, the Federal States, the universities, the universities of applied sciences, the universities of the arts and all those institutions that provide lifelong learning opportunities at Vocational Education level.

Policy dimensions and areas of action

The main dimensions and areas of action are related to widening the participation and opening up the access to higher education and to providing further qualifications towards ensuring the development of competencies for the labour force of the country. To ensure widening participation via enhancing the lifelong learning offer across the country, digital technologies are key, including digital learning materials and MOOCs, as these will not only train academics to teach mature students and to create new programmes, but more importantly to democratise access to high quality education and training.

Policy implementation and impact to date

The first evaluation round will not be completed until 2017; however, from the start of the policy implementation in 2015 over 110 new study courses have been implemented – both in face-to-face and blended modes – in different subject areas such as applied and natural sciences, with the exception of health care, and other social sciences subjects. Also, a considerable number of MOOCs have been developed by German universities thanks to the programme, and are being adopted in the context of lifelong learning for workers. Another interesting aspect that has had a big impact in relation to the implementation of the policy has to do with the accreditation and recognition for access to Higher Education of the vocational training diplomas,

[155] https://www.bmbf.de/en/index.html
[156] https://en.wikipedia.org/wiki/Fachhochschule

which is a key enabler to facilitate workers' access to universities and universities of applied sciences.

One important outcome of the policy is the Open Applied Sciences Universities Bremen (Offene Hochschulen Bremen)[157] project, a consortium of universities from Bremen State[158] that provides a wide formative offer for non-traditional and new target groups.

Key barriers and enablers during implementation

The main barriers encountered during the implementation were the tensions between the Central Government and the different Federal States, which led to long and complicated negotiations on different aspects of the policy, slowing down its start-up phase.

Also, considering that both traditional and applied sciences universities are facing an important transformation and modernisation phase, a certain level of reluctance exists amongst academics whom will be affected in different ways: educators from both traditional universities (Universitäten), who have normally more hours for research than for teaching, and from Applied Science Universities (Fachhochschulen), whose contract normally does not contemplate research as part of their activities, are now expected to increase their teaching hours to teach in the new blended and part-time courses, and see this as an increase of their workload.

Relation between the policy and the EU-level developments

The structure of Germany as a federal state makes the policy quite complex, as its implementation and success depend on a wide range of actors at National and Federal level, including traditional Universities, Universities of Applied Sciences and Vocational Training Centres who typically respond to policies at the State level. Considering this, the fact that the latest University reforms in Germany have been built in line with EU frameworks, such as the Bologna Process, is a key enabler: national pressure for modernisation cannot be sufficient and the guidance of the EU has been key to modernise the German higher education system.

Lessons learnt and recommendations for future open education policies

The lessons learnt are related to the negotiation between the Central Government and the Federal States, as reaching a compromise and common grounds can be challenging, since some federal states are more open to change than others. The main **recommendation** for future policies aiming at opening up education is to include a system to support the Recognition of Prior Learning, thus able to transform lifelong learning and vocational training systems, and so increasing openness of and democratising access to higher education.

[157] http://www.offene-hochschulen-bremen.de/home/

[158] Bremen is the smallest of the 16 German states – https://en.wikipedia.org/wiki/Bremen_(state)

Germany – Mainstreaming OER

Policy/initiative overview	
Policy title	**Mainstreaming OER**
Policy URL	http://open-educational-resources.de
Description of the policy	The German federal OER policy *Mainstreaming OER* has two main linked strands. It has gained funding, and activity started in October 2016: 1. An Information Office comprised of a central hub and some spokes. 2. A country-wide staff development programme in OER, multi-sector, delivered by a partnership of federal and state governments. Among the states, North Rhine Westphalia delivers this programme via a state agency, and was chosen for the interview. The policy follows on from an *OER Mapping project*[159] that has now concluded and a *Feasibility study on the development and operation of OER infrastructures in education*[160] that reported[161] in February 2016. Notice that the policy paper[162] *Germany's universities position on OER* from HRK (the Rectors' conference) does not qualify as a national or regional policy and that the three White Papers[163] on OER appear to be recommendations not approved policies.
Policy institution	Ministry
Policy date	2016
Policy status	Current
Language	German
Policy jurisdiction	National and regional
E&T sector(s)	School education, Higher education

159 http://mapping-oer.de

160 http://www.dipf.de/de/forschung/projekte/machbarkeitsstudie-zum-aufbau-und-betrieb-von-oer-infrastrukturen-in-der-bildung

161 http://www.pedocs.de/frontdoor.php?source_opus=11715

162 http://open-educational-resources.de/hrk-position-zu-oer/

163 http://open-educational-resources.de/oer-whitepaper/

Policy/initiative overview	
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy □ Recognition ☑ Collaboration □ Research Transversal dimensions □ Strategy □ Technology ☑ Quality ☑ Leadership

Persons interviewed

Barbara Getto and Richard Heinen, University of Duisburg-Essen, Heads of *Mainstreaming OER* programme for North Rhine Westphalia

Interview results

Vision on open education in the country, role of the Ministry

The understanding of open education within German policy making circles seems to be different at the federal and at the state level, While the Federal Ministry of Education and Research[164] focuses mainly on promoting OER, the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder (KMK)[165] takes a broader perspective, where OER is seen as just a component of the broader open education picture. Very recently the KMK published a strategy document titled *Learning in the digital age*[166], based on a very open consultation process which has engaged all relevant stakeholders and which will represent a common starting point at the national level for future activities dealing with open education.

Policy design and involved stakeholders

The policy results both from a top-down stimulus, related to the positive position taken towards OER and open education at the time of the OER.de[167] programme by the European Commission and by OECD, and a bottom-up stimulus, aligned with the grassroots movement on OER which started in Germany in 2012. These stimuli were important for the Federal Ministry of education and Research to publish the two studies *Mapping OER* and *The need for OER infrastructure* and to start up the policy.

Policy dimensions and areas of action

Through the policy, 25 projects have been or will be launched in the next months, covering mainly HE and Schools but also VET and LLL across Germany, focussing on

[164] https://www.bmbf.de/en/index.html – as before
[165] https://www.kmk.org/kmk/information-in-english/standing-conference.html
[166] https://www.lmz-bw.de/kongress2016.html
[167] http://open-educational-resources.de/wp-content/uploads/sites/4/2016/12/Kurzbeschreibungen_OER_Vorhaben_Stand_Dezember2016.pdf

qualifying people to bring OER[168] in their institutions. In terms of funding, for the next two years the policy is equipped with €4 billion for the 25 projects, and a discussion is going on in the German Parliament to increase this sum. If we look at the broader context, the Federal Ministry announced a programme of €5 billion targeting general infrastructure for education, including ICT and on open education. Finally, each State has its own funding stream, for example North Rhine Westphalia has €2 billion in place already, targeting infrastructure for schools. The policy tackles the following dimensions of open education: access, content, leadership, quality and collaboration. In terms of collaboration, the policy wants the 25 projects (conducted in some cases by consortia, in others by single institutions) to work together, sharing OER and practices.

Policy implementation and impact to date

It is too early to look for impact, since some projects started only in November 2016 and some others will start only in early 2017. In any case, the strategy paper *Learning in the digital age*[169] produced by the Conference of Educational Ministries of the already had some impact in terms of fostering a discussion and raising awareness.

Key barriers and enablers during implementation

The main expected challenge is the lack of awareness about OER and the limited understanding of the benefits of producing learning content in the form of OER. Awareness exists among the e-learning and digital learning community, but not beyond that. It will be important to make clear to teachers and managers that the approach is not only about OER and infrastructure but about a new way to look at teaching and learning. In other words, while it is important to work on infrastructure and on OER, the key for the policy's success will be the capacity to keep the big objective in mind, so to have an impact on the whole system.

Relation between the policy and the EU-level developments

There was certainly an input from the EU in terms of priority and strategy. At the projects level there are connections through partners that work also in EU projects. At the moment there is no direct cross-border collaboration with other German-speaking countries: the policy is limited to German institutions.

Recommendations for future open education policies

In terms of **recommendations**, there should be more funding lines for OER and open education within European programmes such as Erasmus+, even if participation in EU projects is very competitive and institutions (in Germany) tend to prefer to apply for national funding.

Further, legal guidelines on OER and copyright from the EU **could help** the discussion at the national level.

It is **important** to keep talking and raising awareness about open education, and the EU could help keeping the discussion alive in Member States.

[168] http://www.bildungsserver.de/Studien-zur-Diskussion-um-Potenziale-freier-Bildungsmedien-Open-Educational-Resources-initiiert-durch-das-BMBF-10828.html

[169] https://www.lmz-bw.de/kongress2016.html – as before

3.10 Greece (EL)

Open education in the country

Greece has a population of just over 11 million. There is some joint working with Cyprus, the other Greek-speaking Member State (population 0,84 million).

There is a useful POERUP report on OER in Greece[170] and wider but older (2011) reports on ICT in education in schools and universities, e.g. by the VISCED project[171].

The Greek government has used EU grants to promote OER, with an implicit, if not explicit, policy of encouragement. In fact, Greece has significant OER activity (as documented in POERUP[172] and the OER World Map – which has a Greek contact point). To add to the national programmes discussed later, we mention two:

- The initiative Mathisi 2.0 plus[173] fosters knowledge building and collaboration in the area of social media and open learning communities in Greece. It has a very strong social media presence.
- Veria Central Public Library[174] gives access to a large digital repository comprising the library's collection, including the collections of the Monastery of St John the Baptist, Skete Veria, and the Lyceum of Greek Women, an annex of Veria. The initiative is financially supported by the *Public Libraries digitisation action* of the Information Society Operational Programme (80% contribution by the European Social Fund). Through a set of metadata mechanisms, the Central Public Library of Veria provides its digital content to the European culture portal Europeana.[175]

Greece is not yet so active in MOOCs, but one should note the *Open Courses* development[176] and an increasing number of in-country analytic papers[177] on the topic of MOOCs.

The OpenDOAR portal reports[178] 35 Open Access repositories in Greece, a good number for the country's population.

Digital schools

The Digital School initiative[179] by the former Ministry of Education, Religious Affairs, Culture and Sports (now Ministry of Education, Research and Religious Affairs),[180] contains the official repository[181] of all the textbooks in the form of e-books for all levels of education (primary, secondary, upper secondary and professional education). It is not clear whether all these textbooks are in OER format but many are. It is also not clear whether they are oriented to independent study (content was not designed in

[170] http://poerup.referata.com/wiki/Greece
[171] http://www.virtualschoolsandcolleges.eu/index.php/Greece
[172] Only two entries made it into the POERUP database; but the narrative report, written by a Greek expert, contains many more examples – http://poerup.referata.com/wiki/Greece#OER_Initiatives_in_Greece
[173] http://mathisi20.gr
[174] http://medusa.libver.gr
[175] http://www.europeana.eu/portal/en
[176] http://opencourses.gr/index.xhtml and *Open courses in a Greek higher education institution: faculty views and attitudes* (http://hci.ece.upatras.gr/files/c203_Avouris_Komis_Garofalakis_ICODL2015.pdf, 2015)
[177] Such as http://conta.uom.gr/conta/publications/PDF/2014-%20INTED-%20MOOCs%20for%20foreign%20language%20learning.pdf and
[178] http://www.opendoar.org/find.php?cID=84&title=Greece
[179] http://dschool.edu.gr
[180] http://www.minedu.gov.gr/ – for News in English see http://www.minedu.gov.gr/grafeio-typoy-kai-dimosion-sxeseon/news-in-english
[181] http://ebooks.edu.gr

a mode allowing its reinvestment in contexts others from their target context of formal learning settings), but they are a useful set of resources.

In its response to the 2012 OECD questionnaire, Greece noted that the documents describing the function and areas of responsibility of the Directorate that handles the educational portal in the then Ministry of Education, Religious Affairs, Culture and Sports of Greece make reference to OER.

The same applies to the *Digital learning supportive materials* (Psifiaka sholika voithimata),[182] also created under an initiative of the Ministry of Education, Religious Affairs, Culture and Sports. These materials are all available under Creative Commons licences.

Earlier interventions

There have been a series of earlier but recent policy interventions. The Operational Programme[183] *Education and Lifelong Learning 2007-2013* was a large scale, nationwide funding programme, part of the 4th Programming period co-funded by the European Social Fund (ESF) and the Greek State. It was the main funding scheme for upgrading the quality of learning at all levels of the educational system, involving the use of Internet technologies. The Programme consisted of four sets of thematic Priority axes, clustered in threes: "Upgrading the quality of education and promoting inclusion"; "Upgrading the systems of initial vocational training and vocational education and linking education with the labour market"; "Enhancing lifelong education for adults" and "Enhancing human capital in order to promote research and innovation".

Within the first set of Priority axes 1, 2 and 3, there were special objectives addressing the need for ICT-based learning, such as: Reforming, modernizing and decentralizing the educational system-reinforcing the mobility of pupils and students; Accelerating the rhythm of integrating ICT in the education process; Reinforcing and improving the quality of teaching staff training in primary and secondary education, with emphasis on innovation and the use of ICT. In addition, several ICT-enhanced educational initiatives are targeted, such as the development of digital educational content, the creation of digital knowledge repositories, and the design and implementation of e-training programmes for teacher trainers and stakeholders in the area of lifelong learning.

However, the economic situation in Greece was not helpful to progress in these areas.

Open Government Plan

For the policy interview it was decided to focus on the 3rd National Action Plan on Open Government 2016-2018. Unlike most of the OGP Action Plans[184] lodged by Member States, many not often with much focus on education at all, this had a clear commitment to open education.

[182] http://www.taexeiola.gr
[183] http://www.edulll.gr/?page_id=32
[184] For access to these, link from http://www.opengovpartnership.org/countries

Policy/initiative overview	
Policy title	**3rd National Action Plan on Open Government 2016-2018**
Policy URL	http://www.opengovpartnership.org/sites/default/files/GREEK_NAP3-OGP-ENG.pdf
Description of the policy	Within the 3rd National Action Plan on Open Government 2016-2018, Commitment 20 is on Open Education. The main planned activities are: • Study for the inventory of available OER • Platform to provide the educational content • Legal assistance for procurement process which will cover open issues • Educational actions for information and sensibilisation on open licenses, OER, in conferences, one-day summit, etc. • Participation in educational conferences • Organisation of conferences or one-day summits focusing on open education.
Policy institution	Ministry of Education, Research and Religious Affairs
Policy date	2016
Policy status	Current (Open Education work will start in May 2017)
Language	English
Policy jurisdiction	National
E&T sectors	School education, Higher education, VET, Adult learning
Dimension of impact	Core dimensions ☑ Access ☑ Content ☐ Pedagogy ☐ Recognition ☐ Collaboration ☐ Research Transversal dimensions ☐ Strategy ☐ Technology ☑ Quality ☐ Leadership

Person interviewed

John Vrettaros, Unit of Digital systems in LLL, Directorate of Digital Governance, Ministry of Education, Research & Religious Affairs

Interview results

Vision on open education in the country, role of the Ministry

The main policy of the Ministry of Education[185] under the current leadership revolves around the idea that open educational data and materials belong to everyone. The Ministry of Education plays the core role in open education in relation with the other ministries. There is a clear political goal in the country related to opening up education.

Policy design and involved stakeholders

I was involved as a policy maker and researcher in the design, implementation and assessment phase of the policy. The implementation of the policy was important for improving education and also the democratisation of education.

The two main projects of open education that were launched by the Ministry were the Open Academic Lessons and the depository Photodentro.[186]

There were numerous Open Academic Lesson initiatives with the purpose of creating open lessons on all academic levels for everyone.

These two projects together cost €25 million. Many more projects are due to be funded for the implementation of the open education policy across all education levels.

Policy dimensions and areas of action

The policy dimensions that are most important are as follows: Open data, Open materials, Open lessons, Open collaborations, Open research, Open Certification, Open source.

Policy implementation and impact to date

The two projects mentioned above[187] have been a great success to the beneficiaries; further improvements can be made to benefit a wider array of people. There were other programmes of lesser importance and scale. In order to make open education a reality, a national strategy across all of open education must be implemented and coordinated.

Key barriers and enablers during implementation

The main barrier was the preparation of the trainers. This challenge can be faced with the proper and continuous training of the trainers across all educational levels.

[185] He is using the short name for the *Ministry of Education, Research and Religious Affairs* – http://www.minedu.gov.gr

[186] http://photodentro.edu.gr states (in translation):

"Photodentro is the National Repository of Learning Content for Primary and Secondary Education. It is the central e-service of the Ministry of Education for unified search and distribution of digital educational content to schools. It is open to everyone: students, teachers, parents and anyone else interested... It promotes the use of open educational resources (OER) for schools, implementing the national strategy for digital educational content. All material is freely available under license Creative Commons CC BY-NC-SA or other similar, more open licenses."

[187] Open Academic Lessons and Photodentro

Relation between the policy and the EU-level developments

The EU initiatives are proving to be a great success and Greece would like to be a part of this whole initiative.

Recommendations for future open education policies

In terms of **recommendations**, the EU should enforce the standards on open education on every Member State

It **should also possibly provide multilingual good practices** for all the Member States.

3.11 Hungary (HU)

Open education in the country

Hungary has a population of just under 10 million. More so than most Member States, it pays close attention to the diaspora (of Hungarian speakers), with a government minister[188] in charge of these activities. In particular there are a number of Hungarian-speaking universities outside Hungary[189] in nearby countries. (This aspect is relevant later in this section.)

Hungary has been intensively studied in respect of OER and open education in the last few years. There is a POERUP country report as recently as 2014 that embedded OER, MOOC and related open education activities in the context of ICT for education. There was a more recent study (2015) by ADOERUP (for the European Parliament)[190]. In the D-TRANSFORM study[191] *Business Models for Opening Up Education* that analysed six Member States, Hungary was one of the countries covered. For some background on distance learning in Hungary see the 2016 IDEAL report[192] *Distance Education in Hungary*.

There was a government Digital Renewal Action Plan 2010-2014,[193] which was said to promote the use of OER in line with the recommendations and goals of the *Europe 2020* Digital Renewal Action Plan strategy. There seems to be now no full text of this plan in English on the web, but it is still available[194] in Hungarian, and another summary report[195] states that this:

> includes four action plans which deal with ensuring equal opportunities for citizens, increasing the competitiveness of enterprises and the improvement of the ICT infrastructure of the country. The Hungarian government hopes that the information communication sector will provide a breakthrough for the country since an increased number of digitally literate citizens will contribute to a higher economic performance for the country.

There is a new Digital Strategy[196] published in 2016. It is available only in Hungarian but the terms "open access", "open education resources", "open courses" and similar one are often emphasised in the text. However the state of play is not well developed, be it in OER, MOOCs or distance learning: there is little OER activity in higher education. In particular no Hungarian university is a member of the Open Education Consortium, there are rather few MOOCs originating from Hungary, though now some from the K-MOOC project[197], and there are just three (accredited) distance learning programmes listed.

In contrast, Open Access is well developed. Since 2007, a government decree has mandated that all funded researchers must deposit their results in an OA repository or publish in an OA journal. This also applies to Doctoral dissertations. The OpenDOAR

[188] http://www.kormany.hu/en/prime-minister-s-office/news/maintaining-the-hungarian-identity-of-the-diaspora-is-of-crucial-importance

[189] http://www.mrk.hu/wp-content/themes/mrk/documents/hungarian_higher_education_2015.pdf p. 3

[190] http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf, pp.101-107

[191] http://www.dtransform.eu/wp-content/uploads/2016/04/O1-A2Business-models-edition-1-final.pdf, pp. 43-45

[192] http://www.studyportals.com/wp-content/uploads/2015/08/ideal_hungary-case-study1.pdf

[193] https://ec.europa.eu/growth/tools-databases/dem/initiatives/2302/digital-renewal-action-plan-2010-2014 contains a summary

[194] http://www.terport.hu/webfm_send/2709

[195] http://ppemi.ens-cachan.fr/data/media/colloque140528/rapports/HUNGARY_2014.pdf

[196] http://www.kormany.hu/download/0/cc/d0000/MDO.pdf

[197] https://kmooc.uni-obuda.hu

portal lists 35 Open Access repositories[198] for Hungary, a high ratio per million population. Open Data is also an active area[199]. The Hungarian government has decided that, from April 2012, public administrations in Hungary should only provide official documents in internationally recognised open standards-based document formats and must be able to accept and process such documents. The Hungarian government also recommends[200] that public administrations and other public organisations switch to free open source office software – otherwise, they will need to give reasons for their continued use of proprietary software.

Extensive desk research and consultation (mainly face to face at several meetings) did not surface any recent policy proposals in the mainstream open education or ICT in education areas. However these conversations did point to interesting initiatives at the institutional level.

Initiatives at BME

The BME operates an open portal, ALFA[201], rather similar to a MOOC, which aims to promote mathematics and physics courses for students. The portal states:

> In our experience, especially with varying levels of previous studies, mathematics and physics prove to be tough hurdles to climb for our new students, irrespective of their individual specializations. It is very important for our university to ease our new students' adjustment... At this site you can solve problems in mathematics and physics to help you prepare for your undergraduate studies. The topics covered are not comprehensive, they rather focus on areas that we consider most important for your studies at our university."

In September 2016, with support from the *Hungarian Academy of Sciences*, BME started a four-year project[202] to provide methodological support to the open curriculum development at BME and a number of partner sites. The site observes:

> Due to the complex nature of the subject, the new kind of electronic materials and contents will be developed and piloted in a vast scope of vocational training, namely in the fields of mechanical engineering, information technology, engineering and economics. The efficiency monitoring and the summary of the research results are to be evaluated in connection with the school subjects of the secondary vocational training.
>
> During the research and development, the creative involvement of the vocational partner institutions and their teachers is a priority in the first phase of the project (2016-2018) in the four assigned and engaged vocational schools. After the first piloted part, in the second phase the preparations for extending the project among a wider circle of specific vocational schools are to be made, ensuring that an innovative methodological network of 10-12 institutions will be formed in which the teacher-student-centred interactive open content development and its effects are to be analysed and evaluated in practice. Based on our findings, recommendations for wider vocational piloting and the consideration of the research results in vocational teacher training will be made.

K-MOOC project

The Minister responsible for the Hungarian Diaspora has in 2015 developed a policy to support them via MOOCs under the K-MOOC[203] project. A Carpathian Basin Online Education Centre has been set up supported by a consortium of universities led by

[198] http://www.opendoar.org/find.php?cID=97&title=Hungary

[199] See for example http://opendata.hu/about

[200] https://joinup.ec.europa.eu/community/osor/news/hungary-increase-use-open-source-software

[201] https://alfa.bme.hu/?lang=en

[202] http://www.ocd.bme.hu/en/main/

[203] https://kmooc.uni-obuda.hu

Óbuda University, a university of advanced technology.[204] Participants come from Hungarian universities, colleges, and trans-border Hungarian-language higher education institutions in nearby countries. The K-MOOC policies include rules for credit transfer. K-MOOC course institutions[205] apart from Óbuda University include the University of Debrecen (the oldest continually operating institution in Hungary), together with Charles Esterhazy University and Kaposvár University (two new universities), and Dennis Gabor College (a private institution).

Report received by

András Benedek, Vice-Rector, Budapest University of Technology and Economics

Interview results

Vision on open education in the country, role of the Ministry

The vision in the country is to establish and support an open learning environment, to organise open courses for students and adults mostly in HE and adult education and to develop Open Educational Resources for those attending open (formal or informal) education. The Ministry forms the strategy (now the National Digital Education Strategy 2016) and takes leadership of the national projects in this field. There is a clear political goal related to opening up education. Although educational practice is rather conservative in Hungary, the target setting in this strategy is clear.

Policy design and involved stakeholders

The educational institutions generally are key to the real reform steps towards open education. However, in recent years especially the universities were very conservative.

Policy implementation and impact to date

With reference to the former policy on infrastructure development projects 2012-2016 (large distribution of smart boards, pupils' tablets, expansion internet access), this had limited success.

Key barriers and enablers during implementation

Key barriers in the infrastructure development projects 2012-2016 were, first, lack of methodological innovation and second, issues of physical sustainability of the equipment. The key enabler is to make concerted efforts to change the attitude of HE leadership, in particular changing the rigid academic thinking, in order to transform the role of their institutions in the new innovation process.

Relation between the policy and the EU-level developments

Hungarian institutions aim to keep in touch with EU developments – for example my institution sent several senior delegates to the EU-funded Digital Leadership School in Barcelona last November where EU experts were present.

Lessons learnt and recommendations for future open education policies.

The key **recommendation** is for the EU to support processes to change the thinking of institutional leaders.

[204] Originally founded in 1879 – http://bgk.uni-obuda.hu/en/faculty/our-history

[205] https://www.uni-obuda.hu/en; http://www.edu.unideb.hu/; https://uni-eszterhazy.hu/en; http://english.ke.hu/; and http://dennis-gabor-college.eu/

3.12 Ireland (IE)

Open education in the country

Ireland has a population of 4,6 million. This makes it similar in population to Denmark (5,7 million), Scotland (5,3 million) and Norway (5,1 million). It is a unitary state.

Although there is no official policy document on open education in Ireland, a number of relevant developments must be mentioned in the field of HE.

The *National Strategy for Higher Education to 2030*, published in 2011, made a large number of recommendations – 26 spread over nine pages[206] – but none mentioned OER or open education specifically. However, in May 2014 the report on *Building Digital Capacity in Irish Higher Education*[207] was published, containing several references to "open education", and a *Call for Proposals* was released[208] later in 2014 which set up the *National Forum for the Enhancement of Teaching and Learning in Higher Education*[209] and invited higher education institutions:

> to make collaborative proposals for funding under the Teaching and Learning Enhancement Fund 2014 (Building Digital Capacity in Irish Higher Education). The fund amounts to €6 million and the total investment is over a 3-year time-frame ending in 2016.

In terms of Open Access, the *National Principles for Open Access Policy Statement*[210] is designed to support the free flow of information across national and international research communities; to support the principle of research-enabled teaching and learning and the generation of Open Educational Resources (OER); to contribute to Open Innovation through richer and more effective knowledge transfer and diffusion; and to support greater transparency, accountability and public awareness of the results of publicly funded research. The OpenDOAR portal[211] lists 22 Open Access repositories for Ireland.

It must be noted that in Ireland policy towards part-time learning is seen by some experts as unhelpful to distance learning and other innovative modes of provision. Part-time and distance learning courses have to charge fees[212] since there is no government support (unless the distance learning course is full-time) – and there are no loans available. In the D-TRANSFORM study[213] *Business Models for Opening Up Education* which analysed six Member States, Ireland was one of the countries covered and this issue was covered in detail.

There are some moves to change the approach to fees, which have not resulted in a policy yet. An expert group produced a magisterial report *Investing in National*

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[206] http://www.hea.ie/sites/default/files/national_strategy_for_higher_education_2030.pdf – see especially pp. 17-25

[207] http://www.teachingandlearning.ie/wp-content/uploads/2015/03/Digital-Roadmap-web.pdf

[208] http://www.teachingandlearning.ie/digital-enhancement-funding/teaching-learning-enhancement-fund-call-proposals/ – the first phase of now three phases

[209] http://www.teachingandlearning.ie

[210] http://openaccess.thehealthwell.info/sites/default/files/documents/NationalPrinciplesonOAPolicyStatement.pdf

[211] http://www.opendoar.org/find.php?cID=103&title=Ireland

[212] http://www.citizensinformation.ie/en/education/third_level_education/fees_and_supports_for_third_level_education/fees.html

[213] http://www.dtransform.eu/wp-content/uploads/2016/04/O1-A2Business-models-edition-1-final.pdf, pp. 43-45

Ambition[214] in March 2016 which exhaustively analysed the policy options, but has inevitably attracted criticism.[215]

Thus the policy which is most relevant to open education is the National Forum for the Enhancement of Teaching and Learning in Higher Education.

Overview of the selected policy	
Policy title	**National Forum for the Enhancement of Teaching and Learning in Higher Education**
Policy URL	http://www.teachingandlearning.ie
Description	The *National Forum for the Enhancement of Teaching and Learning in Higher Education* aims to enhance the teaching and learning for all students in higher education. The Forum will engage in a range of activities aimed at: • Championing all those who contribute to great teaching and learning in higher education • Inspiring great practice • Developing teachers and learners • Identifying and promoting best practice in professional development • Building digital capacity • Promoting key enhancement themes • Enabling innovation in a fast-changing educational environment.
Institution	Higher Education Authority
Policy date	2012
Status	Current
Language	English
Jurisdiction	National
E&T sector	Higher education
Dimension of impact	Core dimensions □ Access ☑ Content ☑ Pedagogy □ Recognition ☑ Collaboration ☑ Research Transversal dimensions ☑ Strategy ☑ Technology ☑ Quality ☑ Leadership

[214] Full title *INVESTING IN NATIONAL AMBITION: A STRATEGY FOR FUNDING HIGHER EDUCATION* – https://www.education.ie/en/Publications/Policy-Reports/Investing-in-National-Ambition-A-Strategy-for-Funding-Higher-Education.pdf

[215] For example, http://www.irishexaminer.com/business/columnists/brian-lucey/student-loans-proposal-will-add-to-personal-debt-413456.html and http://www.independent.ie/irish-news/education/facing-a-higher-degree-of-debt-students-could-graduate-owing-20000-34884772.html

Person interviewed

Terry Maguire, Director, National Forum for the Advancement of Teaching and Learning in Higher Education

Interview results

Vision on open education in the country, role of the Ministry

In the last years, the Irish Higher Education Authority[216] has promoted mainly open access and open data, but also open education is progressively gaining ground in the policy discourse and being considered as a key asset to improve education by building digital capacities among academics. The role of the Authority is to promote innovation and quality assurance in education[217] and to provide funding for HE, including financing the National Forum for the Advancement of Teaching and Learning in Higher Education.

Policy design and involved stakeholders

Starting from the principles contained in the *Innovation 2020* document[218] and in the *National Strategy for Higher Education to 2030*[219], the National Forum for the Enhancement of Teaching and Learning in Higher Education was set up in 2012, aiming to enhance teaching and learning and to promote collaboration among universities, technical schools and colleges, along three main pillars: professional development, digital capacity (including a roadmap, with a strong focus on open access and open education), promotion of equality. The project was launched after a consultation with the HE sector, as HEIs needed support to bring together good practices which were not visible and there was a national perspective in the HE sector to showcase the impact these practices have in HE.

The project aims at being an agent of change to support the adoption of Open Educational practices and building digital capacities amongst academics in Ireland. The vision is to place open education at the same level of importance in HE in which Open Access and Open Data are regarded. The core role of the Ministry was to represent the voice of the educators highlighting the importance of teaching and learning in HEIs aiming at promote an equal status for Open Access, Open Data in research and Open Educational Resources in teaching and learning. The initial funding was €900.000 for operative costs plus €9 million which is distributed across the sector via calls for projects and competitions which includes projects involving students.

Policy dimensions and areas of action

The policy aims to enhance teaching and learning by strengthening collaboration among universities and institutes of technology, along the following four pillars: Professional Development, Digital capacity building, National awards for excellence, and improving the quality of STEM education.

Policy implementation and impact to date

The main objective, which was to launch a national digital platform for HE collaboration, was achieved. Nowadays the Forum is working on building capacity and

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216 http://www.hea.ie

217 Via Quality and Qualifications Ireland, a sub-agency – https://www.qqi.ie

218 https://www.djei.ie/en/Publications/Publication-files/Innovation-2020.pdf

219 http://www.hea.ie/sites/default/files/national_strategy_for_higher_education_2030.pdf

raising awareness in OE amongst the sector. What the policy did, in summary, is the following:

- It sponsored a research on open access for learning content[220]
- Nowadays every HE institution in Ireland has access to its own open repository
- It launched a peer-reviewed process to recognise innovative strategies for T&L through these materials
- Nowadays all HEI have collaborative spaces for open collaboration on any subject
- It works towards identifying problems in the sector by having appointed persons in each institution to act as interlocutors.

An example of a funded project is all-aboard[221] which aims to identify the wide range of skills and knowledge that students, and all those who work in Higher Education, will need to feel confident and creative with when learning, working and exploring the digital world in the next years.

The Forum is actually being evaluated: recommendations will come soon on whether the Forum will become a stable governmental service that is financially sustainable.

Key barriers and enablers during implementation

One of the main difficulties observed is the treatment perceived by academics and the government regarding teaching and learning, which is seen as a second class element in contrast with research in higher education, as academics tend to be assessed and promoted because of the quality of their research instead of their teaching excellence.

The challenge can be faced by giving a voice to the teachers, towards changing the perception of the value of teaching and learning, and by reaching out to educators within their institutions through the organisation of events and capacity building moments.

Relation between the policy and the EU-level developments

The policy is framed within the EU framework towards higher education modernisation, aiming at achieving teaching and learning excellence, and aims at producing good practices for academic development that can be shared internationally at European level.

Lessons learnt and recommendations for future open education policies

It is **suggested** to the EU to promote excellence in teaching and learning, embedding its value in the policies they promote.

Also, the EU should **aim at promoting professional development** in open education, based on consultation with teachers.

It is further **advised** that a policy such as the National Forum for the Enhancement of Teaching and Learning should not be positioned within an institution (Ministry or HEIs), but be independent, as in the case of Ireland.

And finally, policy makers in open education should always remember that if a policy is to be an agent of change, the engaged stakeholders will feel a bit uncomfortable and **must be guided** through the process of embracing the proposed novelties.

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[220] http://www.teachingandlearning.ie/wp-content/uploads/2015/07/Project-1-LearningResourcesandOpenAccess-1607.pdf

[221] http://allaboardhe.org

3.13 Italy (IT)

Open Education in the country

Italy has a population of nearly 60 million. It is subdivided into 20 regions. *Five of these regions have a special autonomous status* that enables them to enact legislation on some of their local matters including language aspects in some cases. For example there is a system of German-speaking schools in South Tyrol[222] and the Free University of Bozen-Bolzano[223] "aims to offer students a multilingual, practice-oriented education that meets the demands of the local and the European labour market. Lectures and seminars are held in German, Italian and English."

Italy has been intensively studied in respect of OER and open education in the last few years by EU projects. There was a POERUP country report[224] in 2013, with a tabular supplement[225] in summer 2014, which embedded OER, MOOC and related open education activities in the context of ICT for education. A narrative update[226] to this material was prepared in 2015 for the Open Education Working Group. In the D-TRANSFORM study[227] *Business Models for Opening Up Education* which analysed six Member States, Italy was one of the countries covered, with information on distance learning and MOOCs – and fees.

In terms of higher education policy, "openness" is not present in the latest Italian HE reform, but some developments must be mentioned. First, the Working Group on Open Access created within CRUI (the Italian Conference of Rectors) a sub-group on OER, which ran an analysis of the use of OER in Italian universities, and a sub-group on MOOCs that produced some guidelines[228]. Second, the Ministry of University and research has recently provided support for the Italian MOOCs platform called EduOpen[229], launched in 2016.

Several OER-related initiatives must be mentioned in the school sector, especially at the regional level. Two examples are the project from the Lombardy administrative region – *Progetto Scuole Lombardia Digitale*[230] – working to develop the ICT skills of school teachers and their use of OER, funded and managed from the Regional School office; and the project *A scuola di Open Coesione*[231]. Another interesting running initiative is the project *Risorse per docenti dai progetti nazionali*[232], a collection of OERs for the lifelong learning and training of teachers, unfortunately limited to languages and literature. It is a sub-action for the professional development of teachers and promoted by the *National Operational Programme* 2007/2013.

In terms of Open Access, a 2013 Law[233] envisages that public institutions responsible for the provision of funding for scientific research shall take the necessary measures to promote open access to research data that is publicly funded in an amount equal to or

[222] In the autonomous region of Trentino-Alto Adige/Südtirol

[223] https://www.unibz.it and https://en.wikipedia.org/wiki/Free_University_of_Bozen-Bolzano

[224] http://poerup.referata.com/wiki/Italy

[225] http://poerup.referata.com/wiki/File:Open_Education_Initiatives_in_Italy.pdf

[226] http://education.okfn.org/open-education-italy/

[227] http://www.dtransform.eu/wp-content/uploads/2016/04/O1-A2Business-models-edition-1-final.pdf, pp. 43-45

[228] https://www.crui.it/images/allegati/pubblicazioni/2015/mooc_2015.pdf

[229] http://eduopen.org

[230] http://www.istruzione.lombardia.gov.it/argomenti/scuola-lombardia-digitale

[231] http://www.ascuoladiopencoesione.it

[232] http://risorsedocentipon.indire.it/home_piattaforma

[233] http://www.gazzettaufficiale.it/eli/id/2013/10/08/13G00158/sg

greater than 50% subject to certain conditions. The OpenDOAR portal[234] lists 110 Open Access repositories for Italy.

Openness is present in the recent national school reform, called La Buona Scuola[235] (Law 107/2015), under the **Piano Nazionale Scuola Digitale** (National Digital School Plan), which has been selected for interview.

Overview of the selected policy	
Policy title	**Piano Nazionale Scuola Digitale** **National Digital School Plan**
Policy URL	http://www.istruzione.it/scuola_digitale/allegati/2016/pnsd_en.pdf
Description	The Italian National Plan for Digital Education (Piano Nazionale Scuola Digitale – PNSD) is a policy launched by the Ministry of Education, University and Research for setting up a comprehensive innovation strategy across Italy's school system and bringing it into the digital age. It is one of the pillars of *La Buona Scuola* school reform (Law 107/2015). It is an organic plan for innovation in Italian schools, with cohesive programmes and actions organized into five main areas: tools, skills, content, staff training and supporting measures. Within the plan, Action 23 deals specifically with the promotion of OER and with the delivery of guidelines for content production.
Institution	Ministry of Education, University and Research
Policy date	2015
Status	Current
Language	Italian (summary in English)
Jurisdiction	National
E&T sector	School education
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy □ Recognition ☑ Collaboration □ Research Transversal dimensions □ Strategy □ Technology □ Quality ☑ Leadership

[234] http://opendoar.org/find.php?p=2&step=20&cID=106&format=summary&sort=r.rName
[235] https://labuonascuola.gov.it/index_en

Person interviewed

Donatella Solda, Executive Director, Cabinet of the Minister, Ministry of Education, University and Research

Interview results

Vision on open education in the country, role of the Ministry

A vision on open education exists within the Italian Ministry of Education, University and Research[236] (MIUR), embedding different understandings and approaches, since MIUR is in charge of education from school to HE. Even if policies and initiatives in different sectors are not fully coherent with each other, mainly due to the fact that they have been launched at different times, contacts exist among different sectors within the Ministry. Open education is understood both in terms of teaching practices and in terms of learning resources: the Piano Nazionale Scuola Digitale is the first policy on ICT in schools that will make this approach practical. Openness is a transversal priority: we cannot speak about digital without speaking about openness, promoting critical citizenship and an active approach towards ICT and online knowledge.

Policy design and involved stakeholders

The policy was designed in such a way to involve as many public and private stakeholders as possible, also as far as funding is foreseen. Apart from current funding from the MIUR for school education, funds from other Ministerial services as well as regional funds from the European Social Fund (for school libraries for instance) have been activated, and synergy is happening with other Ministries (in broadband for schools for example). Partnerships with private sector stakeholders are also happening through the local laboratories[237] – *Laboratori Territoriali* – where a call of €80 million has been launched for coding and digital citizenship courses delivery for primary and secondary schools[238].

Policy dimensions and areas of action

The ministry funds OER production and supports schools that take openness into account (in terms of Open Data or open government for example). Areas of work include Spaces and Instruments (such as stakeholders involvement and Open Data), Competencies and Content (where OER open curriculum and platforms are funded), and Training and Best Practices.

Policy implementation and impact to date

The policy was launched in October 2015. The plan is structured through pillar actions with individual action plans, easily monitorable. All actions have started: some are completed already; others are still in process (such as the Unique Identity of teachers through the SPEED platform). The policy has managed to produce a "new narrative" on ICT for education (for example buying 50 padlets costing €1000 each instead of a LIM costing €50000), and has activated 8300 *animatori digitali* – digital animators[239] – in each school, this being probably the most shocking change that schools had to cope with. In a nutshell, short-term results are there already, but the long-term system results of the policies will not actually be visible for some 10 years.

[236] The MIUR web site is called not miur.it but http://www.istruzione.it
[237] http://www.istruzione.it/scuola_digitale/prog-laboratori-territoriali.shtml
[238] http://www.istruzione.it/scuola_digitale/prog-laboratori-territoriali.shtml
[239] http://www.istruzione.it/scuola_digitale/prog-animatori-digitali.shtml

Key barriers and enablers during implementation

The biggest barrier is the time needed (at least two years) to build teachers competencies to meaningfully work in digital ways, coupled with the need to create effective training paths that can cope with the scale of the training demand, since there are not enough experts in these fields. Another barrier is the slow bureaucratic processes in the Ministry in coping with such a radical policy as mentioned.

The main enablers have been that the policy has allowed teachers to self-organise and valorise innovative approaches, and the role of private sector actors (such as publishers through the Publishers Association[240] or companies such as Google or Intel who have offered investments connected to the policy). Thanks to this, the Plan was able to generate a higher-level demand for schools with respect to previous policy cycles, and stakeholders replied in line with this.

Relation between the policy and the EU-level developments

The policy is in line with the EU priorities on open education, and inspired by the 2013 EC Communication *Opening up Education*[241].

Lessons learnt and recommendations for future open education policies

The approach of living policy making[242] is probably the secret of the success of the policy: engaging and accompanying stakeholders in the implementation phase is actually the core activity of the MIUR staff in charge of the policy; this needs a lot of support time but pays off in terms of impact and perceived relevance of the initiative.

[240] http://www.aie.it/English.aspx

[241] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52013DC0654 – Italy is one of the few countries to mention this

[242] See http://www.slideshare.net/damienlanfrey1/from-open-government-to-living-policy-making-59162036

3.14 Latvia (LV)

Open education in the country

Latvia is the middle (and middle-sized) of the three Baltic States, with a population of just under 2 million. (Estonia is 1,3 million and Lithuania 2,9 million.)

Latvia has been only minimally studied in respect of OER and open education in the last few years by EU projects. However, there was a 6-page study (2015) by ADOERUP (for the European Parliament)[243].

There appears to be no current policy related to open education in Latvia. The Open Government Plan for Latvia 2014-16 makes no commitments with respect to education either. Until recently, there was an active Lifelong Learning Policy 2007-13[244]. However, although the development of open resources was *implied* in that document, the terms "e-learning", "virtual", "OER", "distance", "open" etc. were not *used* in the document in relevant ways. The policy documentation related to adult and lifelong education does not identify any specific targeted tasks and actions planned to introduce measures (or directly support introduction of) opening up education.

In contrast with the centralised activity originating from the Estonian e-University and a thriving Distance Education Network in Lithuania, in Latvia in 2000 a plan for creating *The Virtual University of Latvia* was supported by the Ministry of Economics, however not by the Ministry of Education and Science, and was never activated.

Despite this, there are distance-teaching activities in Latvia from some universities, and also several virtual schools. These are mainly the results of the Phare Multi-country Programme for Distance Education (1994-1999) which aimed at introducing distance education in 11 Central and Eastern European countries. For Latvia[245] this established three distance education centres at the universities in Latvia, trained over 100 academic staff members, developed several distance education courses and started the introduction of virtual learning platforms at the universities. This has had long-term beneficial consequences.

In 2012 the e-learning platform ORTUS of the Riga Technical University was evaluated by EADTU experts and received the E-xcellence Quality Label[246].

An example of a cross border project is the Latvian-Lithuanian project[247] *eBig3* run by the Distance Education Centre at the Riga Technical University, which combines three aspects of technology enhanced learning in complementary ways (eLearning, TV based learning and mobile learning) to produce an effective and innovative cross-media learning delivery system that goes beyond traditional web-based learning approaches. The project received the BOLDIC Award for 2013 and the annual BOLDIC conference for 2014 was organised in Riga with the theme of open resources online.

For Open Access the OpenDOAR portal records[248] only 3 repositories (for a population of 2 million with over 20 higher education institutions).

[243] http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf, pp.114-119

[244] http://asemlllhub.org/fileadmin/www.dpu.dk/asemeducationandresearchhubforlifelonglearning/nationalllls trategies/resources_3348.pdf

[245] http://files.eric.ed.gov/fulltext/ED438452.pdf – pp. 21-23 on Latvia

[246] http://e-xcellencelabel.eadtu.eu/e-xcellence/qualified-institutions

[247] https://ortus.rtu.lv/science/en/publications/19768-eLearning+Approach+eBig3%3A+Development,+Delivery+and+Evaluation

[248] http://www.opendoar.org/find.php?cID=119&title=Latvia

Person interviewed

Ilmārs Slaidiņš, Professor and OER expert, Riga Technical University

Interview results

Vision on open education in the country, role of the Ministry

It was reported that the understanding of open education amongst the experts at Government level is rather scarce, and that when open education projects are developed these are mainly initiated by teachers and their institutions, and supported by international (including EU) or public grants, since funds from the Government are limited even when available. Also, it is important to consider that the use of open licenses such as Creative Commons is not yet recognised by the Latvian legislation.[249]

State of the art of open education

The country does not have a particular policy in this field, as there seems to be a narrow understanding of open education in the Government, and because there are other key issues to address in relation to improving education in the country, such as the demands of teachers for better salaries. However, there are organisations in the country that are promoting the use and adoption of digital technologies in education like the Latvian ICT association LIKTA[250], which organises events to connect schools and teachers and supports educational portals such as MyKoob[251]. This contains educational resources developed within the state supported project LIIS (Latvian Education Informatisation System)[252]. This project started in 1997 with an aim to introduce IT in schools and ended in 2003: in that period it developed learning resources for schools, trained teachers and introduced the ECDL standard (650 teachers tested).

Further, some universities are engaged in promoting the development and exchange of teaching resources in portals such as Skolotajs[253]. This portal is created and supported by the public foundation *Elektronisko mācību līdzekļu kvalitātes asociācija* (e-MLKA)[254]. This Association comprises people from IT-related companies, universities and schools.

Latvia is indeed quite active in promoting Open Access to research papers and data, also through the participation in projects such as OpenAIRE[255] and FOSTER[256]. There is good cooperation among universities (University of Latvia and Riga Technical University) in organising the implementation of Open Access initiatives and several Open Access events and supporting the development of the *Latvian Open Access Research portal*[257].

Key barriers and enablers during implementation

The three main barriers to the development of open education in the country are the lack of strategic support for the development and promotion of open education, the

249 See the minimal entry for Creative Commons Latvia – the site openfm.lv does not now exist

250 https://www.likta.lv/en/about_us/Pages/about_us.aspx

251 https://www.mykoob.lv

252 Summarised in English, French and German at https://www.researchgate.net/publication/233595415_Latvian_Education_Informatization_System_LIIS

253 http://skolotajs.lv/Lapas/Sakums.aspx

254 http://www.emlka.lv

255 https://www.openaire.eu

256 https://www.fosteropenscience.eu

257 http://www.napd.lu.lv

lack of recognition of Creative Commons licenses and finally the absence of dedicated financial support in the area of OER and open education.

Lessons learnt and recommendations for future open education policies

In terms of **recommendations**, support, both financially and at a promotional level, would be needed to ensure that the Government and policy makers are aware of open education.

Second, it is **recommended** that the EU provides funds to initiate and open the discussions and promote exploratory projects in countries where open education is not yet been considered and provide action plans, not just recommendations and policies, but guidelines and exchange of expertise with clear goals and targets.

3.15 Lithuania (LT)

Open education in the country

Lithuania is the southernmost (and largest in population) of the three Baltic States, with a population of 2,9 million. (Estonia is 1,3 million and Latvia 2 million.)

The comprehensive report[258] on *Open Educational Resources in Lithuania* was written for UNESCO Institute for Information Technologies in Education (IITE), but in 2011, so is now quite old. However, the author of that report provided an update[259] in 2015 for the Open Education Working Group, in the context of open education.

The OpenDOAR portal lists 11 Open Access repositories for Lithuania,[260] a high ratio per million population.

Distance learning is quite well known and there is an active national distance learning association LieDM.[261] Despite this the standard *Education and Training Monitor* 2015 report[262] for Lithuania makes no mention of OER, open or distance in relevant contexts.

More usefully the *Monitor* reports on higher education reform (p. 6):

> In a 2014 study[263] (MOSTA[264] 2014), the Lithuanian Government and stakeholders identified the main challenges on the quality of higher education and the relevance of tertiary students' skills to the labour market. In response, in January 2015 the government presented a proposal to amend the law on higher education and research (Lithuanian Government 2015). The proposal includes the following main measures:
>
> i) performance contracts will be brought in between higher education institutions and the State governing the activities of higher education institutions and student admission requirements for a three-year period;
>
> ii) state-financed student places will be planned for each field of study, based on the skills needs identified by the government;
>
> iii) centrally determined minimum admission requirements will be set. These will apply both to public (both state-financed and self-financed higher education places) and to private institutions (until now universities could set their own admission requirements);
>
> iv) the total duration of bachelor's and master's programmes can be reduced by one year;
>
> v) career guidance will become obligatory for institutions;
>
> vi) higher education institutions will be managed by a Senate composed of external members.

There is nothing to criticise in these reforms and they are in line with developments in some other Member States; yet there is no explicit mention of ICT, even though

[258] http://unesdoc.unesco.org/images/0021/002144/214493e.pdf

[259] http://education.okfn.org/open-education-lithuania/

[260] http://www.opendoar.org/find.php?cID=125&title=Lithuania

[261] http://vma.liedm.lt

[262] http://ec.europa.eu/dgs/education_culture/repository/education/tools/docs/2015/monitor2015-lithuania_en.pdf

[263] *Studijų kokybė Lietuvoje: suinteresuotų šalių požiūris* (Quality of Studies in Lithuania: Stakeholders Opinion), http://www.mosta.lt/images/leidiniai/Studiju_kokybe_suinteresuotuju_saliu_poziuris._Santrauka.pdf

[264] MOSTA (http://www.mosta.lt/en/) is an interesting agency – see their reports in English at http://www.mosta.lt/en/reports-and-publications, especially http://www.mosta.lt/images/leidiniai/Effectiveness_of_higher_education_Policy_brief.pdf

target (iv) might be facilitated by a blended learning approach. However, the reforms go on to observe that:

> In response to increased interest among students for professionally oriented programmes, pathways will be opened up from these programmes towards traditional master's programmes. Lithuania also plans to make higher education programmes more relevant to the labour market by promoting cooperation on study content development with social partners and by helping employers to offer more work-based learning opportunities to students in tertiary education.

These aims traditionally are facilitated by ICT deployment.

There are also plans to modernise vocational education and training and to promote adult learning, but again with no strong ICT aspect.

In the end it was decided to choose a more ICT-specific action plan, the so-called Activity Plan for ICT Implementation in General and Vocational Education for 2014–2016, which has the merit of not only extensively mentioning ICT but also open content and MOOCs.

Policy/initiative overview	
Policy title	**Activity Plan for ICT Implementation in General and Vocational Education for 2014–2016**
Policy URL	https://www.e-tar.lt/portal/lt/legalAct/e5ee5450e0de11e388bee944977d73d2
Description of the policy	In Lithuania the majority (68%) of teachers learned to apply ICT during the lessons, the large part (40%) of teachers' work places are computerised, teachers and student can use educational portal *ESchool*, a majority of schools (80%) use e-diaries. Over 60% of grade 8 students use their own computers and mobile phones for learning. Lithuania's Internet network is sufficiently developed, and computerisation of the economy is growing. But there is still low teachers' motivation to use ICT and only a minority of schools (32%) use virtual information systems for learning. The IT curriculum does not reflect the needs of modern world, and the preparation of IT professionals does not match market demand. Thus in 2014 the Ministry approved *ICT implementation in general and vocational education activities plan for 2014 – 2016*, which seeks that after few years: • Teachers actively participate in virtual forums, exchange experience, and participate in distance learning (e.g. MOOC) • Students can learn in virtual environments, to self-assess their learning outcomes. Assessment information is available to teachers and principals to make decisions • Open content and other resources are accessible by schools' safe wireless networks. Students can use their own mobile devices for learning both at school and at home (BYOD) • Updated IT subject curriculum is attractive to students, and it is offered both in formal and informal way. Students are acquainted with IT possibilities already at lower stage.

Policy/initiative overview	
	Future activities in the Activity Plan are related to open digital content creation, development of already created content and adaptation to students with special needs; and development of methodological material and teacher training.
Policy institution	Ministry of Education
Policy date	2014
Policy status	Current
Language	Lithuanian
Policy jurisdiction	National
E&T sectors	School education, VET
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy ☑ Recognition □ Collaboration □ Research Transversal dimensions □ Strategy ☑ Technology ☑ Quality □ Leadership

Persons interviewed

- Giedrius Vaidelis, Director of Education Development Centre
- Vaino Brazdeikis, Director of Centre of Information Technologies in Education under the Ministry of Education and Science

Interview results

Vision on open education in the country, role of the Ministry

At governmental level, open education is quite well understood: mostly the concept of Open Educational Resources; however, this understanding seems to decrease at school level.

The role of the Ministry is to support the implementation of ICT for teaching and learning, by providing network and equipment, but also to develop digital skills in the teaching body. Thus by promoting a better digital infrastructure they can promote innovation in teaching and learning. To develop new skills for educators, training is needed, therefore the use of OER to support and motivate the teachers is key – this is widely understood by the Ministry.

Policy design and involved stakeholders

The policy design aims at reducing social exclusion and problems by improving education and by developing new skills in teachers and students, aspiring also to develop citizenship skills. The main stakeholders are the Ministry and its agencies, but also the schools and the municipalities, as schools depend also from these last ones.

Policy dimensions and areas of action

The main dimensions are the implementation and/or improvement of ICT in schools, including the provision of Internet/Wi-Fi, computers, interactive boards and other devices that can be used for teaching and learning.

Another dimension is the provision of digital content for teacher training and for sharing of teaching and learning resources, and also, the development of a centralised assessment system.

Policy implementation and impact to date

So far, there have been a large number of schools equipped with digital technologies and a considerable number of teachers had been trained. There are also an important number of resources that have been developed to train teachers.

Key barriers and enablers during implementation

Some of the barriers encountered during the implementation are related to the lack of motivation from some municipalities in supporting the implementation of new technologies and/or in training the teachers.

Another barrier encountered is the age of the teachers in the country: as in average, these are much older than in other European countries, and also, only a minority understand English, therefore, in some cases learning new things in English is difficult for them. Also, there is reluctance from some school principals in adopting new technologies and innovative teaching methods, as they prefer some rather traditional approaches.

Some of the enablers can be understood as the provision of training for school principals, leading them to understand the changing of paradigm in the educational processes, to support them into gradually overcoming the initial reluctance of the teachers; also, the showcasing of some data portraying progress in learning by using technologies has been a source of motivation for some educators and principals, as they can see results, thus leading them to support and promote training for teachers towards enhancing the educational results at school level.

Relation between the policy and the EU-level developments

The relationship between this policy and EU-level developments is related to the aim of widening participation in education and the reduction of social inequality towards developing a better and more skilled citizenship.

Lessons learnt and recommendations for future open education policies

One of the lessons learnt is the importance of considering and involving school principals, as they can be both an obstacle and an enabler in the implementation of policies and agendas.

For future OE policies, it is **recommended** that the EU could provide a library of Open Source Software, that could be translated for sharing and creating content or for innovation, as for countries with less-used languages (Lithuanian is spoken by less than 3 million people) it is expensive to purchase software because its translation is costly or there is no translation available.

Also **the EU should facilitate teachers' mobility**, offer more Erasmus+ projects to enhance teachers' capabilities, and provide a platform for the sharing of good practices that can facilitate and motivate teachers' training.

3.16 Luxembourg (LU)

Open education in the country

Luxembourg is a small country (population just over 0,5 million) with just one higher education provider, the University of Luxembourg[265]. (The Luxembourg Institute of Science and Technology[266] (LIST) is not a university but a research institute with no teaching function.) This implies that national HE policy is equivalent to the strategy of the University. In confirmation of this view, the Ministry of Higher Education and Research web site[267] is very minimal in both its English version and its French version (in contrast, Malta, though smaller in population, has two public tertiary institutions and a number of private providers.)

The University web site has a minimal page on the Library, no description of IT services, nothing about distance education and only a minimal page about lifelong learning. The phrase "open educational resources" is not used within the web site even though many programmes are taught in English[268]Deliverable D.3 draft v2.docx.

The OpenDOAR portal lists[269] 4 Open Access repositories for Luxembourg. This apparently paradoxically high result is explained by the fact that Luxembourg hosts a number of research centres and foundations in addition to the one University.

In the schools sector, Luxembourg is a trilingual country with – as reported by OECD and EU[270] – a number of challenges:

> Students with an immigrant background generally achieve significantly worse results than non-immigrant students. Similarly, the percentage of early school leavers is relatively high among students with an immigrant background. Performance in basic skills, furthermore, remains somewhat below the average in reading, mathematics and science.

School reform is said by outside observers to be "key for further improvement".

As summarised in the two reports cited, none of the suggested reforms mention standard keywords such as "OER", "open", "distance", "flexible", "lifelong" etc. in any way suggesting use of open education or technology-based approaches. However, it is known that the Ministry has an agreement with the Canadian company Vretta[271] to use the ICT-based system MatemaTIC[272] across all Luxembourg schools.

MathemaTIC

The Ministry of National Education, Children and Youth[273] of the Grand Duchy of Luxembourg has signed an agreement with Vretta for the development of the personalized e-learning platform, MathemaTIC, for students in Grades 3 & 4 (Cycle 3) and Grades 7 & 8.

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265 http://wwwen.uni.lu
266 https://www.list.lu
267 http://www.mesr.public.lu/enssup/index.html
268 http://wwwen.uni.lu/international/courses_taught_in_english
269 http://www.opendoar.org/find.php?cID=126&title=Luxembourg
270 https://www.oecd.org/luxembourg/Education-Policy-Outlook-Country-Profile-Luxembourg.pdf; and http://ec.europa.eu/dgs/education_culture/repository/education/library/publications/monitor15_en.pdf p.14
271 https://www.vretta.com
272 http://www.prweb.com/releases/2016/11/prweb13850110.htm
273 http://www.men.public.lu/fr/index.html – no English site

This is in support of the Digital Lëtzebuerg[274] strategy announced in October 2014 (see below).

The collaboration also includes partners from the French Ministry of Education (department DEPP)[275], the University of Luxembourg, the Luxembourg Centre for Educational Testing[276] (LUCET, part of the University), the Luxembourg Institute of Social-Economic Research[277] (LISER), and Le Centre de gestion informatique de l'éducation[278] (CGIE).

During the 2015-2016 school year, MathemaTIC for Grades 5 & 6 (Cycle 4) was piloted in 41 schools in Luxembourg. The MathemaTIC team developed interactive learning and assessment modules aligned to the mathematical competencies outlined in the national curriculum document for Cycle 4, covering levels 8-10.

Digital Lëtzebuerg

This was launched in October 2014; its aim[279] is to "strengthen and consolidate in the long term the country's position in the ICT field".

Six specific actions were originally set up: the development of telecom infrastructures; support for innovation and access to financing for start-ups; innovation in services to the financial sector ('FinTech'); e-skills; e-administration; the promotion of the Grand Duchy's assets in other countries. Thus strand 4 directly relates to education and training and strand 1 indirectly (via better internet access for schools etc.).

[274] http://www.luxembourg.public.lu/en/investir/secteurs-cles/economie-numerique/digital-letzebuerg/index.html

[275] http://www.education.gouv.fr/cid1180/direction-de-l-evaluation-de-la-prospective-et-de-la-performance.html

[276] http://wwwen.uni.lu/recherche/flshase/luxembourg_centre_for_educational_testing_lucet

[277] https://www.liser.lu

[278] http://portal.education.lu/cgie/

[279] http://www.luxembourg.public.lu/en/investir/secteurs-cles/economie-numerique/digital-letzebuerg/index.html

3.17 Netherlands (NL)

Open education in the country

Netherlands (population of nearly 17 million) is a unitary state. It has an element of common work, for example via NVAO in quality procedures, with the Flanders region of Belgium (Flemish being very similar to Dutch).

Netherlands has been studied in respect of OER and open education in the last few years by EU-funded and other projects. In terms of public reports, there was a substantial POERUP country report,[280] augmented by a policy options supplement,[281] in 2014. There was only a brief study in 2015 by ADOERUP (for the European Parliament)[282].

The HE policy for the Netherlands makes no specific mention of e-learning but appears to contain no inhibitors to this. The national quality agency NVAO[283] is one of the few in Europe (along with UK and Ireland) that is aware of e-learning and takes some account of it in its deliberations. Its *Self-Assessment Report*[284] for the 2017 ENQA Review makes some specific mentions:

> Students demand more flexibility in the organisation of education, especially in life-long learning. NVAO can use its expertise to assist maintaining standards of quality in these developments. It has published papers on quality assurance in online education and MOOCS[285]. (p. 24)
>
> *3. Input in discussions on quality assurance and accreditation in the Bologna process*
> NVAO contributed to the development of the ESG, to discussions and meetings on learning outcomes, qualifications frameworks, joint programmes, quality culture, and MOOCs. (p. 41)
>
> Each year NVAO organises in cooperation with ECA a topical international seminar with participation of Dutch and Flemish HEIs, on themes related to the Bologna agenda (e.g. mutual recognition of qualifications; online learning; employability; joint programmes). (p. 41)
>
> ESG 1.6: In the case of assessments of long-distance education, a specialist with expertise in online education is mandatory in the expert panel. (p. 56)

However, "open education" (as such or similar phrases) is not mentioned.

In 2009 the Ministry of Education, Culture & Science initiated a programme to mainstream OER in all educational sectors through creating the Wikiwijs portal[286] for finding, sharing and reworking OER. Government support for this comprehensive programme was withdrawn at the end of 2013 and Wikwijs was refocused. Current government focus is on MOOCs, but progress seems slow. MOOC activity is quite widespread, with Coursera having 4 members, FutureLearn 3, iversity 1 and the Open Education Consortium 4.

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[280] http://poerup.referata.com/wiki/Netherlands

[281] http://poerup.referata.com/wiki/File:POERUP_D4.3.3_Options_brief_pack_Netherlands.pdf

[282] http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf, pp.129-130

[283] https://www.nvao.com/system/files/pdf/ENQA%20Review%202017%20NVAO%20Self-Assessment%20Report_0.pdf

[284] https://www.nvao.com/system/files/pdf/ENQA%20Review%202017%20NVAO%20Self-Assessment%20Report_0.pdf – dated October 2016

[285] See for example *MOOCs and online HE: A survey* – http://ecahe.eu/assets/uploads/2014/08/NVAO_MOOCs_and_online_HE_A_survey_June_2014.pdf (notice it is not now on the NVAO site)

[286] https://www.wikiwijsleermiddelenplein.nl/startpagina/vmo

A 2012 SURF report[287] noted (p. 4) that:

> A small, active group of universities of applied sciences can be distinguished that are interested in OER, that are developing initiatives, and that have plans for taking matters further, but most of the respondents at these institutions say that in the present period of budget cuts and discussions of quality they do not have the scope for developing a vision or policy regarding OER.

Despite this, SURF[288] publishes an insightful annual report on open and online education making the best of the largely grassroots activity.

The OpenDOAR portal reports[289] that there are 34 Open Access repositories in the Netherlands.

In 2015 the Dutch Ministry of Education, Culture and Science formulated an ambitious programme for open and online education in the Netherlands in its Strategic Agenda HO2025, *de waarde(n) van weten* (Higher Education 2025, the value of knowing), with the ambition (pp. 29-30) that:

> all teaching staff at Dutch institutes of higher education make their educational resources openly available, i.e. open access higher education, and that, as a result, the Netherlands plays a pioneering role in the world.

In spring 2016, a Task Force of the Ministry investigated what measures should be taken to realize the ambitions of the policy. After interviewing many stakeholders, they came up with three categories of hurdles that hinder widespread adoption of OER and other forms of open online education (although the latter was narrowed down to MOOCs): culture, infrastructure and professionalization. Currently, they are in the process of finalizing a four years programme (2017-2020) to take action in their ambition for widespread adoption.

Overview of the selected policy	
Policy title	**HO2025, de waarde(n) van weten** **Higher Education 2025, The value of knowing**
Policy URL	https://www.government.nl/documents/reports/2015/07/01/the-value-of-knowledge
Description	The policy presents a number of objectives for 2025 to modernise HE, and the actions that the Netherlands intends to put in place to achieve this. This strategic agenda therefore considers ways in which to increase quality in a manner that is tangible for both students and university staff, and Openness is at the core of the strategy. The ambition for 2025 of the plan is that all teaching staff at Dutch institutes of higher education make their educational resources openly available, i.e. open access higher education, and that, as a result, the Netherlands plays a pioneering role in the world. Further, the plans attaches importance to the Dutch institutes' recognition of each other's MOOCs and Open Educational Resource.
Institution	Ministry of Education, Culture and Science
Policy date	2015
Status	Current

[287] https://www.surf.nl/binaries/content/assets/surf/en/2012/article+OER+in+the+Dutch+Educational+Landscape.pdf

[288] https://www.surf.nl

[289] http://www.opendoar.org/find.php?cID=151&title=Netherlands

Overview of the selected policy	
Language	English
Jurisdiction	National
E&T sector	Higher education
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy ☑ Recognition ☑ Collaboration ☑ Research Transversal dimensions ☑ Strategy ☐ Technology ☑ Quality ☑ Leadership

Person interviewed

Ruud Nauts, Policy responsible, Ministry of Education, Culture and Science,

Interview results

Vision on open education in the country, role of the Ministry

Our Ministry[290] sees open education as an important asset, putting it at the same level as Open Access in the higher education context. Open education is perceived as an element that can foster quality and reduce cost of education, therefore widening participation in higher education, ultimately supporting the development of an open culture in teaching and learning.

Policy design and involved stakeholders

The policy was launched because the Dutch Government believes that open education is a strategy able to enhance and widen-up education, promoting the sharing of teaching resources and practices. The main stakeholders involved in the policy preparation were the Ministry of Education itself, the Dutch Universities and the Universities of Applied Sciences as well as SURF, the agency that supports open education in The Netherlands. SURF is particularly important since among other things it helps the Government to allocate the ministerial funds into projects and initiatives by selecting them by open competitions, which cover a wide range of activities, from MOOCs to OER repositories.

Policy dimensions and areas of action

The core dimensions of the policy can be understood as enabling the sharing of educational content, with the aim that by 2025 resources will be openly shared across all schools and HEIs. To reach this aim, the policy is supporting initiatives from Dutch higher education Institutions in coalition at national and international level. Also, the Ministry aims at including students and teachers in the discussions towards shifting the teaching and learning culture towards openness and supporting the development

[290] https://www.government.nl/ministries/ministry-of-education-culture-and-science

of an open culture, providing technical support to staff and students to share and find OERs via institutional infrastructures.

Policy implementation and impact to date

The initial objectives have been achieved to a great extent, as higher education Institutions are thinking at strategic level what open education means to them moving from the old approach of technical developments towards a strategic one. An interesting example is the project developed by TU Delft in the form of a coalition with European Universities to develop MOOCs which can be taken by students from the universities and upon completion of the course the students are given credits in the same way they are credited for face to face courses. Another relevant project is the coalition among Dutch technical universities[291] led by TU Delft which promotes the sharing of OER, as they support the idea that open education is embedded in Open Science, therefore promoting the scientific and technical development of the country.

Key barriers and enablers during implementation

The main barriers encountered can be understood as issues related with the aim of changing the teaching and learning culture towards an open culture. First, the resistance of educators to change their practices and get training to innovate in the classroom, and second the fact that, despite the efforts of financing projects in open education, institutional support and recognition for educators to implement these projects was lower than expected. In relation with the enablers, these can be understood from different perspectives. First, it has been important to ensure the political promotion of the open education agenda within the country, through endorsement of the Minister and other politicians in their public appearances. Also, it is key to promote and support open education by financing initiatives at higher education and school level, and finally it is crucial to address new and innovative approaches to open education.

Relation between the policy and the EU-level developments

The frame of this policy is in line with the European principles for promoting the development of an open education culture across Member States. Because of its success, this policy can be a model that can be adapted for the development of further policies and agendas on open education by other European countries.

Lessons learnt and recommendations for future open education policies

The success of the policy is connected to the extensive support provided to educators to embrace a change of culture and practice, but this support to cultural change needs to be made via actions that are endorsing and acknowledging good practices, allocating funding for projects and consistently providing training for educators and avoiding forcing this cultural change via mandates.

A **first recommendation** for further developments of open education in Europe is related to the creation of a space where policy makers can share good practices across countries and institutions.

A **further recommendation**, connected to the fact that a high number of MOOCs have been produced by European HEIs as part of their open education remit, is that after ensuring the quality of these online courses, students can take them as part of their elective modules gaining credits upon completion of these courses as if these were part of a sort of e-Erasmus, ensuring that these courses live up to their full potential.

[291] http://www.open.tudelft.nl/en/education

3.18 Poland (PL)

Open education in the country

Poland is a unitary state with a population of nearly 39 million.

Poland, like Germany, Netherlands and the UK (as well as France and Spain) underwent intensive analysis by POERUP. There is a country report[292] and an interesting policy options paper[293] written by two Polish experts commissioned by the well-known NGO *Centrum Cyfrowe Projekt*[294].

In terms of Open Access, the OpenDOAR portal records[295] 87 Open Access repositories in Poland.

Digital School Programme

Probably the OER-related project in Poland best known outside Poland is the *Digital School Programme*, announced[296] in April 2012. This is the largest government-sponsored open education programme in Polish history, and has created a full set of educational materials for grades 4-6 licensed under CC-BY licence.

The Digital School programme with the *Digital Textbooks* component was initially drafted and proposed to the Prime Minister Office by the Modern Poland Foundation, the Centre for Civic Education, and Creative Commons Poland (with the cooperation of the Prime Minister's Office). All those organisations are members of the Coalition for Open Education[297] (KOED), a network of NGOs and educational institutions promoting Open Education in Poland.

One of the most ambitious features was the creation of a national repository of training materials. Teachers in all of the test schools will have access to this nationwide database.

The first draft was accepted by the Ministry of Education, but at a later stage of the negotiations, the free licensing requirement was left out. Both the Coalition for Open Education and the Modern Poland Foundation took part in the public consultation process; their comments in support of free licensing were agreed and accepted. As a result of the adopted regulation, schools will be computerized and all educational materials for grades 4-6 will have a Creative Commons license (CC-BY-3.0) to allow for easy sharing and attribution. By accepting the regulation and now also accepting the materials, Polish schools will soon be fully adopting the open education model. The textbooks are to be available under the Creative Commons Attribution license, in an open format (with the full specification being freely available both technically and legally), and for Web access as required by the W3C Web Content Accessibility Guidelines. So far, it appears that the only non-accessible material may be some of the images, which contain embedded text and thus may be inaccessible to blind students.

With the change in government in 2015, it has become less clear how this project would progress; consequently it was decided not to use this policy for the interview.

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[292] http://poerup.referata.com/wiki/Poland

[293] http://poerup.referata.com/w/images/POERUP_D4.3._4_Country_Option_Pack_Poland_v1.0.pdf

[294] http://centrumcyfrowe.pl/english/

[295] http://opendoar.nottingham.ac.uk/find.php?p=1&step=20&cID=172&format=summary

[296] http://creativecommons.pl/2012/04/digital-school-program-with-open-textbooks-approved-by-polish-government/

[297] http://koed.org.pl/en/

Digital Poland

Consideration was given to the Operational Programme Digital Poland for 2014-2020[298] but apart from the obvious benefit of improving broadband access to schools and other educational institutions, it did not propose significant interventions in or changes to any educational sector.

OP KED – Operational Program for Knowledge Education Development

Consequently it was decided to use the new regional fund policy OP KED – Operational Program Knowledge Education Development – as the basis for the interview.

Policy/initiative overview	
Policy title	**OP KED – Operational Program for Knowledge Education Development**
Policy URL	https://www.power.gov.pl/media/10256/OPKED_zatwierdzony_przez_KE_en_calosc.docx
Description of the policy	The Polish Ministry of Development introduced in 2014 a broad open licensing requirement for all educational resources funded from the European Structural Fund[299] with about €10 billion to be spent in Poland until 2020. This will be achieved through a large regional fund policy called Operational Program Knowledge Education Development (OP KED), and through 16 regional operational programmes, which all have a strong educational focus.
Policy institution	Ministry of Development
Policy date	2014
Policy status	Current
Language	Polish
Policy jurisdiction	National
E&T sectors	School education, Higher education, VET, Adult learning
Dimension of impact	Core dimensions ☐ Access ☑ Content ☐ Pedagogy ☐ Recognition ☐ Collaboration ☐ Research Transversal dimensions ☐ Strategy ☐ Technology ☐ Quality ☐ Leadership

[298] https://www.polskacyfrowa.gov.pl/media/10410/POPC_eng_1632015.pdf
[299] http://ec.europa.eu/regional_policy/en/funding/

Report received by

Beata Pojawa, Department of European Structural fund at the Ministry of Development,

Interview results

The report received was quite long but we have reproduced it in full as it is a good demonstration of how open education and related topics fit into a real-world ESF programme intervention in a large Member State. *Textual material in italics flags the topics of most relevance*.

Vision on open education in the country, role of the Ministry

Open education is an important part of educational policy. It aims to increase the access to the learning offered through formal and informal educational system for all the recipients of the educational offer. The term "open" refers to the content of education and the educational process – understood as methods and tools for learning. To us, "open" means accessible, flexible, developed in collaboration with the school environment, responding to the expectations of the labour market and local society, and tailored to new technologies. Implementation of the idea of openness in education is a guarantee of universal access to information, knowledge and experience exchange. However, in Poland it is still very strongly identified with Open Educational Resources.

The Ministry of Economic Development[300] is responsible for managing the implementation of European Funds[301] in Poland, including European Social Fund. The Minister is obliged to coordinate the national programme financed by the European Social Fund – OP KED (Operational Programme Knowledge Education Development).

Policy dimensions and areas of action

As mentioned before, OP KED provides support aimed at supporting reforms in the area of employment, social inclusion, education, health and good governance. These activities are concentrated on the improvement of efficiency in selected areas of public policies. Actions provided in the Programme are only a small sample of existing policies.

The Minister of Economic Development is also the coordinator of ESF implementation in 16 Regional Operational Programmes. ROPs provide support for students, schools and teachers.

Open education in the OP KED is implemented on several levels:

- ensuring *open educational resources* by preparing e-textbooks and developing didactic e-materials accompanying the existing e-textbooks
- creating sets of *education tools* for each educational stage, as well as *revision of learning content* in terms of students' key competences necessary to operate on the labour market
- reviewing and updating of core curricula and other content of VET *(in cooperation with social partners)*, in order to take into account employers' expectations regarding knowledge, skills and competences
- strengthening *cooperation of schools with entrepreneurs, universities and social partners* in order to mobilise business-education partnerships
- inclusion of qualifications into an *integrated qualifications system*

[300] https://www.mr.gov.pl/en/

[301] https://www.mr.gov.pl/en/site/what-we-do/european-funds/

- increasing the *competences of persons participating in higher education* to match the needs of the economy, labour market and the society
- transnational mobility programmes pursuant to the rules specified for the *Erasmus+* programme

Innovative methods and tools

First and foremost, OP KED intervention is concentrated on increasing the use of *innovative methods and tools* supporting the teaching process concentrated on developing students' key competences. Despite the changes in the Polish education system in the recent years, which had a positive impact on improving the quality of work of schools (proved[302] by the results of the PISA study), the remaining challenge is its further improvement towards an even more inclusive and practical approach to science. The needs are related to increasing the use of modern educational content, tools and resources *(e.g. the introduction of e-textbooks and accompanying e-resources)*, strengthening the innovative approach to teaching, and involving the creation of a new core curriculum aimed at teaching competences such as communication, languages, innovation, entrepreneurship and analytical skills as well as social competences (cooperation, problem solving). The competences developed in the process of formal education are not sufficient to effectively perform work. Apart from practical skills, employers expect graduates to have competences needed to actively participate in the labour market. In Polish schools, especially in vocational schools key competences are nowadays poorly developed.

Therefore, ESF supports schools in the process of developing key competences of their students. In the 2014-2020 period ESF intervention is focused on 4 key areas:

1. *the use of modern information and communication technologies;*
2. modern teaching (the use of experimental methods in education, including equipping classrooms for teaching mathematics and sciences and to prepare teachers to teach experimental);
3. training of key competences and skills needed in the labour market (creativity, innovation and entrepreneurship);
4. an individualized approach to each student (providing psycho-pedagogical diagnostic tools and conducting individual work with the student).

As to the e-textbooks, thanks to ESF support (in the previous programming period) 14 open digital e-books have been created. It is planned that by the end of 2023 14 e-textbooks for general education and 150 for vocational education will be developed under the programme. The ESF intervention will also result in more than 13.500 didactic e-materials developed under the programme. All of these materials will be accessible for public use. The funding allocation is €69 million.

Adjustment of higher education to the needs and trends of the labour market

Poland also is taking steps towards better adjustment of higher education to the needs and trends of the labour market. Universities can develop, update and implement educational programs adjusted to the labour market needs. A very important element in this field is strengthening cooperation between universities and employers. Employers can cooperate with universities at the very early stage of creating the curriculum, and after that they can participate in its implementation. This is done by organizing internships for students and involving business practitioners in workshops for students. The close cooperation of universities with employers is one of the most important elements ensuring that curricula correspond to the current labour market

[302] "Between 2003 and 2012, Italy, Poland and Portugal increased their shares of top performers and simultaneously reduced their shares of low performers in mathematics" – https://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf p. 4

needs. These actions are possible both in practical and general educational programmes. In addition, universities can implement programmes developing students' competences. Such programmes enrich the standard curriculum and give students the opportunity to participate in additional activities, such as certified training courses, workshops organized in cooperation with employers and practical activities carried out in the context of project teams. These activities focus on professional, language, *ICT*, analytical, communication and entrepreneurship competences. In the field of assistance provided to higher education, it is planned that 80% of university graduates supported under the ESF will take up employment within 12 months after graduation. Furthermore, 75.000 participants will improve their skills in the framework of university activities supported under the ESF by 2023. The funding allocation is €697 million.

Strengthening cooperation of schools with entrepreneurs/universities/social partners

Another OP KED priority is to focus on strengthening cooperation of schools with entrepreneurs, universities and social partners, thus mobilising business-education partnerships. Relatively few schools have experience in such cooperation, which can result in improving the learning outcomes achieved by schools. In this context, it is particularly important to improve mechanisms of direct cooperation between vocational schools and employers. It is planned to develop mechanisms of widespread involvement of employers in the cooperation, in particular through mutual identification of needs, expectations and opportunities in the area of developing qualifications and occupational skills, participation in modernisation of the educational offer, common curricula, development of new qualifications and modernisation of the existing ones, improvement of the vocational examination system, development of mechanisms to increase participation of employers in organisation of internships and traineeships for students and development of programmes for practical vocational training. In 2014-2020 ESF intervention will help to attain the above-mentioned outcomes.

Sector Skills Councils

An important mechanism of ensuring employers' involvement in modernising education and training process will be the Sector Skills Councils. The Sector Skills Councils are aimed to improve the functioning of the vocational education area in Poland by linking its educational offer with the needs of the labour market. They will involve the employers in the education process and the identification of educational needs since the entrepreneurs are the most reliable sources of information about demand for skills in the short and medium-term perspective. Sector Councils will be established primarily on a bottom-up basis. Social partners or other organizations representing the sector will be able to notify the need for the establishment of a Sector Council in the sector they identify.

Programme Council for Competences

Regarding *modernisation of teaching methods* within the scope of the OP KED, it is planned to establish the Programme Council for Competences and to identify qualifications and vocational needs with the participation of entrepreneurs for 15 economy sectors. The Programme Council for Competences will coordinate and monitor the work of sectoral councils for competences and ensure wide access to the results of labour market monitoring. As a part of the OP KED it is planned to involve 525 entrepreneurs in identification and forecasting of needs for qualifications and occupations on the labour market. Additionally it is estimated that 163.000 examination tasks for vocational examinations will be developed in cooperation with employers. Furthermore, it is estimated that as a result of the ESF support 25 social partner teams for vocational education will be established and 190 occupations core curricula will be modernized. The funding allocation is €64,5 million.

Integrated Qualifications System

One of the main priorities of ESF intervention is to provide *alternative flexible pathways to attain competences*, including a combination of validation of skills acquired outside formal education and a relevant offer of education or training. The achievement of the above-mentioned challenges is possible due to the solutions provided under the National Qualification System, aiming at establishing and granting qualifications. Poland, similarly to many European countries, started to implement the Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the *European Qualifications Framework for lifelong learning*, and therefore undertook to modernise the National Qualification System and to create the common reference framework in line with European standards. The most important elements of the NQS (i.e. the Polish Qualification Framework, Integrated Qualification Register, validation system, quality assurance system) were developed within ESF intervention in the previous programming period. In 2014-2020 ESF intervention will concentrate on implementing and supporting the functioning of the *Integrated Qualifications System* especially through: preparing the entities establishing qualifications (ministers), certifying and validating institutions and institutions of external quality assurance to implement solutions in terms of granting qualifications, compliant with the Integrated Qualifications System standards, preparing descriptions of 200 qualifications granted outside the education and higher education systems, developing sectoral qualifications frameworks linked to the Polish Qualifications Framework in 16 sectors, functioning of the Integrated Qualifications Register and its experts' base.

Under the OP KED it is envisaged to ensure and co-finance the creation and functioning of the Integrated Qualifications Register which will contain qualifications issued in Poland. The aim of the OP KED projects will be to introduce all "complete" qualifications and 200 partial qualifications (non-formal education) to the Integrated Qualifications Register. As a result of the implementation of the Integrated Qualifications Register, it is estimated that 270.000 diplomas and certificates will be granted in the field of non-formal education under respective level of the Polish Qualifications Framework. The funding allocation is €54,5 million.

Transnational mobility programmes

In the 2014-2020 programming period Poland introduced a new type of ESF-funded projects – transnational mobility programmes for certain target groups. Its aim was to enable the gaining of new skills and competences thanks to various activities implemented abroad. First of all, Poland took the opportunity of using ESF resources to supplement activities undertaken within the Erasmus+ programme through supporting the transnational mobility of individuals and helping them to gain new skills and competences during their learning and training process abroad. In this regard, ESF funds can significantly increase the extent of Erasmus+ impact. Support planned in OP KED aims at increasing chances of young people to find employment. The support in that area is focused on spatial and vocational mobility of students by offering them an opportunity to go and study abroad and raise their professional qualifications and practical competences as well as international placements for VET students to gain practical professional experience. In addition, the support shall also include mobility of teaching staff to enable them learning new teaching methods and techniques as well as changing their attitudes in order to improve the quality of education process. In the *transnational mobility programmes* it is planned to support over 71,400 people. Due to the participation in this support, 90% of them will acquire professional or key competences upon leaving the programme. So far around 8000 persons have received support under transnational mobility programmes. In addition, 6000 persons have acquired professional or key competences after leaving the programme. The funding allocation is €297 million.

Policy impact to date

The process of attaining all abovementioned objectives is in progress, so it is difficult to assess its effectiveness.

Key barriers and enablers during implementation

Implementation of these measures goes efficiently. However many of them depend on cooperation with a wide range of stakeholders. Therefore, frequent bottlenecks are problems with the issue of combining various interests.

Another challenge is the fast-changing socio-economic situation. The Fund must be elastic so it can adequately respond to situations, and do so comprehensively.

Another challenge is openness to innovation and the possibility of their implementation. Innovations must be realistic, otherwise they cannot be implemented. *It still remains a challenge to design the objectives that can be achieved.*

3.19 Romania (RO)

Open Education in the country

Romania is a unitary state with a population of nearly 20 million, rather more than the next-smaller Member State, the Netherlands (17 million), but considerably less than the next larger Member State, Poland (39 million).

POERUP produced a country report[303] on Romania in 2014. In terms of OER in Adult Education, the country was also studied in 2015 for the ADOERUP project funded by the European Parliament, with advice from an in-country expert,[304] and in the EU OERup! Project[305]. A useful synthesis of OER-related analytic work with the catchy title *The Power of the Three Words and One Acronym: OER vs OER* was published[306] in 2015 by a team of Romanian experts.

As stated in that last-mentioned paper, there have been significant developments over many years in national OER policies, flowing from the former Knowledge Economy Project[307] (KEP), implemented by the Ministry of Communication and Information Society between 2005-2013, and funded by the World Bank. The Ministry of Education, Research, Youth and Sport was a partner in this programme, which had three components: Expanded access to Information & Communication Technologies and improved digital literacy, Development and promotion of government e-services and Promotion of e-commerce and innovation support for SMEs.

One of the important activities of the KEP project towards the field of open education was the elaboration of a set of recommendations for the Romanian Ministry of Education for policies supporting Open Source (OS), Open Educational Resources (OER) and Open Educational Practices (OEP): to adopt a clear definition of open licenses and to support the principle that public funded products should carry such licenses; to facilitate the sustainable implementation of OER by creating incentives for use and reuse, and funding technical infrastructure to increase access to OER.

Some of these recommendations were specified in the *Proposal for public policies for ICT integration in the pre-university system* and adopted by the Ministry of Communication and Information Society and by the Ministry of Education, Research, Youth and Sport as long ago as 2007. The activities in the KEP project have led schools towards a shift in focus from the resources themselves towards the practices associated with the creation, use and management of OER: that is, open educational practices (OEP*).*

The Government Programme for 2013-2016[308] adopted in December 2012 specifies that the Ministry of Information Society and the Ministry of Education will collaborate to support the innovative integration of Web 2.0 and Open Educational Resources in education, to promote the use of open/free resources, and the development and sharing of resources by teachers and students.

The *Romanian Coalition for Open Educational Resources* was initiated in October 2013. The initial memorandum of understanding was signed by the members of the project

303 http://poerup.referata.com/wiki/Romania

304 http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf, pp. 124-128

305 http://www.oerup.eu/fileadmin/_oerup/dokumente/need_analysis_report_IREA_Romania.pdf

306 http://www.sciencedirect.com/science/article/pii/S1877042815027299

307 http://documents.worldbank.org/curated/en/764741468333031527/pdf/ICR26580ICR0Ro000PUBLIC00Box379811B.pdf

308 http://arhiva.gov.ro/upload/articles/105576/program-de-guvernare-2013-2016-bun1.pdf – see especially pp. 22-23

OER Awareness Activities for Librarians and Academics in Romania and has been signed also by private companies.

In the library context, the OpenDOAR portal reports that there are just three[309] Open Access repositories in Romania. Thus progress seems slow in this area.

MOOC initiatives include:

- UniCampus[310], a project supported by the Ministry of Education, started in 2014 under the initiative of University Politehnica Timisoara and developed by the Association of Technical Universities from Romania[311] to offer MOOCs
- UniBuc Virtual[312] (from the University of Bucharest) offers three MOOCs for Teacher Training
- The mooc.ro portal[313].

There is also an increasing in-Romania literature[314] on MOOCs.

The Distance Learning Portal[315] indicates just one institution offering distance learning in Romania, University "Eftimie Murgu" of Resita,[316] but searches indicate that there are others including the Transylvania University of Brasov, [317] Polytechnic University of Timisoara[318] and the "Babes-Bolyai" University of Cluj-Napoca[319] – and probably many more.

National Strategy on the Digital Agenda for Romania 2020

In 2014 the Romanian Government adopted the National Strategy on the Digital Agenda for Romania 2020 which focuses on three main pillars: the modernization of the public administration, supporting the competitiveness of the private sector via ICT, and providing ICT access and digital education to the public at large. The full plan, available in English, is a very long document[320] but there is a useful summary[321] from which the following material is taken. It sets out four areas of action. First, e-Government, Interoperability, Cyber Security, Cloud Computing and Social Media – which aims to increase efficiency and reduce costs in the public sector in Romania by modernizing the administration. Second, ICT in education, culture and health – which aims to support these technologies at the sectoral level. Third, ICT in e-commerce, and research, development and innovation in ICT – aimed at regional comparative advantages of Romania, and backing growth in the private sector. Fourth, Broadband and digital infrastructure services – aimed at ensuring social inclusion.

[309] http://www.opendoar.org/find.php?cID=177&title=Romania

[310] https://unicampus.ro

[311] http://rouni.ro

[312] http://www.unibuc-virtual.net

[313] http://mooc.ro

[314] For example, "A Comparative Analysis of MOOC (Massive Open Online Course) Platforms", published in the Romanian journal *Informatica Economică* (vol. 20, no. 2/2016) – http://www.revistaie.ase.ro/content/78/01%20-%20Conache,%20Dima,%20Mutu.pdf

[315] http://www.distancelearningportal.com – search for "Romania"

[316] This has a Department of Distance Learning – http://www.uem.ro/index.php?id=86

[317] http://www.unitbv.ro/en/AcademicProgrammes/Bachelor%E2%80%99sDegreeProgrammes/DistanceLearning.aspx

[318] https://niif.videotorium.hu/en/recordings/949/the-development-of-the-politehnica-university-of-timisoara-distance-learning-web-portal

[319] http://www.ceebd.co.uk/ceeed/un/rom/ro019020.htm

[320] http://www.mcsi.ro/Transparenta-decizionala/Proiecte-2014/Digital-Agenda-Strategy-for-Romania,-8-september-2

[321] http://gov.ro/en/government/cabinet-meeting/national-strategy-on-the-digital-agenda-for-romania-2020

A full implementation of the strategic vision of the ICT sector in Romania will result in a total investment of around €2.4 billion.

Concrete measures set out in the Strategy will lead to:

- Ensuring access to electronic public services for citizens and organizations (e-government services);
- Improving access to the Internet by increasing the coverage of high-speed electronic broadband communications networks;
- Increased use of the Internet;
- E-commerce promotion;
- Increasing the number of cross-border electronic public services;
- *Enhancing digital content and the development of ICT infrastructure in education, health and culture;*
- Supporting the growth of the ICT sector added value by supporting research, development and innovation in the field.

However, after reviewing this and noting that only one measure was directly relevant to open education, it was decided to focus for the interview on the Open Government Plan for Romania which has several interesting specifically OER aspects.

Policy/initiative overview	
Policy title	**National Open Government Plan (Virtual School Library and Open Educational Resources)**
Policy URL	http://www.opengovpartnership.org/sites/default/files/Romania-NAP_2016-2018%20EN.pdf
Description of the policy	With the objective of improving transparency in the public education system, the 2016-2018 National Action Plan for Open Government has introduced a chapter on education to help implementing the legal framework for the use of OER created through the Law on national education no. 1/2011, called the Virtual School Library. By creating the Virtual School Library[322] (work should have started in September 2016) and defining a national policy regarding open educational resources, the commitment aims to increase access to quality education and foster innovation.
Policy institution	Ministry of National Education and Scientific Research
Policy date	2016
Policy status	Current
Language	Romanian, English
Policy jurisdiction	National
E&T sector	School education

[322] See Commitment 16 on pp. 51-54 of the OGP Plan http://ogp.gov.ro/wp-content/uploads/2016/11/NAP_2016-2018-EN.pdf

Policy/initiative overview	
Dimension of impact	Core dimensions ☑ Access ☑ Content □ Pedagogy □ Recognition □ Collaboration □ Research Transversal dimensions ☑ Strategy □ Technology □ Quality □ Leadership

The Virtual Library

This material[323] is taken from the OGP Plan for Romania, Commitment 16.

> By creating the Virtual School Library and defining a national policy regarding open educational resources, the commitment aims to increase access to quality education and foster innovation.
>
> The sources for these materials will be:
>
> - documents produced by the MENCS[324] and subordinate agencies, particularly curricula and textbooks that the ministry buys directly;
> - resources produced in EU funded programmes, regardless of the beneficiary. The financing contracts will include clauses stating that the produced resources will be published under an open license and will be uploaded on the national portal;
> - new resources created by teachers and used for teaching activities, including school inspections. It is well known that teachers are permanently creating a host of teaching materials, and these materials can also be uploaded to the portal;
> - resources that are already developed by teachers and are distributed to other communities. The users of these communities will be encouraged to transfer the most valuable resources to the national portal;
> - educational resources that resulted from the implementation of EU funded projects will be part of this library;
> - starting a public consultation process regarding the acquisition of textbooks, so that the content of the textbooks is also bought and becomes the property of MENCS;
>
> The implementation terms will be discussed and agreed within the MENCS.

[323] See previous footnote

[324] MENCS is the abbreviation for the Romanian name of the Ministry: *Ministerul Educației Naționale și Cercetării Științifice* – http://www.edu.ro

Persons interviewed

- Radu Puchiu, Secretary of State, Office of the Prime Minister
- Diana Andone, Director, eLearning Center, Politehnica University of Timisoara

Interview results

Vision on open education in the country, role of the Ministry

In Romania, public efforts for opening up education are mainly framed under the Open Government Partnership (OGP) umbrella. This has allowed several discussions to take place, involving civil society (NGOs, universities) as well as governmental services. Since not all relevant discussions in the country are framed under the open education "label", the OGP is a good place for dialogue between Government and civil society to happen. A Coalition on Open Education[325] was launched in 2013 involving many stakeholders. In terms of vision, we cannot say that there is a common understanding but progress is being made through the discussions framed in the OGP work. The Prime Minister's Office is in charge of the whole OGP partnership, while the Ministry of Education[326] is in charge of the Commitment of the OGP related to education, a smooth cooperation exists between the two institutions.

Policy design and involved stakeholders

The whole OGP resulted from a large consultation process, where independent recommendations and civil society comments were submitted to the government. As for the case of open education, the OE Coalition submitted a number of proposals for the National Action Plan. Within the OGP, every action is provided with a budget, connected to the one of the responsible ministries: in the case of open education, the budget is taken from the general allocations of the Ministry of Education.

Policy dimensions and areas of action

The main dimensions tackled by the policy are access to education (also for disadvantaged people and communities), content, collaboration, leadership and strategy. These dimensions are fundamental to reach a real transformation of the Romanian educational panorama, and have been kept in mind when the policy was designed.

Policy implementation and impact to date

A first important impact of the policy was the one of raising the visibility of open education in Romania. A number of actions are ongoing, with a good involvement of the Ministry of Education (this is not the case in all chapters of the OGP) and with strong engagement by civil society organisations: stakeholders are working on the Virtual Library platform that can count on five open courses already. The Office of the Prime Minister has set some deadlines for each activity, for example to collect resources for the Virtual Library: they expect to be on time with resources collections by the first quarter of 2017. What is not there yet is a clause that all products of EU projects shall be openly licensed. In March 2017 they will have a clearer picture of the state of development of the different actions.

[325] For some background see the report of the second *Romanian National Open Education Conference*, 2015, at http://education.okfn.org/romanian-noec/

[326] http://www.edu.ro

Key barriers and enablers during implementation

The two main challenges are *capacity*, meaning that most teachers and other staff lack the skills to work with open methods and resources, and *leadership*, which is important to raise visibility of open education.

Leadership is particularly important since many stakeholders are afraid of change. Committed leaders must be found at all levels and sectors: a push from above is not enough, one needs leaders and champions to use the data and the resources openly produced. These challenges persist even in universities that do work on open education and that have MOOCs (such as the Polytechnic University of Bucharest),[327] mainly because universities are afraid of opening up their offer.

Relation between the policy and the EU-level developments

In general, the perception is that the work done by European institutions helps in terms of funding and regulations of important areas. The office of the Prime Minister looks at the work of the EU and at its policies as a guiding light, and takes inspiration from that. Still, national and EU priorities do not always match: for example the National Research Agency, despite the fact that the European Commission is pushing a lot for Open Access, has not yet adopted Open Access as a default for publicly-funded research results[328] and is more inclined to open the resources internally and not to the general public.

Lessons learnt and recommendations for future open education policies

The first **recommendation** is that, for countries which have an established national agenda (through the Open Government Partnership in the specific case of Romania), receiving European recommendations and framework indication would help a lot, in open education but also in Open Access for research and Open Data, since it would further strengthen the efforts of the national government.

Secondly, since the open education community in Romania is quite small with people knowing how to use the tools but not so much the concepts, the EU could help to reach out to practitioners in the country who are not used to work with OER and OE and mainstream these approaches.

In summary, there is a problem of visibility at two levels. What the EU is doing on open education should be more visible in Romania, and what Romania does in the field should be more visible in the Europe. Because of this fact, studies like this one are extremely useful.

[327] http://www.upb.ro/en/

[328] As noted earlier, only three Open Access repositories are recorded for Romania in the OpenDOAR portal

3.20 Slovakia (SK)

Open Education in the country

Slovakia is a small unitary state with a population of 5,4 million – about the same size as Croatia, Ireland, Finland and Denmark.

There is little prior information on OER and more general open education activity in Slovakia – it seems that the country has been neglected by European study projects. The OER World Map[329] has no entries and no country contact for Slovakia; and POERUP narrative reports and databases of 2014 [330] contain no information on MOOCs or OER in Slovakia. However, mention should be made of the recent (2016) BizMOOC[331] project involving Košice IT Valley.

Interestingly, Slovakia does not feature in the OpenDOAR portal[332] in terms of Open Access repositories in the country.

However, the **Open Government Partnership National Action Plan** includes commitments for OER and Open Access and this justified its inclusion as the policy chosen for the interview.

Policy/initiative overview	
Policy title	**Open Government Partnership Action Plan**
Policy URL	http://www.minv.sk/swift_data/source/rozvoj_obcianskej_spolocnosti/otvorene_vladnutie/akcne_plany/2015/OGP_2015_Action-plan-Slovakia_final.pdf
Description of the policy	One chapter of the OGP Action Plan for 2015-2016 of Slovakia is devoted to OER, starting with the statement "Creation of educational materials used in public institutions is primarily financed through public funds and therefore these should be available for public re-use, including other purposes than originally intended, just as it is with Open Data." A number of activities were planned for 2015-2016: a) map existing digitally available educational resources and repositories at the Ministry of Education, b) analyse and propose a procurement process of educational resources in primary and secondary education and identify possible barriers to their publication under "Creative Commons Attribution" open license, c) run a pilot of the procurement process, d) propose measures and their implementation to raise awareness among teachers and other educational staff about open educational resources, and e) join multilateral activities in Europe and beyond that support the creation, improvement, sharing and re-use of open educational resources.
Policy institution	Ministry of Education
Policy date	2015

329 https://oerworldmap.org/country/sk

330 http://poerup.referata.com/wiki/Slovakia and http://poerup.referata.com/wiki/Open_Education_Initiatives_-_by_country

331 http://www.kosiceitvalley.sk/en/2016/04/22/society-survey-on-massive-open-online-courses-mooc_bizmooc/

332 http://www.opendoar.org/find.php

Policy/initiative overview	
Policy status	Current (but coming to an end in 2016)
Language	English, Slovak
Policy jurisdiction	National
E&T sector	School education
Dimension of impact	Core dimensions ☑ Access ☑ Content □ Pedagogy □ Recognition ☑ Collaboration □ Research Transversal dimensions □ Strategy □ Technology □ Quality □ Leadership

Person interviewed

Iveta Ferčíková, Office of the Plenipotentiary for the Development of the Civil Society, Slovakia.

Interview results

Vision on open education in the country, role of the Ministry

There is a good understanding of open education both at the Ministry of Education[333] and at the Ministry of Interior[334], and their joint vision is related to the need for changing the teaching and learning culture and improving education in the country. The education commitments inside the OGP national plan aim to reform the education and to change the way in which resources and used and produced, in order to develop a culture of cooperation.

Policy design and involved stakeholders

For the OGP plan there are two main stakeholders in relation with the education commitments, the Ministry of Interior and the Ministry of Education. However, to embed the open education commitments in the plan a national working group was established, including members from NGOs, Academia, and the Ministries; and for two years they worked together to draft and discuss the action plan while the Ministry of Education evaluated the viability of the commitments.

Policy dimensions and areas of action

The main dimensions and areas of action of the National Open Government Partnership are related with Open Data, Open Education, Open Justice, Civic Engagement and the national legislative framework.

[333] In full, the Ministry of Education, Science, Research and Sport – https://www.minedu.sk/about-the-ministry/

[334] http://www.minv.sk/?ministry-of-interior

The core dimension in regards to open education aims to challenge the traditional ways of teaching and learning and enhance the digitisation of resources but also to provide verifiable and reliable information to the citizens to prevent people believing in false and fake sites that misinform the public.

Another interesting dimension is to provide an effective mechanism to change procurement, as now if publishers are commissioned by the government with the production of educational content, this has to be released under Open Licenses.

Policy implementation and impact to date

As the commitments are indeed quite new, their implementation is still in progress, but the Ministry of Education is promoting the commitments and intending to find effective routes to raise awareness about open education. Also the Ministry is aiming at supporting the development of a repository of Open Resources.

Key barriers and enablers during implementation

The main barrier encountered was to introduce the concept of open education in the Ministry, followed by the challenges presented by the publishers, which are seeing a change in the procurement mechanisms that may see their business model radically changing.

Relation between the policy and the EU-level developments

The Open Government Partnership plan goes aligns with broader international agendas, and the Republic of Slovakia is pioneering on including open education in the commitments.

Lessons learnt and recommendations for future open education policies

It is **recommended** that open education it is introduced to the Member States using a *common framework*.

Also, it is **necessary** that the EU provides leadership, support and recommendations for Ministries of Education and also **financial mechanisms** to create national repositories for OER.

Finally, it is important to develop a common framework in relation with procurement of educational resources and textbooks commissioned to private publishers by the governments and funded with public funds or with European funds, to be published under open licenses.

3.21 Sweden (SE)

Open Education in the country

Sweden is a unitary state with a population of around 9,7 million, slightly less than those of Hungary, Portugal, Czech Republic and Greece, but much larger than the Scandinavian countries with which it traditionally collaborates. (It is reported that there are great similarities between Swedish, Norwegian and Danish.[335])

Sweden has been studied in respect of OER and open education in the last few years by EU projects, but rather less so than it is studied by EU projects for its other aspects of e-learning[336]. There is a brief POERUP country report in 2014 which embedded OER, MOOC and related open education activities in the broader context of ICT for education. There was a more recent 7-page report within the study (2015) by ADOERUP on OER for Adult Education (for the European Parliament)[337].

Sweden is one of the more active Member States in distance learning at higher education level. Putting this in a EU context, "distance learning at HE level is widespread in the UK (found in almost every large university) and also found to a substantial extent in Spain, France and Sweden".[338]

In higher education, there is no central support. The Swedish Net University, the former agency supporting online learning, was closed down[339] around eight years ago. However, its longer-term effects can still be seen in the substantial amount of distance learning activity, as noted in the last paragraph. In fact,[340] "the number of students opting for distance education alone has also risen since the beginning of the century from just over 18,000in 2000 to just under 68,000 in the autumn of 2011".

Some HE policy was in fact, in the view of non-Swedish experts, inimical to lifelong learning: a National Audit Office review in 2011 of "efficiency" of the HE sector – *Efficiency and productivity for universities and colleges* – led to a conclusion that the university college subsector and its work on distance learning was less "efficient" than research universities. This report appears to have helped to create a climate of resulting in some mergers and generally less focus on university colleges, as so often in Member States the more innovative subset of providers.

There was also a reorganisation of the HE quality regime that led to the Swedish Quality Agency being deregistered[341] by ENQA and then re-organised.[342]

Sweden was rather late in entering the MOOC movement. In more detail,[343]

> In 2014 the first Swedish universities began offering courses via the main global MOOC consortia Coursera and EdX. The Open Education Europa MOOC scorecard records a total of 9 in all.226 Recent MOOCs include Chalmers Technical University – 2 courses

[335] See https://www.babbel.com/en/magazine/the-scandinavian-languages-three-for-the-price-of-one for an informal introduction to this issue

[336] See for example the comprehensive but older reports with focus on schools (http://www.virtualschoolsandcolleges.eu/index.php/Sweden, 2011) and HE (http://www.virtualschoolsandcolleges.eu/index.php/Sweden_from_Re.ViCa, 2009)

[337] http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf, pp.108-114

[338] http://www.dtransform.eu/wp-content/uploads/2016/04/O1-A2Business-models-edition-1-final.pdf p.22

[339] http://www.virtualschoolsandcolleges.eu/index.php/Swedish_Net_University

[340] http://www.uka.se/download/18.1c251de913ecebc40e780003405/1403093616367/annual-report-2013-ny.pdf p. 29

[341] http://www.universityworldnews.com/article.php?story=20120503164105608

[342] http://www.enqa.eu/index.php/sweden-develops-a-new-system-for-quality-assurance/

[343] http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf p. 111

during spring 2015; Karolinska Institute – 5 courses 2014-2015; Lund University – 3 courses during 2015; Mid Sweden University – one course in autumn 2014 and Karlstad University (Lifelong Learning Web) – several open professional development courses for school teachers in cooperation with the National education authority (Skolverket) and Norwegian Lillehammar University College. Uppsala University is planning to launch MOOCs in 2015.

The Swedish government (as in Norway and UK) commissioned and then released a report on MOOCs[344] via the Swedish Higher Education Authority[345] (UKÄ) who made a series of positive recommendations – to government and universities. To government the key recommendations were:

- HEIs should be provided with an explicit possibility of arranging MOOCs as a specific form of education. UKÄ therefore proposes a new ordinance on open online courses.
- The HEIs should be allowed to use their funding for the development and arrangement of open online courses up to a specified level.
- In order to provide all HEIs with the possibility of developing open online courses earmarked direct funding should be allocated for the organisation of such courses as well as for development of digital methods for teaching and learning in higher education.
- Although open online courses should be offered free of charge, the HEIs should be permitted to charge fees for certificates awarded for these courses. This would facilitate cooperation with the international platforms and the HEIs would be able to choose themselves the channels used to distribute their courses.

These proposals are still out for consultation. They are controversial to some Swedish interests – in particular the recommendations that propose that MOOCs should occupy a zone separate from accredited higher education and so be susceptible to having supplementary fees charged. In the view[346] of the union of university teachers, this seems a new assault on the principles of free state education, already eroded since non-EU students are now charged high fees.

There is no timescale given by the government as to when any conclusions on MOOCs get turned into policies.

In regards to Open Access, the OpenDOAR portal records[347] 42 Open Access repositories in Sweden.

Schools and Adult Education sectors

There is no information made available on ICT in the schools sector. ICT in schools has not been a focus of recent Swedish government activities. However, it should be noted that the long-standing and well-known virtual school Sofia Distans[348] is in fact a state school and thus gets public funding[349] support.

One expert suggested that there were some interesting policy developments in terms of OER in the Folkbildning sector (Adult Education) at the Swedish National Council of

344 http://english.uka.se/higher-education-system/massive-open-online-courses-moocs.html

345 http://english.uka.se

346 http://sulf.se/en/consultation-response/massive-open-online-courses-moocs-at-swedish-universities-20161/

347 http://www.opendoar.org/find.php?cID=204&title=Sweden

348 http://www.sofiadistans.nu – for more detail watch http://www.virtualschoolsandcolleges.info/presentation/sofia-distance-education-ronny-karlsson-catherina-sawarell-mai-wall/

349 http://www.sofiadistans.nu/elev-utomlands/

Adult Education[350]. However, advice from government officials is that the Council is "autonomous" (like a university) thus not "an arm of government" – hence any such policies are not national or regional policies, thus not within the scope of this report.

Person interviewed

Per Rosenblad, Ministry Secretary, Ministry of Education and Research, responsible for the compilation of the answers on the Sweden MOOC report

Interview results

Vision on open education in the country, role of the Ministry

There is no specific national definition of open education but nevertheless there are initiatives relevant to the concept. In general terms the aim of the Swedish government is to make higher education accessible to everyone and make participation possible for all regardless of background, where you live or other circumstances. Widening participation and gender balance are priorities to the Swedish government.

Regarding Open Research the government presented its position in the recently published research bill *Collaborating for Knowledge* – for society's challenges and strengthened competitiveness – unfortunately not available in English.[351]

Policy design and involved stakeholders

Considering that the Swedish government understands the value of open education but because higher education in the country is free,[352] there is no policy to support activities in this regard, but there is a strong commitment in relation with Open Science and Open Access.

Policy dimensions and areas of action

Sweden in committed to widening access and participation. Higher education institutions have a responsibility to ensure that societal diversity is reflected in higher education. In principle, this can be regarded as the basic definition of widening access, although operative work on widening access may vary. Each person's right to higher education and, in the long term, to power and influence, is an issue of democracy. In purely economic terms, Sweden cannot afford to miss out on potentially excellent students. Also, diversity among students brings new perspectives and broader experiences, so heterogeneous student groups contribute to increased educational quality, as knowledge develops through the meeting of different perspectives. Another aspect of quality is that students are prepared to encounter social diversity after studying at an HEI that has diversity.

Policy implementation and impact to date

Several Swedish higher education institutions are developing massive open online course (MOOCs), which is also viewed as a way of learning a new technology and developing teaching methods. In 2015 the Swedish Higher Education Authority

[350] http://www.eaea.org/en/membership/eaea-members/sweden-he-swedish-national-council-of-adult-education-ordinary-member.html

[351] However, an English summary is available at http://www.government.se/press-releases/2016/11/collaborating-for-knowledge--for-societys-challenges-and-strengthened-competitiveness/

[352] Noting that non-EU students incur "economic" fees – http://www.studera.nu/startpage/higher-education-studies/higher-education-in-sweden/application-and-tuition-fees/

received an assignment from the government to study the opportunities and the obstacles related to the introduction of massive open online courses in higher education in Sweden. The report was presented recently[353] and the government will now consider the proposals.

Key barriers and enablers during implementation

In relation with widening participation and recognition of foreign qualifications, the Swedish Council for Higher Education[354] (Universitets- och högskolerådet) is the public agency responsible for recognition of foreign qualifications. The Council evaluates foreign secondary education, post-secondary vocational education and foreign academic qualifications.

A person who has completed a foreign academic qualification with a degree can apply to have it evaluated by the Council. The Council will provide a general evaluation statement that can be used when applying for work. The statement helps the potential employer to understand what the person has studied by describing the degree and comparing it to an equivalent Swedish degree.

Lessons learnt and recommendations for future open education policies

As Sweden does not have a policy in regards to open education, **it would be recommended that the EU advise the governments and ministries about the development of policies in this field**, as from the ministry point of view, open education does not seems to be a movement in the country, even though some educators and institutions are acting in this field without the involvement of the government.

However, the value of open education for widening participation is understood at governmental level.

[353] Summarised at http://english.uka.se/higher-education-system/massive-open-online-courses-moocs.html
[354] https://www.uhr.se/en/start/

3.22 United Kingdom (UK)

Open education in the country

The United Kingdom has an overall population of somewhat under 65 million. Despite much theoretical argument, the UK is in reality not a unitary state, though not really a federal state either. This causes particular issues for the education sector, where in general terms the four "home nations" operate differently. England, Wales and Northern Ireland operate in relatively similar ways but very differently from Scotland – much more so than in any other Member State (even the federal or highly devolved ones) with the possible exception of Belgium.

OECD, EU, UNESCO and other agencies reporting on educational matters often group the first three together, but sometimes even they are treated separately[355] – and some consolidated reports still try to treat the UK as a whole, with varying degrees[356] of plausibility.

Whereas copyright legislation is controlled by the UK government, the education systems of three of the four home nations are run by the devolved administrations of Northern Ireland, Scotland and Wales, with the central government responsible for just England. There are not, therefore, and cannot be, any national OER policies for the UK as a whole.

Before the change of political parties at the helm of the national government in 2010, the central government funded a major OER programme (from 2009-2012), largely for HE, through the JISC/HEA OER Programme[357], run jointly by JISC[358] – Joint Information Systems Committee and HEA[359] – Higher Education Academy. In reality (and in line with politics) it was in fact mainly focussed on England, with small amounts of spill-over to the other home nations.

In addition to the OER Programme, which had an investment totalling about £5,4 million, JISC funded a Content Programme[360] between 2011 and 2013. This programme built on previous JISC Digitisation and Content Programmes which addressed issues related to the creation and delivery of digital content in parallel with the skills and strategies needed within institutions to support digitisation activity, including nine projects focusing on the digitisation of OERs.

Within each of the four home nations, recent developments have been patchy.

In **England** (population 53 million), following the change of government in 2010, funding was withdrawn from national programmes for ICT support and development in schools and VET and there was no national policy for ICT in education. In 2013, the situation changed slightly, with the establishment of ETAG[361] (Education Technology Action Group) and FELTAG[362] (Further Education Learning & Technology Action Group). FELTAG produced a report for the Department of Business, Innovation and Skills[363], to which the Department responded; there are indications of movement towards a more positive ICT policy in schools and further education, including online learning, but no mention of OER and no clear indication that there are policies in the pipeline.

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[355] Such as in http://eacea.ec.europa.eu/education/eurydice/documents/facts_and_figures/fees_support.pdf
[356] Such as https://www.oecd.org/unitedkingdom/PISA-2015-United-Kingdom.pdf
[357] https://www.jisc.ac.uk/rd/projects/open-education
[358] https://www.jisc.ac.uk
[359] https://www.heacademy.ac.uk
[360] http://www.webarchive.org.uk/wayback/archive/20140614023117/http://www.jisc.ac.uk/whatwedo/programmes/digitisation/content2011_2013.aspx
[361] http://etag.report
[362] http://feltag.org.uk
[363] http://feltag.org.uk/wp-content/uploads/2012/01/FELTAG-REPORT-FINAL.pdf

Apart from university issues related to *Brexit* (research funding, staff recruitment, non-UK students etc.), current concerns of the England government in education are the new Higher Education Bill[364] setting up the Teaching Excellence Framework and related changes to quality and accreditation, including for private providers[365] – sometimes now called "challenger institutions".[366] While there is some rhetoric on the need to reduce higher education costs, the purpose of the TEF is seen by some commentators to be a vehicle so that universities can *increase* their fees.

Open Access continues steady progress, but open education is little mentioned in policy circles. The OpenDOAR portal reports[367] that there are 250 Open Access repositories across the UK.

In **Scotland** (population 5,3 million[368]), a number of national curriculum and technology groups have come together *voluntarily* to form **Open Scotland**[369] which produced an *Open Scotland Declaration*[370] in the summer of 2013. This focuses significantly on developing policies to promote OER uptake and is supported by several government-funded organizations.

In 2014 a new initiative Opening Educational Practices in Scotland (OEPS) was launched by the Scottish Funding Council[371] and the project provided support for a revision of the Open Scotland Declaration and its launch as version 1.0. There is an interview report on this later in this section.

Wales (population 3 million) made rapid progress in open education until 2014, at which point everything in open education more or less just stopped. Wales had had a national open education group, funded by HEFCW[372] (the Welsh Funding Council) and in September 2013 the Welsh universities had committed themselves to open education policies and the promotion of OER via the *Wales Open Education Declaration of Intent*[373].

This was the nearest to a formal government policy promoting OER in any of the home nations of the UK, and the Welsh government's intention was that this would spread beyond higher education to encompass all education sectors.

However, there is not much current movement in the schools or further education (VET) fields – and in the HE field, months before the *Brexit* decision, the financial pressures on Wales had led to open education initiatives being de-funded and staff dismissed.

The population of **Northern Ireland** is just 1,8 million: in education terms, they tend to follow England and Wales rather than Scotland. There is little sign of open education activity.

[364] http://services.parliament.uk/bills/2016-17/highereducationandresearch.html
[365] Now called "challenger ins
[366] https://www.jisc.ac.uk/blog/are-challenger-institutions-really-gamechangers-for-the-future-of-higher-education-21-dec-2016
[367] http://www.opendoar.org/find.php
[368] Almost exactly 1/10 of England's population
[369] http://openscot.net
[370] http://declaration.openscot.net
[371] http://www.sfc.ac.uk
[372] https://www.hefcw.ac.uk/home/home.aspx
[373] http://www.oerwales.ac.uk/wp-content/uploads/2014/11/OER-Declaration-of-Intent-Sept-2013.pdf

Scotland

Overview of the selected policy	
Policy title	**OEPS – Opening Educational Practices in Scotland**
Policy URL	https://oepscotland.org
Description	Opening Educational Practices in Scotland aims to facilitate best practice in open education in Scotland. It does this through the development of a peer support network and an online hub and awareness raising activities. It aims to enhance the capacity and reputation of the Scottish tertiary education sector in developing publicly available online materials supported by high quality pedagogy and learning technology. It provides an opportunity for the higher education sector in Scotland to build on its collaborative ethos and establish a support network for best practice and innovation in developing publicly available online resources. OEPS is a cross-sector project funded by the Scottish Funding Council and led by the Open University in Scotland.[374]
Institution	Scottish Funding Council
Policy date	2014
Status	Current
Language	English
Jurisdiction	Regional (Scotland)
E&T sector	Higher education
Dimension of impact	Core dimensions ☑ Access ☑ Content ☑ Pedagogy □ Recognition ☑ Collaboration Research Transversal dimensions ☑ Strategy □ Technology ☑ Quality ☑ Leadership

Person interviewed

Pete Cannell, Project co-director, OEPS, Open University in Scotland

Interview results

Vision on open education in the country, role of the Ministry

Different stakeholders have different visions on open education: universities are starting to engage, with a few having a specific policy on OER,[375] trade unions and

[374] http://www.open.ac.uk/scotland/ – the Open University is the leading provider of part-time education in Scotland, with around 15,000 students (in a 5,3 million population)

charities see access to education as an important issue; at governmental level there was a lot of interest in OE starting from 2013 with the Open Scotland declaration[376], focussing on equity and on widening access to education in connection with MOOCs developments, however this interest has waned in the last two years, and now there is an absence of any coordinated policy on OE. For example, the recent 2016 national policy on school education does not mention open education.[377]

Policy design and involved stakeholders

The primary reason for launching the policy was to increase equity and social justice (these are big issues for the Scottish government) together with fostering innovative practices underpinned by open education. The project is funded by the Scottish Government and led by the Open University in Scotland, working with all universities and colleges in the country, plus the informal education sector.

Policy dimensions and areas of action

OEPS aims to produce evidence on the impact of Open Educational Practices and supports collaboration amongst different partners including formal and informal educational institutions, with particular interest in organisations outside the Higher Education sector, through online collaborative work and workshops[378].

The total funding is £1,3 million[379] for 3 years, and the Open University Scotland is responsible for administrating and distributing these funds. Through this policy, the aim is to understand the level of reality of the promise of OER and OEP; to identify the barriers that prevent access to education for all, as well as the pedagogical issues that underpin the adoption of OEP; and finally to uncover the tensions between culture and individuals and the drivers of use of OER at institutional level in regards to teaching and research excellence and outreach.

Policy implementation and impact to date

The original objectives of the policy have been met: quantifiable objectives have been assessed and the results presented as reports; however, those aims such as change of culture and practice are more difficult to demonstrate. Nonetheless, thanks to the policy, now several Scottish organisations are doing OEP for themselves [380]; for instance it was reported that the University of the West of Scotland is now working on collaborative curriculum development using OER, and the University of the Highlands and the Islands are increasing their adoption of OER and OEP.

The project has had an important impact in creating partnerships amongst formal institutions and between formal and informal ones, also through the use of the OpenLearnWorks[381] platform, with collaboratively designed OER among different HEIs.

Key barriers and enablers during implementation

One difficulty mentioned is that institutional staff doesn’t seem to fully understand what it means to systematically adopt Open Educational Practices. To overcome this, the policy has been putting a lot of effort in explaining to everyone what open

[375] See http://www.ed.ac.uk/files/atoms/files/openeducationalresourcespolicy.pdf and http://www.gcu.ac.uk/media/gcalwebv2/library/content/pdffiles/GCU-Interim-Open-Educational-Resources-Policy-Approved.pdf

[376] http://declaration.openscot.net

[377] http://www.gov.scot/Topics/Education/Schools/NationalImprovementFramework

[378] https://www.uhi.ac.uk/en/learning-and-teaching-academy/events/thinking-about-open-2

[379] About €1,5 million at current exchange rates

[380] http://jime.open.ac.uk/articles/10.5334/jime.412

[381] http://www.open.edu/openlearnworks

education can do, through forums, events etc. They have been looking for partners wanting to start OEP projects and supported them by training them via learning design workshops and through the collaborative platform OpenLearnWorks. The situation is similar in the informal learning sector, also there more effort should be put forward to support OEP understanding and development.

Relation between the policy and the EU-level developments

The policy coordinating team is following what is going on at the EU level; they have studied on how developments in Scotland are connected with and reflect to developments internationally but with a focus on social justice and in widening participation.

Lessons learnt and recommendations for future open education policies

It was suggested that the EU as well as other Member States should focus on promoting diverse and engaging models of Open Educational Practices, both at formal and informal education levels, propagating a wide range of OEP and models and must not just focus on promoting and delivering Open Education via MOOCs exclusively.

England

Overview of the selected policy	
Policy title	**Higher Education Funding Council for England, national OER programmes**
Policy URL	https://oersynth.pbworks.com/w/page/60338879/HEFCE-OER-Review-Final-Report
Description of the policy	In 2008 the JISC *Good Intentions* report[382] concluded that the landscape around learning materials had changed sufficiently to support a range of sustainable models for sharing. In 2009 the Higher Education Funding Council for England funded four years of development. UKOER1 – April 2009 to April 2010 – supported 29 pilot projects and activities around the open release of learning resources. UKOER2 – August 2010 to August 2011 – funded 36 research and technical projects examining the release, discovery and use of OER by academics. UKOER3 – October 2011 to October 2012 – supported the continued application of OER and related activity and processes across the HE and VET sector via 13 projects funded to investigate the use of OER approaches to work towards particular strategic, policy and societal goals. JISC finally funded a Content Programme between 2011 and 2013 which addressed issues related to the creation and delivery of digital content in parallel with the skills and strategies needed within institutions to support digitisation activity. It funded 9 projects focusing on digitising and openly released archival and special collections of primary sources, aiming to embed such resources within teaching and learning.

[382] http://repository.jisc.ac.uk/265/1/goodintentionspublic.pdf

Overview of the selected policy	
	For a recent evaluation report by Littlejohn et al see "Motives and tensions in the release of Open Educational Resources: the JISC UKOER programme", *AJET* Vol 32, No 4 (2016).[383]
Policy institution	Higher Education Funding Council for England
Policy date	2009-13
Policy status	Closed
Language	English
Policy jurisdiction	Regional (England)
E&T sectors	Higher education, VET (in later phases)
Dimension of impact	Core dimensions ☐ Access ☑ Content ☑ Pedagogy ☐ Recognition ☑ Collaboration ☐ Research Transversal dimensions ☑ Strategy ☑ Technology ☐ Quality ☐ Leadership

Person interviewed

David Kernohan, Senior co-design manager, Jisc

Interview results

Vision on open education in the country, role of the Ministry

At Government level there is understanding of open education, however, contrary with their support to Open Access and Open Science, there has been very little support for open education. Also, currently the UK government is not funding activities, initiatives and projects, however, the government it is still funding the Joint Information Systems Committee (Jisc) and the Higher Education Academy (HEA) and those institutions provide some support for the development and promotion of open education.

Policy design and involved stakeholders

The main actors of this agenda are the Higher Education Funding Council for England (HEFCE), the Joint Information Systems Committee (JISC) and UK Higher Education Academy (HEA) and, as stated in their report "The activities and impact of the HEFCE-funded initiatives must be considered in relation to wider political, economic, social and technological contexts and questions have emerged around how far open educational practice challenges or supports notions of traditional higher education".

[383] https://ajet.org.au/index.php/AJET/article/view/2258

Policy dimensions and areas of action

The dimensions of the policy can be understood as follows: Phase 1 – Large scale release of OER, Phase 2 – Extending OER release, OER use and discovery and Phase 3 – Strategic, policy and societal goals for OER and open approaches.

The HEFCE OER review framework consisted of four focus areas: Culture and practice; Releasing and using OER; Processes for sustainability; and Benefits and impact.

Policy implementation and impact to date

Despite the success of this policy promoting open education, its funds were not extended, however, a large and strong community was built, and this can be considered its greatest achievement and impact, as the open education community kept working together and developing initiatives: for example, nowadays some are related with developing open textbooks due to the high costs of education in England and the UK community keeps organising international conferences on the themes of open education[384] as there is a large interest in developing projects and research and publishing and sharing the outcomes of their research and projects in open education related themes.

Key barriers and enablers during implementation

The main barriers presented were related with the lack or scarcity of funding at national level and somehow with the little institutional support in some instances, as for example some institutions had funds only to support and develop MOOCs, but any other open education initiative was neither funded nor supported.

The enablers of open education in UK are the members of the OE community, which, despite not having enough funds promote, advocate and seek for funds at national and international to develop OE initiatives and projects and support other communities of practice at national and international level to develop open education in their own contexts.

Relation between the policy and the EU-level developments

This policy was related to and aligned with EU developments in relation with open education, however, to keep progressing and to be able to adapt and adopt policies and innovative projects from other European countries funds are necessary, for example to support the development of Open Textbooks, as HE fees in the UK are very high, and the costs of textbooks increases the overall cost of education.[385]

Lessons learnt and recommendations for future open education policies

In relation with the lessons learnt, the fact of having developed a strong community of open education practitioners and researchers continuing working in supporting and developing open education despite funds being stopped is the most interesting result of the policy.

As **recommendations** for future open education policies, it is recommended to think carefully about the reasons behind developing them; also, it is necessary to provide spaces for people to experiment and to innovate at collaborative level, therefore the

[384] The next being OER17 in April 2017 in London – https://oer17.oerconf.org

[385] To a point; as the *SharedOER* final report notes (footnote 50) "A simple calculation based on the reported cost of textbooks (http://www.theatlantic.com/business/archive/2013/01/why-are-college-textbooks-so-absurdlyexpensive/266801/) and the out-of-state fee, a proxy for true cost (http://www.topuniversities.com/studentinfo/student-finance/how-much-does-it-cost-study-us) suggests a figure of just under 3% in the US" – http://publications.jrc.ec.europa.eu/repository/bitstream/JRC94956/jrc94956.pdf p. 14

EU could provide with an online collaborative space for open education practitioners for experimentation and to share good practices.

Also, it is **not recommended** to centre the efforts on building repositories, as metrics and data of usage tend concentrate too much attention in detriment to other more important elements that surround them, therefore, these risk closure when metrics of usage seem too low.

4. Analysis and conclusions

4.1 Introduction

This chapter provides an analysis of the interviews, correlated with the Member State narratives (which incorporate and link to much additional information collected through desk research). It is based on the 22 Member States and the interviews linked to these. Where appropriate wider considerations are taken into account, including what the UNIR team know of developments in the other 6 Member States.

Caveats include the following:

- The desk research parts of the country reports are brief documents: although they are normally based directly on input by country experts only a few experts per country could be consulted in the time available;
- The interview reports are also brief documents; many nuances are not documented or were not probed in a session of typically one hour in what was usually an interview of a person not known to the team, or vice versa;
- On the whole, statements by Ministries are taken at face value, though the researchers looked for URLs to confirm each statement made about specific policies, projects and institutions;
- No warranty is given as to the comprehensiveness of the research – in most Member States as soon as one relevant policy became clear the desk research was curtailed in the interests of efficiency within limited budgets (only for UK and Germany was this rule broken, and only because these are large federal states with much activity in open education);
- In particular the team did not run extensive general analysis of national policies for education (which most Member States have) or national policies for ICT in education (which few Member States now have);
- In a few cases we saw copies of the UNESCO OER country survey[386] documents currently circulating. We took a deliberate decision not to draw on these for any conclusions but where available we did use them as a source of information on initiatives and policies, *but only where such initiatives and policies could be independently verified*.

4.2 Emerging approaches to policy for opening up education

Based on the study results, we suggest that four types of policies involving opening up education are present at the moment across Europe:

- Policies focusing specifically on opening up education through the promotion of OER and OEP (e.g. Germany, Scotland, Netherlands, UK);
- Policies relating to general ICT for learning with some open education component (e.g. Cyprus, Ireland, Italy, Lithuania, Poland);
- Comprehensive strategic educational policies with some open education component (e.g. Croatia, Czech Republic, Estonia);
- Polices from National Open Government Plans with some open education component (e.g. Greece, Romania, Slovakia).

[386] http://rcoer.col.org/surveys.html

4.3 Correspondence between policies and the OpenEdu framework

The identified policies have been analysed following the dimensions of the OpenEdu framework produced by JRC[387], in the table below. The fact that the great majority of the policies target a number of openness dimensions, including in many case some of the transversal dimensions identified by JRC in their research, shows that the understanding of open education of the majority of European policy makers – even though not their totality – goes beyond open content.

		Core dimensions						**Transversal dimensions**			
Policy	**MS**	Access	Content	Pedagogy	Recognition	Collaboration	Research	Strategy	Technology	Quality	Leadership
Strategy of Education, Science and Technology	HR					X		X		X	
Digital Strategy for Cyprus (Measure 16 eEducation)	CY	X	X	X				X	X		
Strategy for Education Policy of the Czech Republic 2020	CZ	X	X	X					X		
Estonian Lifelong Learning Strategy 2020	EE	X	X				X		X	X	
Open Universities 2011-2020	DE	X	X	X		X		X			
Mainstreaming OER	DE	X	X	X		X				X	X
National Action Plan on Open Government 2016-2018	EL	X	X							X	
National Forum for the Enhancement of T&L in HE	IE		X	X		X	X	X	X	X	X
National Digital School Plan	IT	X	X	X		X					X
Activity Plan for ICT Implementation in General and Vocational Education	LT	X	X	X	X				X	X	
Higher Education 2025, The value of knowledge	NL	X	X	X	X	X	X	X		X	X
Program for Knowledge Education Development	PL		X								
National Open Government Plan (VS Library and OER)	RO	X	X					X			
Open Government Partnership Action Plan	SK	X	X			X					
HE Funding Council, National OER programmes England	UK	X	X			X			X	X	
Opening Educational Practices in Scotland	UK	X	X	X		X		X		X	

Interestingly, the Collaboration dimension was quoted as very important in a number of interviews (for instance from Finland, Italy, Romania and Scotland), showing a certain degree of "maturity" in the understanding of what open education is about.

[387] Inamorato dos Santos, A., Punie, Y., Castaño-Muñoz, J. (2016) *Opening up Education: A Support Framework for Higher Education Institutions*. JRC Science for Policy Report, EUR 27938 EN; doi:10.2791/293408

4.4 Policy implementation and impact to date

In general terms most of the policies are too new to have had much evidence-based impact. In addition some countries like Germany and Netherlands had substantial activity before there was a relevant policy in place and it is hard yet to disentangle the effect of the policy from the general volume of activity. Finally several interviewees seemed vague about funding and timescales.

At an overall EU-wide level, it is clear from many reports[388] that in the UK and France there is a substantial amount of open educational initiatives, even measured on an "amount per head of population" basis and that in both these countries this is mainly due to policies, though not all to national/regional policies.[389] Germany had developed a lesser but reasonable level of MOOCs and a large amount of OER in advance of any policies and with the recent investment in digital education and OER is likely to become a leader in the EU. Spain and Netherlands also had substantial amounts of open education prior to any policy. In contrast the Scandinavian countries and much of New Member States have so far little open education activity.[390] Italy occupies an intermediate position with several MOOC and OER initiatives, most in advance of specific policies.

Below we give some highlights and raise some issues.

Member States without policy-driven activity

Eight countries (over 1/3 of our set of 22) – **Austria, Bulgaria, Denmark, Finland, Hungary, Latvia, Luxembourg and Sweden** – appear to have no current active policies containing open education aspects (in the meaning utilised in the present study – see the introduction), or at least (such as the efit21 policy for Austria or the K-MOOC policy for Hungary) none that we could surface interviewees for.

Austria, **Finland** and **Hungary** are considering proposals on possible policies, as is **Sweden**, once the government there decides what to do about their MOOCs report.

Luxembourg does have an active ICT in schools programme, but seemingly without any open education aspects.

Member States with policy-driven activity

Croatia has "development of Open Educational Resources" in its policy but there are no details in the policy documents and it was not possible to get an understanding of the detailed planning on OER through the interview.

Cyprus has a general ICT in education strategy but the interviews revealed only some tactical interventions (one under an EU-funded project and one a collaboration largely driven by Greece), and no strategic open education activity. Yet in distance education, Cyprus is increasingly active with its own Open University and the private University of Nicosia with an active online learning programme delivered via a joint agreement with a Welsh university and targeting Africa.

[388] Such as http://www.dtransform.eu/business-models-for-opening-up-education-report-available

[389] Note in particular the effect of FutureLearn, a policy from a hegemonic provider, discreetly facilitated by a Minister, but with no national funding or policy framework. The role of major non-state actors is out of scope for this study but needs attention if one is to understand the overall situation in countries. Other such actors are the Ufi Trust in UK and Folkbildningsrådet in Sweden. The role of international NGOs such as the Soros Foundation and Creative Commons also needs consideration.

[390] The relatively close (but not perfect) correlation between the level of distance education activity (open education in the old "Open University" or "Open and Distance Learning sense) and open education activity in a given Member State is not in scope for this study.

Czech Republic also has a general ICT in education strategy as a subset of its overall education policy, but in contrast to Cyprus, appears to be taking forward existing open education activity (e.g. *Metodicky*) and making some decisions, e.g. on Creative Commons. However, the interview felt that progress was slow and constrained by capacity issues in the Ministry.

Estonia has a currently active Lifelong Learning Strategy that mentions Open Educational Resources, continues support for platforms for sharing content (e.g. among teachers) and has a focus on training teachers. However, there was no specific information of the impact of its 5-years €60 million programme except that "teachers are being trained in digital competences across the country and online platforms are been built to support the sharing and creation of resources, while guidance and support is being provided to teachers and students to effective use this platforms".

Germany is now highly active in OER and quite active in MOOCs, all without any national or regional policies specific to open education until very recently. However, there is now a *Mainstreaming OER* programme, based on thorough prior research and consultation; and also a continuation of their earlier *Open universities* initiative that now has branched into MOOCs.

Greece is one of the three countries using the Open Government Programme mechanism to drive through its open education plans, via "Commitment 20". This is building on a number of existing developments including Open Academic Lessons and the repository Photodentro.

Ireland has an active ICT in higher education policy and funding mechanism, which covers OER but apparently with more emphasis on open access issues. The country was starting from a rather low position in use of ICT in higher education but is catching up fast.

Italy has made a strong start with its policy National Digital School Plan but notes that long-term effects cannot be demonstrated yet; in parallel a number of OER and MOOC-related activities have been started without any direct public policy support.

Lithuania has an ICT in education policy, which appears largely focused on schools and VET. They identified a number of barriers including greater support needed from the EU.

Netherlands has a new (2015) policy to modernize higher education with a strong core of OER. However, some of the projects it references started before the policy did (TU Delft has been active in MOOCs for some years) so cannot be regarded as successes for the policy. Nevertheless it is expected that the policy will bring Netherlands up to the open education level of nearby relevant countries (France, UK, Germany) in a few years.

Poland has a digital schools programme but the policy chosen for focus was the Programme for Knowledge Education Development, since this explicitly states that all resources funded by the European Structural Fund should be openly licensed. The programme is very thorough and impressively documented in its general forward-looking aspects but the specific open education aims and concrete gains are not clearly described, and much of the programme could be regarded as "catch up" in areas of education reform – much needed but not specific to open education.

Romania is the second of the three countries using the Open Government Programme mechanism to drive through its open education plans. The aims of the Virtual Library are impressive but work on this aspect has only just started.

Slovakia is the third such country: a full chapter of the OGP Action Plan is devoted to OER. However, the country starts from a very low base in OER and notes that implementation is still in progress.

UK does not have and cannot have a unified approach to education policy in any sector, though there are still some "federal" agencies, such as Jisc for ICT, which are working to provide a level of uniformity in ICT, for higher education at least. In Scotland the OEPS project cites benefits at two universities but there are 19 universities in Scotland and no large or high-rank universities are mentioned as having changed as a consequence of the OEPS project (the University of Edinburgh has been active in MOOCs and OER for several years, as has the Open University in Scotland, the project lead). In England the HEFCE-funded OER programmes have left a strong legacy but there is no current policy fostering OER or MOOCs in higher education, or indeed in any other sector of education (the FutureLearn MOOCs consortium is purely an initiative of the UK Open University, with no government funding or support).

4.5 Key barriers and enablers during implementation

Understanding what are the main barriers that can prevent open education policies (or, for countries where there is no policy, open education initiatives) to fully succeed is important both for policy makers actually running policies and for planning future initiatives aiming at opening up education. At the same time, spotting the potential enablers of open education is fundamental, since these can be strengthened through policy actions and therefore act as multiplicators for the success of future policies and initiatives.

Barriers

The main barriers identified by the interviewees have been grouped here below:

- **Low ICT-readiness**: lack of ICT devices for schools, students and teachers (EE), poor access to internet, including lack of Wi-Fi and poor connectivity – especially in countryside areas (EE)
- **Broader institutional issues**: "The slow bureaucratic processes in the Ministry" (IT) or – in federal or semi-federal countries – tensions between the Central Government and the different States "which led to long and complicated negotiations on different aspects of the policy" (DE), or the general economic downturn (CY)
- **Low policy priority assigned to open education**: lack of policy (DK), "lack of strategic support for the development and promotion of open education" (LV), "lack of financial support" (LV) and lack of a dedicated team "to promote, support and advocate for Open and Digital Education at the ministerial level, as such a team would enable policy implementation in a more effective way" (CZ)
- **Fragmentation of initiatives**: "there are quite a few open education initiatives in Austrian universities that work in their context, but there is nothing that works on a national scale" (AT); "independent institutions which want to work together (*on open educational projects*) have to modify and harmonise their timelines and priorities: to change this takes a lot of time and commitment by the single institutions" (FI), "management processes related to students of other universities should be further simplified in terms of information availability, interoperability and credits recognition" (FI)
- **Lack of institutional support**: educators get little support to implement open education in their institutions, despite the efforts of financing projects in open education (NL); "some institutions had funds only to support and develop MOOCs, but any other open education initiative was neither funded nor supported" (UK)

- In the university sector, **primacy of research over teaching**: "One of the main difficulties observed is the treatment perceived by academics and the government regarding teaching and learning, which is seen as a second class element in contrast with research in higher education, as academics tend to be assessed and promoted because of the quality of their research instead of their teaching excellence" (IE)
- **Resistance to cultural change**: a high degree of cultural change is required (CY), connected with the "reluctance of certain groups of educators in embracing change and adopting a digital culture for teaching and learning" (DK), and with the "reluctance amongst academics towards sharing the resources they produce" (HR). In even more detail, "a significant barrier is the yet dominant traditional approach to teaching and learning: it was noted that the preferred teaching material in the country are printed textbooks and that there is reluctance among the teachers to adopt and embrace new digital technologies." (EE). Even in an advanced country in ICT terms, there is "the resistance of educators to change their practices and get training to innovate in the classroom" (NL), while "open licensing of teaching materials is a challenge since the norm is that content belongs to the teachers" (FI). Cultural change affects educational leaders also: "there is reluctance from some school principals in adopting new technologies and innovative teaching methods, as they prefer some rather traditional approaches" (LT); "Committed leaders must be found at all levels and sectors: a push from above is not enough, one needs leaders and champions to use the data and the resources openly produced" (RO)
- **Lack of awareness about open education**, "and about OER, copyright and open licenses" (HR); "institutional staff don't seem to fully understand what it means to systematically adopt Open Educational Practices" (UK/Scotland) and has a "limited understanding of the benefits of producing learning content in the form of OER" (DE)
- **Low open education capacity within the teaching population**, connected to "the need to create effective training paths that can cope with the scale of the training demand, since there are not enough experts in these fields" (IT), and to the time needed to build teachers competencies to meaningfully work in digital ways – estimated as "at least 2 years" (IT). "Training of trainers would be needed" (FI), "and to do so better institutional and inter-institutional coordination would help, since it is not always clear who is in charge of supporting professors when it comes to OER and open education" (AT); "most teachers and other staff lack the skills to work with open methods and resources" (RO)
- **Absence of open licenses recognition**, such as the lack of recognition of Creative Commons licenses, or equivalent (LV), connected with the resistances of publishers, "which are seeing a change in the procurement mechanisms that may see their business model radically changing" (SK)

Enablers

The main enablers for open education to thrive, in the eyes of the interviewees, are hereby presented:

- **Clear policy priority assigned to open education**: having a clear policy framework (CY, DE), with government support and promotion (EE), implementing National Reform Programme (CY) and "programmes democratising access to higher education" (DE), with a focus on "new and innovative approaches to open education" (NL). The involvement of the private sector was mentioned as an important policy partner "offering funds and/or services" (IT)

- **Awareness raising on open education targeting leaders and educators**: The key enabler is to make concerted efforts to change the attitude of HE leadership, in particular changing the rigid academic thinking" (HU). Further, "reaching out to educators within their institutions through the organisation of events and capacity building moments" (IE) and ensuring "the political promotion of the open education agenda within the country, through endorsement of the Minister and other politicians in their public appearances" (NL). This needs "putting a lot of effort in explaining to everyone what open education can do, through forums, events etc." (UK/Scotland). "It will be important to make clear to teachers and managers that the approach is not only about OER and infrastructure but about a new way to look at teaching and learning" (DE)
- **Capacity building for educators and other stakeholders on open education**: "training and guidance for teachers" (EE), "training and guidance across the educational sector benefitting students" (EE), "training and support for parents towards understanding how their children will use technologies" (EE), "proper and continuous training of the trainers across all educational levels" (GR). Educational leaders should also be trained: "leading them to understand the changing of paradigm in the educational processes, to support them into gradually overcoming the initial reluctance of the teachers" (LT)
- **Empowering educators**: Self-organisation of teachers (IT), "giving a voice to the teachers, changing the perception of the value of teaching and learning" (IE)
- **Broader issues**: "the economic crisis can be also perceived as an enabler, as sharing of resources was useful to support teachers and students when other means were not available, so open education was widely promoted as a mean to overcome economic factors that could negatively affect education" (CY)
- **Online platforms** were mentioned only once as enablers, as tools "to share open educational resources" (EE)
- **Grassroots communities**: Finally, it was quoted that the main enablers for open education are "the members of the OE community, which, despite not having enough funds, promote, advocate and seek for funds at national and international to develop OE initiatives and projects and support other communities of practice at national and international level to develop open education in their own contexts" (UK).

4.6 Relation between the policy and the EU-level developments

Most Member States interviewed made mention of EU aspects and of these, all considered that their policies are in line with EU policies (the exceptions were mainly those who did not offer policies to be interviewed on).

Among those who did make mention, there appears to be a reasonably good understanding of open education in Austria, Cyprus, Denmark (especially, including Open Science), Germany (very positively and thoroughly), Italy (at least for schools), Netherlands, and UK/Scotland.

A few countries expressed some reservations or took a narrower focus, suggesting that they had looking in some detail at the wording. This approach is to be commended.

Czech Republic stated that "Czech policies are in line with the recommendations of the EU *as far as promoting the development of innovative and digital skills*, including open education" (our italics).

Estonia seemed to limit this to "the general aim of developing an open and digital culture amongst educators".

Finland mentioned specifically "the ET2020 Expert Working Groups, *even if the openness part of the work has not really started*" (our italics).

Ireland took as its focus "aiming at achieving teaching and learning excellence, and aims at producing good practices for academic development that can be shared internationally at European level".

Latvia took as its focus the "aim of widening participation in education and the reduction of social inequality towards developing a better and more skilled citizenship".

Netherlands was keen to flow back its knowhow to Europe, saying "this policy can be a model that can be adapted for the development of further policies and agendas on open education by other European countries".

Slovakia took an interesting standpoint, saying "The Open Government Partnership plan goes aligns with broader international agendas, and the Republic of Slovakia is pioneering on including open education in the commitments", thus again hinting at flow back.

However, even if most of the interviews stated that coherence exists between their national policy and EU policies in the field, few countries, with the notable exception of Italy, mentioned any of the specific key EU documents on open education, in particular the C*ommunication "Opening up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources".*

No commentary was offered on for example whether they felt that Erasmus+ was delivering on the promises made in the *Communication* or any of the recommendations made in it, for example "encourage the production, including through public procurement, of high-quality educational materials whose copyrights would belong to public authorities". No interviewee mentioned the value of the JRC's *Opening up Education: A Support Framework for Higher Education Institutions*, or any other of the studies by JRC or by other institution or project doing research on open education policy.

It is hard to escape the conclusion that the Commission's work in this area needs far more thorough dissemination, and that this would motivate MS representatives to make more visible their activities, as stated by the Romanian interviewee: "What the EU is doing on open education should be more visible in Romania, and what Romania does in the field should be more visible in the Europe".

5. Suggested recommendations for future open education policies

The various recommendations given by interviewees in the country reports are here brought together and grouped in a way informed by the dimensions of the OpenEdu framework, but extended to including the usual dimensions of EU action such as research, dissemination, and funding. Some brief commentary is included.

5.1 Recommendations for the European Union

Justification for open education

The European Commission and Member States who are engaged in implementation of open education mostly embed their open education actions (digital skills, repositories, etc.) within wider policies, such as ICT for education (or a sector of education), lifelong learning, open government, digital nation, etc. Thus there has to be a justification of why open education is or facilitates the answer to the policy questions being raised. This is what this recommendation is about.

UK.2	The EU should think carefully about the *reasons* behind developing open education policies.

Standards for open education

It was interesting that such a strong approach, at variance to some extent with the pedagogic flexibility flagged later, should be proposed, especially since the EU has no formal role in education in Member States and little of what is wanted is covered by other pan-European agreements such as Bologna or European Standards and Guidelines.

SK.1	Open education should be introduced by the EU to the Member States using a common framework.
EL.1	The EU should enforce the standards on open education on every MS.

Raising awareness on open education

Recommendations such as the ones below are probably a more realistic alternative to the ones proposed above under "Standards".

LV.1	EU support, at a promotional level, is needed to ensure that MS Government and institutional policy makers are aware of open education.
CY.1	The EU should provide a means to share agendas and strategies in relation to lifelong learning, digital literacies and development around open education initiatives.
DE.4	It is important to keep talking and raising awareness about Open Education: the EU should help to keep the discussion alive in MS.
RO.1	Even for Member States which have an established national agenda, receiving European recommendations and framework indicators would help a lot, not only in open education but also in Open Access for research and Open Data, since it would further strengthen the efforts of the national government. *Thus the EU should disseminate to all Member States, not only smaller or poorer ones*.

To pick up on earlier discussions, it is very important that the EU explains clearly how "open education" in the modern EU sense both draws on yet is different from "Open and Distance Learning", a phrase that the EU used to use a lot[391] in the last 20 years. In particular Finland and Denmark expressed some concerns on this issue but it is likely that these would be to some extent shared in Germany and Sweden also.

Related to this is the status of the phrase "opening up education" where it seems to be much less used in EU circles now. And again how does it differ from Open Education? The other issue is the eternal argument, heard at every open education conference as to whether MOOCs are part of open education or not.[392] (In fact, they fit better into the ODL model since they are "open enrolment".)

Funding and support for open education

It is not surprising that Member States should request more funding, especially when the recommendations come from states used to substantial Structural Funds, but it is still noteworthy. Those used to project funding have noticed some discontinuity between the Lifelong Learning Programme and Erasmus+ and the lack of coherence generated by an increased number of projects run from the national agencies.

DE.2	There should be more EU funding lines for OER and Open Education within European programmes such as Erasmus+ for example: participation in EU projects is currently very competitive and in some countries institutions tend to prefer to apply for national funding.
LV.1	Support from the EU, *financially,* is needed to ensure that MS institutional policy makers are aware of open education.
LV.2	The EU should provide funds to initiate and open the discussions and promote exploratory projects in countries where open education is not yet been considered and provide *action plans*, not just recommendations and policies, with guidelines and exchange of expertise with clear goals and targets.
LT.2	The EU should provide a library of Open Source Software, that could be translated for sharing and creating content, as for countries with less-used languages it is expensive to purchase software because its translation is costly or at worst there is no translation available.
SK.3	The EU should provide financial mechanisms to create national repositories for OER.
UK.3	The EU should not focus too much on repositories as metrics and data of usage tend concentrate too much attention in detriment to other more important elements that surround them, therefore, these risk closure when metrics of usage seem too low.
CZ.1	The EU should develop resources developed by EU stakeholders that define and clarify open education and its associated concepts. (In fact, even if the core principles are there, the concept is not yet widely spread, and therefore even when in principle aspects of openness are present in policies and projects, these are not clearly stated and not easily identifiable in official documents.)

[391] As one example of hundreds, http://ec.europa.eu/agriculture/rur/leader2/rural-en/euro/p4-2-6.pdf, 2001

[392] See for example http://www.oeconsortium.org/info-center/topic/moocs-and-oers-which-one-to-go-with/

EL.2	The EU should also provide multilingual good practices for all the MS.
RO.2	In a Member State where the open education community is quite small with people knowing how to use the tools but not so much the concepts, the EU should help to reach out to practitioners in the country who are not used to work with OER and OE, and mainstream these approaches.

Content and copyright

The most interesting points are perhaps i) the observation that EU needs to monitor its rulings on project outputs to ensure that they do in fact appear at all, and that they are openly licensed and ii) the point about procurement approaches (where much work has been done in the US under for example, Common Core).[393]

BG.1	It is key for the EU to lead the fixing of the current copyright issues across Europe, as it is sometimes quite difficult to share materials across countries, because national legislations operate differently and there are not clear common grounds in relation to the use of open licenses.
BG.2	All teaching and learning resources and research outcomes from the EU level (thus Erasmus+, H2020, etc.) must be openly published.
CZ.2	The EU should, in order to ensure that openness-related good practices are known and shared, monitor all the documentation, agendas, polices and their outcomes such as guides, materials and resources produced with EU funding to ensure that they are published under open licenses.
CZ.3	The biggest help would be if the EU would state that everything that is done from EU funds has to have a CC BY license.
DE.3	Legal guidelines on OER and copyright from the EU would help the discussion at the Member State level
SK.4	EU should develop with Member States a common framework in relation to procurement of educational resources and textbooks commissioned to private publishers by the governments and funded with public funds or with European funds, to be published under open licenses.

Recognition of Prior Learning

It was a little surprising that there was not more on this.

NL.2	Since a high number of MOOCs have been produced by European HEIs as part of their open education remit, the EU should ensure that, after ensuring the quality of these online courses, students can take them as part of their elective modules, gaining credits upon completion of these courses as if these were part of a sort of e-Erasmus, ensuring that these courses live up to their full potential.

Leadership

It is gratifying to those involved in leadership development projects in the digital education field[394] to see this strong list of recommendations.

[393] http://poerup.referata.com/w/images/SharedOER_D2-1.pdf – a study for JRC/IPTS

[394] http://www.dtransform.eu – part-funded by Erasmus+

SE.1	The EU should advise governments and ministries about the development of policies in this field.
SK.2	The EU should provide leadership, support and recommendations for Ministries of Education.
HU.1	The EU should support processes to change the thinking of institutional leaders.

Pedagogy

These recommendations are a contrast to those under “Standards” above.

IE.1	The EU should promote excellence in teaching and learning, embedding its value in the policies they promote.
UK.1	The EU as well as Member States should focus on promoting diverse and engaging models of Open Educational Practices, both at formal and informal education levels, propagating a wide range of Open Educational Practices and models and must not just focus on promoting and delivering Open Education via MOOCs exclusively.

Digital skills for students

It was a surprising that there was not much more on this.

EE.1	EU should consider, with Member States, when developing digital skills in schools and when adopting the use of digital devices with children, the concerns of the parents and provide guidance and support to this group to ensure the effective use of these resources.

Teacher training

This is pair of traditional recommendations, but which do need to be re-stated for each programme.

EE.3	The EU should provide Member States not only with a framework of competencies and skills, but guidance and resources to develop these skills, including by providing accredited MOOCs for teachers’ training and more funds for the development of open education
LT.3	The EU should facilitate teachers’ mobility, offer more Erasmus+ projects to enhance teachers’ capabilities, and provide a platform for the sharing of good practices that can facilitate and motivate teachers’ training.

Technology – experimental spaces

NL.1	To facilitate further developments of open education in Europe, the EU should create a space where policy makers can share good practices across countries and institutions.
UK.3	The EU should provide spaces for people to experiment and to innovate at collaborative level, thus an online collaborative space for open education practitioners to use for experimentation and to share good practices.

Refugees

This is of course a topical recommendation.

BG.3	The EU should provide support for initiatives from EU countries to develop open educational platforms and resources for migrants and refugees, to support them learning the language of their host countries, to facilitate them to become integrated into society and to empower them to gain access to the formal educational system.

5.2 Recommendations for Member States

Research

These recommendations certainly find favour with the research team. The current state of knowledge of open education in the EU and related countries is not high, though probably better than in most other continents except for perhaps North America and Australasia.

AT.1	To properly set up a policy in the field of open education a lot of desk research is needed to be done *within* each Member State, since a lot of things are happening nationally and internationally. (Member States cannot and should not fully rely on EU-level research to inform their decisions.)[395]
AT.2	It is important for each Member State to look into not only "who is doing what" in their own country but also who do they have to bring together in order to facilitate decisions and to understand the areas that they have to focus on.[396]

Awareness raising

This is complementary to the recommendations to the EU in terms of awareness raising of open education.

RO.3	What each Member State does in the field should be made more visible at EU level.

Content and copyright

These are also complementary to the recommendations to the EU in terms of awareness raising of open education.

BG.2	Member States must ensure that teaching and learning resources and research outcomes must be openly published if produced using public funds.
SK.4	Member States should work together and with EU to develop a common framework in relation to procurement of educational resources and textbooks commissioned to private publishers by the governments and funded with public funds or with European funds, to be published under open licenses.

[395] Only a minority of Member States have done such studies: such as Sweden, Germany, Netherlands and UK – others do nothing or rely on EU-level reports

[396] Member States have considerably different approaches to education and its funding and organisation

Recognition of Prior Learning

It was a little surprising that there was not more on this.

DE.1	There should be a system in each Member State to support the Recognition of Prior Learning, thus able to transform lifelong learning and vocational training systems, and so increasing openness of and democratising access to higher education.[397]

Leadership

It is gratifying to those involved in leadership development projects in the digital education field[398] to see this strong list of recommendations.

LT.1	Member States should involve school principals, and educational institution leaders more generally, as they can be both an obstacle and an enabler in the implementation of policies and agendas.
IE.3	Policy-makers in open education in Member States should always remember that if a policy is to be an agent of change, the engaged stakeholders will feel a bit uncomfortable and must be guided through the process of embracing the proposed novelties.
IT.1	The approach of "living policy making" is probably the secret of the success of policy in a Member State: engaging and accompanying stakeholders in the implementation phase should actually be the core activity of the staff in charge of the policy; this needs a lot of support time but pays off in terms of impact and perceived relevance of the initiative.

Pedagogy

These recommendations are a contrast to those under "Standards" above. It is really interesting and unusual see Ireland, UK and Austria in agreement on these matters.

AT.3	Policy-makers in Member States, especially federal ones, must be open to different visions when they are planning policies and measures, involving stakeholders, and daring to be a bit visionary.

Digital skills for students

It was a surprising that there was not much more on this.

EE.2	Member States should realise that it is important to consider that digital skills are needed to prepare students for higher education. This can be an effective way to democratise and to widen access to universities.
EE.1	Member States should consider, when developing digital skills in schools and when adopting the use of digital devices with children, the concerns

[397] This is a topic worthy of its own full report. For an introduction see http://eacea.ec.europa.eu/education/eurydice/documents/focus-on/152.pdf and the discussion in the *ADOERUP* 2015 report to the European Parliament, http://www.europarl.europa.eu/RegData/etudes/STUD/2015/563397/IPOL_STU(2015)563397_EN.pdf sections 4.2.6 and 5.1

[398] http://www.dtransform.eu – part-funded by Erasmus+

	of the parents and provide guidance and support to this group to ensure the effective use of these resources.[399]

Collaboration

This fits the European approach better than it might the North American. However it may not fit the student-number-based or outcome-based funding models now common in Member States where either there is competition for student fees or competition for Ministry student-based funding.

FI.1	Member States should, where appropriate, favour more collaboration among institutions: universities need to see the value of this cooperation and the Ministry needs to reward these collaborations, also working on practical issues such as interoperability and information sharing. This will help "institutionalizing" openness.

Organisation

Opinions may vary on the wisdom of this. It is almost routine for quality agencies, less so for other areas of activity.

IE.2	Member States should ensure that a policy should not be positioned within an institution (Ministry or HEIs), but be in an independent agency.

[399] This has been taken very seriously in the UK over several years in the era when Becta was in charge of such policies – see e.g. http://webarchive.nationalarchives.gov.uk/20130401151715/http://www.education.gov.uk/publications/eOrderingDownload/Exploiting%20ICT.pdf – but arguably less so now, though see https://www.theguardian.com/teacher-network/teacher-blog/2014/jul/16/talking-to-parents-how-schools-using-social-media

6. Future research and related work

The following proposals are made:

1. **The study should be extended to cover at least the former Lifelong Learning Programme and the current Erasmus+ Programme countries**. This will substantially increase the value and the political acceptance of the conclusions. Outside the EU these comprise:

- Norway and Iceland (Erasmus+ non-EU Programme countries) – cross-border collaboration with Sweden and Denmark. Norway has substantial OER activity[400] especially NDLA[401] and Iceland has made a good start.[402]
- Liechtenstein (Erasmus+ non-EU Programme country) – cross-border collaboration with Germany. Despite being very small, it has a university, which offers lifelong learning.[403]
- Switzerland (Erasmus+ Partner country) – cross-border collaboration, depending on zone, with France, Germany and Italy. There is substantial online learning, OER[404] and MOOC[405] activity in Switzerland, across three languages.
- Turkey (Erasmus+ non-EU Programme country), with an open university[406] (also offering MOOCs) and substantial OER.[407]
- Yugosphere and nearby countries outside the EU – Macedonia[408] (Erasmus+ Programme country) and Albania, Bosnia and Herzegovina, Kosovo, Montenegro, and Serbia[409] (Erasmus+ Partner countries of Western Balkans) – cross-border collaboration with Slovenia and Croatia.

In addition Moldova[410] should be included (from the Eastern Partnership Countries) – cross-border collaboration with Romania.

Extension to other countries of the European Higher Education Area would also be useful but ideally the costs of this should be shared, for example with UNESCO Moscow if Russia[411] and similar countries were to be included.

2. **Key documents** for such studies which are not available in English (noted that many are, such as those which are OGP plans or bids for Structural Funds) **should be translated into English,** at no cost to the issuing country.

3. DG EAC should consult take steps to ensure that in the area of ICT in education in general, and open education in particular, the lack of recent relevant reports for at least half of the Member States that became evident from this study is put right in the next few years. As an ideal, **each Member State should be studied in detail at least once every five years**. Such a change is likely to require adjustment to the

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400 http://poerup.referata.com/wiki/Norway
401 https://www.openeducationeuropa.eu/en/institution/norwegian-national-digital-learning-arena
402 http://education.okfn.org/open-education-iceland/
403 https://www.uni.li/en/further-education
404 See the OER Atlas – https://oerworldmap.wordpress.com/2016/03/08/printing-the-oer-world-map-the-oer-atlas/
405 https://www.mooc-list.com/countrys/switzerland
406 https://www.anadolu.edu.tr/en
407 See for example http://education.okfn.org/open-education-turkey/ – but there is also substantial unpublished work on OER in Turkey
408 http://education.okfn.org/open-education-macedonia/
409 http://education.okfn.org/open-education-serbia/
410 http://education.okfn.org/open-education-moldova/
411 http://education.okfn.org/open-education-russia/

mechanisms of Erasmus+ – by for example more use of central KA2 actions.[412] It cannot be left to the national nodes – there is too much evidence of both overlap (new projects not building on earlier projects) and underlap (some Member States not studied for over 10 years).

4. While it was an obvious and perhaps necessary reaction to the financial situation, **the use of volunteer labour to document open education should play a minimal part in future research projects in open education**. The evidence from the OER World Map and the Open Education Working Group is that it has not delivered useful results in Europe. As a result the knowledge base is decaying fast.

5. **Future research projects need to contain speakers of the relevant languages under study**, but there are dangers in using only in-country language experts as it is easy for them to become "apologists" for their countries, covering up weaknesses. Within the funding parameters we had, we tried to do our best and believe that we have largely dealt with such issues in the larger countries, but cannot be confident for smaller Member States with less-used languages. A balance of in-country and out-of-country linguistic expertise is the ideal, if funding permits.

[412] https://erasmusplus.org.uk/key-action-2

7. References

The documents we use fall into four main categories:

1. Overall reports
2. EU- or Europe-wide series of reports which have a report for each country and often are updated annually
3. Project outputs or occasional OECD, UNESCO etc reports which have a report for each country they studied (usually no more than 1/3 of Member States, sometimes just 1/4).
4. Specific documents or URLs normally on initiatives

7.1 Overall reports

- Various reports from CEDEFOP and national experts on Recognition of Prior Learning

7.2 EU-wide series of reports

The main ones we consulted were:

- Eurypedia by Eurydice, a set of wiki-type pages on the education systems and policies of each Member State
- *National Student Fee and Support Systems* by Eurydice, a comprehensive report on fees and funding for universities in each member state, annually updated

7.3 Project and agency outputs

- *POERUP wiki*, with a set of country reports on many EU Member States (and many other countries)related to educational policy, OER and MOOCs
- ADOERUP report, produced for the European Parliament, with a focus on adult education and open education, with annexes on eight Member States and briefer entries on four more
- Additional country reports such from UNESCO IITE, OERup! and the Open Education Working Group blog
- *Business models for Opening up Education*, with EU-wide tabulations and sections on seven Member States, a recent report produced for D-TRANSFORM (Erasmus+ project on leadership in open and digital education)
- Country-specific policy papers from the recent Policy Forum on European MOOCs (organised by the HOME project led by EADTU)
- OECD Education policy outlooks and other relevant publications
- OpenDOAR country summaries

7.4 Documents and links for each country

Austria

1. http://www.donau-uni.ac.at/en/
2. University of Salzburg offering at http://salzburg.unigis.net
3. http://www.opendoar.org/find.php?cID=15&title=Austria
4. http://ec.europa.eu/europe2020/pdf/csr2015/nrp2015_austria_en.pdf
5. https://www.oecd.org/edu/school/2016%2006%2014%20OECD_Country%20Background%20Report%20AT%20FINAL.pdf
6. http://wissenschaft.bmwfw.gv.at/fileadmin/user_upload/wissenschaft/naric/The_Austrian_System_of_Higher_Education2015_engl.pdf
7. https://www.fernuni-hagen.de/regionalzentren/ausland.shtml
8. https://www.bmb.gv.at
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Annex 1. List of interviewees

Country	Policy	Interviewee	Role and institution
Austria	efit21 – digitale Bildung	Helga Posset	Federal Ministry for Science, Research and Economy
Croatia	Strategy of Education, Science and Technology	Sandra Kučina Softić	Head of E-learning Office, University of Zagreb
Cyprus	Digital Strategy for Cyprus (Measure 16 eEducation)	Anastasia Economou	Head of ICT Unit, the Ministry-level entity for ICT educational policies in schools
Czech Republic	Strategy for Education Policy of the Czech Republic 2020	Tamara Kovacova	EDUin
Denmark		Line Bækgaard - Fuldmægtig	Danish Agency for Higher Education
Estonia	Estonian Lifelong Learning Strategy 2020	Ene Koitla	Head, Innovation Centre, Estonian Information Technology Foundation for Education
Finland		Ilmari Hyvönen	Senior advisor, Department of Higher Education and Science Policy, Ministry of Education and Culture
Germany	Advancement through Education: Open Universities 2011-2020	Ida Stamm	Senior Consultant, VDI/VDE Innovation, Technik GmbH on behalf of BMBF
Germany	Mainstreaming OER	Barbara Getto and Richard Heinen	Heads of Mainstreaming OER programme for North Rhine Westphalia
Greece	3rd National Action Plan on Open Government 2016-2018	John Vrettaros	Unit of Digital systems in LLL, Directorate of Digital Governance, Ministry of Education, Research & Religious Affairs
Hungary		András Benedek	Vice-Rector, Budapest University of Technology and Economics
Ireland	National Forum for the Advancement of Teaching and Learning in Higher Education	Terry Maguire	Director, National Forum for the Advancement of Teaching and Learning in Higher Education
Italy	Piano Nazionale Scuola Digitale	Donatella Solda	Executive Director, Cabinet of the Minister, Ministry of Education, University and Research

Country	Policy	Interviewee	Role and institution
Latvia		Ilmārs Slaidiņš	Professor, Riga Technical University
Lithuania	Activity Plan for ICT Implementation in General and Vocational Education for 2014–2016	Giedrius Vaidelis	Director, Education Development Centre
Netherlands	Higher Education 2025, The value of knowledge	Ruud Nauts	Policy responsible, Ministry of Education
Poland	OP KED – Operational Program for Knowledge Education Development	Beata Pojawa	Department of European Structural fund at the Ministry of Development
Romania	National Open Government Plan (Virtual School Library and OER)	Radu Puchiu and Diana Andone	Secretary of State, Office of the Prime Minister and Director, eLearning Center, Politehnica University of Timisoara
Slovakia	Open Government Partnership Action Plan	Iveta Ferčíková	Office of the Plenipotentiary for the Development of the Civil Society
Sweden		Per Rosenblad	Ministry Secretary, Ministry of Education and Research
United Kingdom	Open Education Practices Scotland	Pete Canell	OEPS Project coordinator, Open University in Scotland
United Kingdom	Higher Education Funding Council for England, national OER programmes	David Kernohan	Senior co-design manager, Jisc

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1. Dr. Helga Posset, Federal Ministry for Science, Research and Economy, Austria
2. Sandra Kučina Softić, Head of E-Learning Centre at SRCE and the E-learning Office of the University of Zagreb, Croatia
3. Anastasia Economou, Head of the Educational Technology Department, Pedagogical Institute, Ministry of Education and Culture, Cyprus
4. Tamara Kovacova, EDUpoint programme, EDUin (Advising institution to the Ministry of Education), Czech Republic
5. Line Bækgaard-Fuldmægtig, Danish Agency for Higher Education, Denmark
6. Ene Koitla, Head, Innovation Centre, and Inga Kõue, Head of Content Development, Estonian Information Technology Foundation for Education, Estonia
7. Ilmari Hyvönen, Senior advisor, Ministry of Education and Culture, Department of Higher Education and Science Policy, Finland
8. Ida Stamm, Senior Consultant, VDI/VDE Innovation, Technik GmbH on behalf of BMBF, Germany; and Barbara Getto and Richard Heinen, University of Duisburg-Essen, Heads of Mainstreaming OER programme for North Rhine Westphalia, Germany
9. John Vrettaros, Unit of Digital systems in LLL, Directorate of Digital Governance, Ministry of Education, Research & Religious Affairs, Greece
10. András Benedek, Vice-Rector, Budapest University of Technology and Economics, Hungary
11. Terry Maguire, Director, National Forum for the Advancement of Teaching and Learning in Higher Education, Ireland
12. Donatella Solda, Executive Director, Cabinet of the Minister, Ministry of Education, University and Research, Italy
13. Ilmārs Slaidiņš, Professor and OER expert, Riga Technical University, Latvia
14. Giedrius Vaidelis, Director of Education Development Centre, and Vaino Brazdeikis, Director of Centre of Information Technologies in Education under the Ministry of Education and Science, Lithuania
15. Ruud Nauts, Policy responsible, Ministry of Education, Culture and Science, Netherlands
16. Beata Pojawa, Department of European Structural fund at the Ministry of Development, Poland
17. Radu Puchiu, Secretary of State, Office of the Prime Minister, and Diana Andone, Director, eLearning Center, Politehnica University of Timisoara, Romania
18. Iveta Ferčíková, Office of the Plenipotentiary for the Development of the Civil Society, Slovakia
19. Per Rosenblad, Ministry Secretary, Ministry of Education and Research, Sweden
20. Pete Cannell, Project co-director, OEPS, Open University in Scotland, Scotland; and David Kernohan, Senior co-design manager, Jisc, UK

In addition to the interviewees the following people acted as advisors. A considerably longer list of experts were approached but the response rate from such experts was disappointingly low.

Country	Experts and interviewees	Role and institution
Austria	**Dr. Helga Posset** Monika Moises Wolfram Laaser	Federal Ministry for Science, Research and Economy Blended Learning Consultant, Consultant to the Austrian Ministry of Education in International Project Management Instructional designer, Austrian School of Applied Studies; and former Academic Director, FernUniversität in Hagen
Bulgaria		
Croatia	**Sandra Kučina Softić**	Head of E-Learning Centre at SRCE and the E-learning Office of the University of Zagreb
Cyprus	**Anastasia Economou** Kevin Andrews	Head of ICT Unit, the Ministry-level entity for ICT educational policies in schools Chief Academic Officer, UNICAF, University of Nicosia Online
Czech Republic	**Tamara Kovacova**	EDUin
Denmark	**Line Bækgaard-Fuldmægtig** Hanne Shapiro Rikke Warming Tue Vinther-Jørgensen	Danish Agency for Higher Education DTI Special Advisor, Danish Accreditation Institution Senior Consultant, Centre for Education Policy, Ministry of Higher Education and Science
Estonia	**Ene Koitla** **Inga Kõue** Hans Põldoja	Head, Innovation Centre, Estonian Information Technology Foundation for Education Head of Content Development, Estonian Information Technology Foundation for Education Head of Studies, School of Digital Technologies, Tallinn University
Finland	**Ilmari Hyvönen** Pirkko Ruuskanen-Parrukoski Tina Engblom Jouni Kangasniemi	Senior advisor, Department of Higher Education and Science Policy, Ministry of Education and Culture, Director, Finnish Lifelong Learning Foundation Deputy Director, Centre for Lifelong Learning, Abo Akademi University Head of Development, Ministry of Education and Culture

Country	Experts and interviewees	Role and institution
Germany	**Ida Stamm**	Senior Consultant, VDI/VDE Innovation, Technik GmbH on behalf of BMBF
	Barbara Getto and Richard Heinen	University of Duisburg-Essen, Heads of Mainstreaming OER programme for North Rhine Westphalia
	Isabel Schünemann	Program Manager, Stifterverband für die Deutsche Wissenschaft
	Jan Neumann	OER World Map, Hochschulbibliothekszentrum des Landes NRW
	Susanne Friz	Abteilung Dienstleistungen, Projekte, Medienentwicklung, FWU Institut für Film und Bild in Wissenschaft und Unterricht gemeinnützige GmbH
	Oliver Janoschka	Head of Programmes, Stifterverband für die Deutsche Wissenschaft
	Ulf-Daniel Ehlers	Vice-President Quality and Academic Affairs, Baden-Württemberg Cooperative State University
Greece	**John Vrettaros**	Unit of Digital systems in LLL, Directorate of Digital Governance, Ministry of Education, Research & Religious Affairs.
	Kalomira Marouga	General Director, Strategic Planning and Design of Electronic Governance, Ministry of Education, Research and Religious Affairs
	Nikitas Kastis	Senior Consultant /Director, Mind2Innovate
	Spiros Borotis	E-Learning Advisor
Hungary	András Benedek	Professor and Vice-Rector, Budapest University of Technology and Economics
	András Szűcs	Secretary General EDEN (European Distance and E-learning Network)
Ireland	**Terry Maguire**	Director, National Forum for the Enhancement of Teaching and Learning
	Brian Mulligan	Online Learning Research and Development, Institute of Technology Sligo
	Mark Brown	Professor and Director, National Institute for Digital Learning, Dublin City University
	Kevin O'Rourke	National Forum for the Enhancement of Teaching and Learning
Italy	**Donatella Solda**	Executive Director, Cabinet of the Minister, Ministry of Education, University and Research
	Ada Giannatelli	E-learning project manager, METID, Politecnico di Milano
	Anna Maria Tammaro	Università di Parma
	Eleonora Pantò	CSP Piemonte
	Matteo Uggeri	Fondazione Politecnico di Milano
Latvia	**Ilmārs Slaidiņš**	Professor, Riga Technical University
Lithuania	**Giedrius Vaidelis**	Director, Education Development Centre
	Vaino Brazdeikis	Director, Centre of Information Technologies in Education, Ministry of Education and Science
	Alvida Lozdienė	Supervisor, Information and Communication Technology Division, Education Development Centre
Luxembourg	Gust Mees	ICT Course Instructor, Life-Long Learner and Blogger
	Anand Karat	President, Vretta

Country	Experts and interviewees	Role and institution
Netherlands	**Ruud Nauts** Robert Schuwer	Policy responsible, Ministry of Education Lector OER (Professor) in OER, Fontys Hogeschool ICT
Poland	**Beata Pojawa** Alek Tarkowski	Department of European Structural fund, Ministry of Development Director, Centrum Cyfrowe
Romania	**Radu Puchiu** **Diana Andone** Radu Vasiu Carmen Holotescu Gabriel Dima	Secretary of State, Office of the Prime Minister Director, eLearning Center, Politehnica University of Timisoara Professor and Chair of Senate, Politehnica University of Timisoara CEO Timsoft; and Professor, University “Ioan Slavici” Timisoara Politehnica University of Bucharest
Slovakia	**Iveta Ferčíková**	Office of the Plenipotentiary for the Development of the Civil Society
Sweden	**Per Rosenblad** Ebba Ossiannilsson Per Westman Alastair Creelman Seth Norberg	Ministry Secretary, Ministry of Education and Research (responsible for the compilation of the answers on the Sweden MOOC report) Consultant Deputy Head of Department, Department of Higher Education Analysis, Swedish Higher Education Authority E-learning specialist, Linnaeus University Director of Education, School Improvement, Unit for School Organisation and Management, SKOLVERKET/Swedish National Agency for Education
United Kingdom	**Pete Cannell** **David Kernohan**	Project co-director, OEPS, OU in Scotland David Kernohan, Senior co-design manager, Jisc

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In Search for the Open Educator: Proposal of a Definition and a Framework to Increase Openness Adoption Among University Educators

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Abstract

The paper explores the change process that university teachers need to go through in order to become fluent with Open Education approaches. Based on a literature review and a set of interviews with a number of leading experts in the field of Open Educational Resources and Open Education, the paper puts forward an original definition of Open Educator which takes into account all the components of teachers' work: learning design, teaching resources, pedagogical approaches and assessment methods- of teachers' activities. Subsequently, to help the development of teachers' openness capacity, the definition is further developed into a holistic framework for teachers, which takes into account all the dimensions of openness included in the definition and which provides teachers with self-development paths along each dimension. By working on the definition and on the framework with the interviewed experts, the paper concludes that a strong relation exists between the use of open approaches and the networking and collaboration attitude of university teachers, and that in order to overcome the technical and cultural barriers that hinder the use of open approaches in Higher Education, it is important to work on the transition phases – in terms of awareness and of capacity building - that teachers have to go through in their journey towards openness.

Keywords: open education, higher education, teachers, open design, open educational resources, open methodology

Introduction: The Realised and Unmet Potential of Open Education

Open Education has the potential to increase quality, access, and attractiveness of Higher Education, fostering "a more democratic and competitive higher education system, with the potential to improve access to education, develop and localize open educational services to suit local contexts, and enhance the integration of education into everyday lives as part of lifelong learning" (Butcher & Hoosen, 2014, p. 9). Weller notes that openness has made it to the center of the Higher Education debate, especially thanks to the media interest raised by the Massive Open Online Courses (MOOCs) phenomenon, and that openness is starting to become the norm, especially in scholarly activities. "There is undoubtedly still a lot more that open education needs to do before it affects all aspects of practice, but the current period marks the moment when open education stopped being a peripheral, specialist interest and began to occupy a place in the mainstream of academic practice" (Weller, 2014 p. 9). Nevertheless, if we look at adoption of open approaches, the picture is controversial. On the one hand, research shows that OER, Open Educational Practices (OEP), Open Textbooks and MOOCs are increasingly being adopted by universities around the world (Esposito, 2013; European Commission, 2013; Grodecka & Śliwowski, 2014), but on the other hand many observers agree that the outreach of the openness in education is still far from its potential impact (Glennie, Harley, Butcher, & Van Wyk, 2012; Hollands & Tirthali, 2014; Kortemeyer, 2013; Okada, Mikroyannidis, Meister, & Little, 2012; Rohs & Ganz, 2015). “Awareness of OER and Creative Commons is growing, but OER repositories remain relatively unused and unknown compared with the main three educational resource sites of YouTube, Khan Academy and TED” (De los Arcos, Farrow, Perryman, Pitt, & Weller, 2014, p. 4). The situation is certainly evolving, even if we need to accept that the consideration made by Conole in 2008 is still valid today: “Arguably then there has never been a better alignment of current thinking in terms of good pedagogy – i.e. emphasising the social and situated nature of learning, rather than a focus on knowledge recall with current practices in the use of technologies – i.e. user-generated content, user-added value and aggregated network effects. Despite this, the impact of Web 2.0 on education has been less dramatic than its impact on other spheres of society – use for social purposes, supporting niche communities, collective political action, amateur journalism and social commentary” (as cited in Weller, 2012, p. 89).

The Missing Bit in Open Education: Open Educators

In the last years, a number of studies have been investigating the reasons for this slow adoption of open approaches, focusing mainly on OER but also on Open Policies and Open Educational Practices (Open Education Group, 2015), but very few research projects have focused on what we think is one of the major *missing links* for openness in education to get mainstreamed, which is the need to empower teachers and lecturers to embrace open approaches in their daily work. A number of observers agree with this priority. Back in 2005, in a report presented to UNESCO, Albright (2005) was already recognising the importance of the involvement of faculty members, both through top-down and bottom-up initiatives. Five years later, Pearce stated that “digital scholarship is more than just using information and communication technologies to research, teach and collaborate, but it is embracing the open values, ideology and potential of technologies born of peer-to-peer networking and wiki ways of working in order to benefit both the academy and society” (Pearce, Weller, Scanlon, & Kinsley, 2010, p. 40). More recently, Allen and Seaman (2014) consider that “faculty are the key decision makers for OER adoption, across disciplines, in the opinion of both chief academic officers and faculty themselves,” (p. 2) and Price (2015) states that transformation in education, to be sustainable, has to be owned by teachers, who are the people who have to implement it. In the well-known model by Boyer (1990), the work of teachers is conceptualized as a continuum that includes the activities of discovery, integration, application and teaching. We believe that the teaching function is the cornerstone for change to happen, as suggested by Pearce et al. (2010): “It is arguably in Boyer’s (1990) fourth function, that of teaching, that we see the biggest impact of digital technologies and open approaches” (p. 40). Following a thorough analysis of all aspects of openness in education, Weller (2012) concludes along the same line: “When we consider the changes in scholarly practice, it is perhaps in teaching that we see the greatest potential for a radically different approach to emerge. The three key elements of digital, networked and open converge most significantly around the production, pedagogy and delivery of education” (p. 85).

Proposing an Holistic Definition of Open Educator

The Open Educators Factory project[1] is tackling specifically the need to explore the change process that university teachers need to go through is we want them to embrace openness in their teaching activities, becoming not only fluent with open approaches but also advocates of openness in higher education. During the first phase of the project we have run a literature review searching for definitions, conceptual frameworks, and guidelines targeting university teachers and aiming at improving their open fluency, and we have then discussed the results of this work with a number of experts in the field of open education, namely, Wayne Mackintosh from the OER Foundation, Rory Mc Greal from Athabasca University, UNESCO/Commonwealth of Learning/ICDE Chair in OER, Chrissi Nerantzi from Manchester Metropolitan University, Antonio Teixeira, President of the European Distance and eLearning Network, and Martin Weller from The Open University UK, ICDE Chair in OER. Given the exploratory nature of the study, we adopted a qualitative approach to data collection and analysis, by using semi-structured interviews divided into two parts: first, a traditional interview with a sequence of themes and questions, and second, an interactive activity in which experts were invited to directly comment and improve the definition and framework presented below.

A first result of the literature review, which was confirmed by the interviewed experts, is that while definitions of OER and Open Education are abundant in policy as well as in scientific literature – even if some degree of disagreement on what openness means is still present (Bates, 2011; Deyman & Farrow, 2013), a definition that encompasses openness within teachers' activities *as a whole* does not seem to exist. On the other hand, we have encountered numerous analyses of the various aspects of what an Open Educator could and should do. Existing literature seems to be focusing on the *objects* of Open Education, such as Open Educational Resources, and more recently, MOOCs (Allen & Seaman, 2014; Cormier, 2008; De los Arcos et al., 2014; Kortemeyer, 2013; Rolfe, 2012; Wild, 2012), or on its *practices*, such as Open Pedagogy (Esposito, 2013; Murphy, 2013; Okada et al., 2012), Open Design (Cochrane & Antonczak, 2015; Conole, 2013; Laurillard, 2012), and Open Scholarship (Pearce et al., 2010; Weller 2012). In addition, teachers are often targeted with guidelines that should facilitate their development towards the adoption of OER (Butcher, 2015; Grodecka & Śliwowski, 2014; Kreutzer, 2014; McGill, 2012) or with competencies frameworks that should structure their professional development in general terms (Department for Business, Innovation and Skills of the UK, 2015; Higher Education Academy, 2011) and with specific reference to ICT (UNESCO 2011).

When asked to point out a general definition of Open Educators, the interviewed experts focused on specific aspects of a teachers' work, but never listed all the areas of activity for teachers. At the same time, they all agree that if we want teachers not only to accompany but rather to drive the change towards openness in education, we need to have a clear and possibly shared understanding of what we mean by an Open Educator. This would help decision makers at different institutional and policy

[1] The Open Educators Factory research project started in April 2015 and will end in March 2017. The project is funded by the Universidad Internacional de la Rioja (UNIR) .

levels as well as the teacher population itself to have a clear "development target" towards which to work. To fill the gap given by the absence of an holistic definition that can represent a clear target for the transformation of teachers into open educators, we created a definition which takes into account both the *objects*, teaching content and tools, and the *practices*, learning design, pedagogical, and assessment approaches, of teachers' activities. As said before, this definition is grounded on our literature review and has been worked out in collaboration with the interviewed experts, whose specific contributions are mentioned later in the analysis of the definition.

Our definition of the Open Educator is the following:

> An Open Educator choses to use open approaches, when possible and appropriate, with the aim to remove all unnecessary barriers to learning. He/she works through an open online identity and relies on online social networking to enrich and implement his/her work, understanding that collaboration bears a responsibility towards the work of others.
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> An Open Educator implements openness along four main activities. He/she:

1. Implements open learning design by openly sharing ideas and plans about his/her teaching activities with experts and with past and potential students, incorporating inputs, and transparently leaving a trace of the development process.

2. Uses open educational content by releasing his/her teaching resources through open licenses, by facilitating sharing of her resources through OER repositories and other means, and by adapting, assembling, and using OERs produced by others in his/her teaching.

3. Adopts open pedagogies fostering co-creation of knowledge by students through online and offline collaboration and allowing learners to contribute to public knowledge resources such as Wikipedia.

4. Implements open assessment practices such as peer and collaborative evaluation, open badges, and e-portfolios, engaging students as well as external stakeholders in learning assessment.

The definition starts with a general paragraph that contextualises the expected transformation of teachers with the existing higher education context, by stating that an Open Educator choses to use open approaches *when possible and appropriate*, meaning that openness should always be adopted if and when it can improve the teaching process and the learners accessibility and performance in a coherent way with the institutional context under which the educator is operating. As one of the interviewed experts put it: "In a nutshell, for an Open Educator open is default, close is exception" (Macintosh, personal communication, July 21, 2015). The paragraph provides a clear answer to the question on why an educator should opt for open approaches, that is to remove all unnecessary barriers to learning (Macintosh, personal communication, July 21, 2015): here we mean both access-related barriers, connected for example with the socioeconomic status of students or with students' disabilities, but also the more subtle barriers connected to learning personalization, learning styles, and preferences (Teixeira, personal communication, October 7, 2015). Then, it is specified that, as Weller suggested during the interview, an Open Educator should work through an open online identity, meaning that he/she should adopt a transparent and consistent attitude in online spaces related to his/her teaching work (Ross, Sinclair, Knox, Bayne, & Macleod, 2014), and rely on online social networking to enrich and implement her teaching, making the connection clear between being open and being networked (Weller, personal communication, June 11, 2015). Finally, the definition stresses the importance of understanding the responsibility towards the work of others that comes with the adoption of open approaches, meaning that an open educator should be cautious about issues like privacy or use of personal data (Nerantzi, personal communication, October 30, 2015).

In its second part, the definition suggests that openness should pervade all the components of teachers' work: the way a teacher designs his/her courses, the way he/she licenses, creates, and shares learning content, the pedagogical practices, and the assessment approaches implemented. The definition is based on the assumption that a correct process of "opening up education," to use the wording of a recent initiative by the European Commission (European Commission, 2013), should be based on opening up all these four components (design, content, teaching, and assessment) that ideally "shall coexist and complement each other within a generalised open culture" (Nerantzi, personal communication, October 30, 2015). First, opening up learning design, by co-designing curriculum and courses with peers and students and allowing the courses to evolve and improve year after year, as "a creative way to breath new life and fresh ideas into course design" (Cochrane & Antonczak, 2015, p. 3). Second, opening up the teaching content, by releasing course material as Open Educational Resources and by making sure it is findable and usable by others (McGreal, personal communication, November 30, 2015). Third, adopting open pedagogical approaches, intended as "a blend of strategies, technologies, and networked communities that make the process and products of education more transparent, understandable, and available to all the people involved" (Grush, 2014, para. 4). Fourth, implementing open assessment practices such as peer evaluation or e-portfolios, opening up the assessment also to the courses themselves, so as to improve them based on peer and student feedback (Nerantzi, personal communication, October 30, 2015) Further, opening up education means also to open up the organisational and learning boundaries of one's teaching activities, for example allowing students to follow courses in an open MOOC style also if they are not enrolled in the university (Dalsgaard & Thestrup, 2015; Weller, personal communication, June 11, 2015), or working towards the provision solutions towards accreditation of the knowledge acquired (Macintosh, personal communication, July 21, 2015; Peterson, 2014).

All interviewed experts pointed out that the transition of teachers towards openness must be seen in a broader change process, connected both with the actual crisis of university systems (High Level Group on the Modernisation of Higher Education, 2013; Sledge & Dovey Fishman, 2014) and with the possibilities offered by ICT and social media. University teachers have always considered themselves as the experts in the body of knowledge that needs to be communicates to students for them to get educated. This role is being increasingly questioned by educational researchers, who claim that thanks to the spread of ICT and to the open and networked approached that they have made possible, new forms of social learning are emerging that challenge the traditional roles within education systems, and in particular the idea that teachers are the only ones entitled to produce knowledge (Schmidt, Geith, Håklev, & Thierstein, 2009). "Since the distributed and networked structure of knowledge in the digital age challenges the traditional view of education delivered within the borders of school, strict time periods, and content, the role of the teacher has been redefined in the context of the connectivist paradigm to include networked learning environments" (Ozturk, 2015, p. 6). In a nutshell, teachers should become critical friends, co-travelers, mediators, and facilitators (Anderson & Dron, 2011; Bates, 2015; Downes, 2012; McLoughling & Lee, 2008; Rivoltella & Rossi, 2012). Notably, this change should not be limited only to staff with a teaching function within universities, but applies also to other stakeholders involved in the learning process, such as curriculum designers, learning material designers, librarians, assessors and validators of learning, teacher trainers, pedagogical advisors and consultants, support staff, quality assurance professionals (Teixeira, personal communication, October 7, 2015).

Open Teaching, Beyond OER, and OEP

The few existing definitions of Open Educator – probably because they were developed when content and courseware were at the center of the open education debate - are built around the idea that an open teacher is the one that uses OER. For example, in 2009, Wiley and Hilton defined open educators as the ones who "publish their course materials online under an open license before the beginning of the course and invite students from outside their university to participate in the course together with the official students of the course" (p. 11). Even if this definition contains a fundamental element of openness that is the importance of opening up courses to non-enrolled students, we believe that adopting OER is just the first necessary step for educators to get open, and that other elements should be present in a definition of Open Educator, starting from the adoption of open teaching (McGreal, personal communication, November 3, 2015).

Building on and adapting the work of McLoughlin and Lee (2008), Stacey (2013), and Reynolds (2015) we propose some reflections on what we mean with open teaching with the aim to show that an Open Educator today should be conceptualized in a much broader way with respect to a teacher who uses openly released resources. First, considering that learners today have a much easier and fact access to ideas, resources, and environments that supports their learning interests and choices, open teaching means to engage the learner in the social process of knowledge development instead of just letting them use the information and learning material presented by the teacher. Second, open teaching means to consider learners as individuals and independent agents within the learning process, allowing them to operate independently and learn at their own pace, in their own direction, and using their own connections. Third, open teaching means to consider your classroom as a learning network, where each connection represents a possibility for learning, using peer-to-peer pedagogies and group assignments over self-study and classroom-based didactic learning pedagogies. Fourth, open teaching means to focus learning design on the learning process rather than on specific outcomes or competencies, since this will empower learners to think in terms of problems and solutions and will provide the possibility to inspire new perspectives and ideas. Fifth, within open teaching, learners should be encouraged to make learning choices and allowed to make mistakes, since choosing often leads to unexpected and unpredictable results, and while there is risk associated with the unknown, there is even greater reward and goodness. Finally, as stressed during the interviews by a couple of experts, within open teaching educators must support connections, dialogues and links within and across learning communities for the purpose of sharing ideas and to solve problems (McGreal, personal communication, November 3, 2015). In summary, open teaching means taking full advantage of the possibilities offered by the web, through an increased degree of socialization and interactivity, access to open environments, and opportunities for easier use of peers. As Teixeira put it during our interview, "good open teaching is the one that can transform access to good OER through organised OEP into meaningful learning" (Teixeira, personal communication, October 7, 2015).

Open teaching methods should not be confused with Open Educational Practices (OEP), since in our understanding, open teaching can take place even without the use of OER, while typically OEPs are defined as a further step of the *openness journey* that follows and enriches the use of OER. OEPs have been defined as the "usage of open educational resources in the frame of open learning architectures" (Camilleri & Ehlers, 2011, p. 6), as "practices which support the creation, use and management of OERs through institutional policies, promote innovative pedagogical models, and respect and empower learners as co-producers on their lifelong learning path" (Andrade et al., 2011, p. 12), or as "the formal assessment and accreditation of informal learning undertaken using OERs" (Murphy, 2013, p. 2). The OPAL consortium (2011) appropriately states that OEP foster the incorporation of social learning in the learning environment, but then again connects the use of open methods to OER: "The social learning element is coming in because learners can use educational resources, modify them and present them to other learners (...), knowledge environments on the basis of OER can be created by learners and shared with other learners or teachers" (p. 3). We believe it is important to "disconnect" the concept of open teaching from the use of OER since many teachers are indeed using open methodologies in their classroom activities, for example by fostering co-creation of knowledge from students allowing them to enrich the course content with any complementary information they deem important. In our view, these teachers can be indeed considered Open Educators even if they do not use – and maybe do not even know the existence of – OER. Instead of focusing on OER as the necessary first step of openness, the Open Educator definition proposed above provides a number of *entry points* into openness (learning design, content, methods, and research) since this would motivate a teacher that is already used to think openly in one of these areas of activity to explore and adopt open approaches in the other areas.

A Self-Development Framework to Foster Openness for Educators

In order to help the development of teachers' *openness capacity*, we are proposing a self-assessment and development framework for teachers that takes into account all the dimensions of openness included in the definition previously presented. The framework, presented in Table 1 below, has been discussed in detail during our interviews, and has been enriched in its structure and definition by the contacted experts. In the columns we represent the four areas of activity of our open educator definition (design, content, teaching and assessment), while in the rows we have categorised – with a necessary degree of generalisation – the different typologies of educators with respect to openness for each area of activity. To make an example, in the teaching area (third column of our table), the three layers correspond to the three predominant learning spaces in higher education as identified by Cronin: "physical classrooms (e.g., lecture halls, classrooms, labs), bounded online spaces (e.g., members-only Learning Management Systems or online communities), and open online spaces (e.g., the web, open platforms, social media, etc.)" (Cronin, 2014, p. 2).

Table 1

The Open Educators Factory Framework

Areas of Activity

A. Design	B. Content	C. Teaching	C. Assessment

Layer three: Open collaboration	Open designer	OER expert	Open teacher	Open evaluator
	Second transition phase: Transformation into Open Educator			
Layer two Bilateral collaboration/ Small groups	Collaborative designer	OER novice	Engaging teacher	Innovative evaluator
	First transition phase: Awareness			
Layer one: Individual work	Individual designer	OER-null	Traditional teacher	Lone evaluator

Starting from the bottom, for each column we have defined three levels of openness that an educator reaches once she goes through some necessary transition phases that are transversal to all four components. The first transition phase has to do with being aware of open approaches and today continues to represent the main obstacle for teaching populations to opt for openness (Browne, Holding, Howell, & Rodway-Dyer, 2010; Nerantzi, personal communication, October 30, 2015, Weller, personal communication, June 11, 2015). The second transition phase deals with becoming *fluent* with openness: once gone through this transition, an educator should be able to adopt open approaches as default in the way she designs her courses, she develops and shares content, she interacts with students, and she carries on learning assessment.

The framework shows that for all areas of activity a clear correspondence exists between the level of openness of an educator – conceptualised in the three horizontal layers in the table – and her collaboration and networking attitudes. This relation between open approaches and open networking was often stressed during the interviews: "An Open Educator is by nature a networked educator" (Weller, personal communication, June 11, 2015). The educators typologies at the bottom of the table - individual designers, OER-null educators, traditional teachers, and lone evaluators - all have in common the fact that they do not rely systematically on collaboration in their daily work; specifically, they do not share with others their courses ideas, they do not openly release their teaching materials nor use materials produced by others, and they do not engage students in cooperation activities nor in assessment. One layer up, the collaborative designers, the OER novices, the engaging teachers, and the innovative evaluators all have in common the fact that they typically collaborate bilaterally or though small-group collaboration with peers and colleagues, either from the same university or through online means: "All teachers collaborate with colleagues next door, the challenge is to collaborate openly with peers you have never met in person" (Macintosh, personal communication, July 21, 2015). Finally, educators in the third layer are the ones that adopt open online collaboration practices in the way they design their courses, release their materials and reuse materials by others, and in the way they teach and assess students. As suggested by Weller during the interview, at this level of openness fluency, teachers typically rely on an open online identity and make full and confident use of online communities and social networks (personal communication, June 11, 2015). The relation between openness and networking is in line with the findings of a number of researchers in the field (Esposito, 2013; Murphy, 2013; Okada et al., 2012; Orr, Rimini, & Van Damme, 2015; Recker, Yuan, & Ye., 2014; Weller, 2011, 2012, 2014) and was stressed by Macintosh: "Starting from connected learning is the right angle: if we start from collaborating and networking, openness will come. You can't be an open educator without being transparent in what you do" (personal communication, July 21, 2015). The importance of looking at networking and at stakeholders' involvement when working to improve openness adoption among the teachers' population was stressed by Teixeira during his interview: "Teachers are a key element in the process but they are not the only missing link. The missing link is an articulated holistic approach: you can have a supportive government with funding, great institutional strategy, inspiring leadership, wonderful teachers, willing families and students, but to be successful you need to have all of this together and articulated" (personal communication, October 7, 2015).

It is important to notice that typically an educator will be more open in one or more areas of work and less in others. A teacher might be releasing her content openly, falling in the category of OER-novice, and fostering collaboration among students through flipped-classroom methods bring in the innovative teacher category, but might have never experimented with open design or open assessment. On the other hand, a teacher might be adopting peer-based assessment practices but, for whatever reason, might not be releasing her content as OER. All the interviewed experts agreed that the strength of the table stands in the fact that it can spot any advancement towards openness in any single area of activity, and can therefore motivate educators to explore other areas of work where open approaches can be adopted. In other words, by using the table as a self-reflection tool, an educator will not simply understand whether she falls in the "open educator" category or not - we fear that the very great majority of educators would not qualify in the top layer in all columns, as mentioned during the interviews by most of the experts - but she will get an understanding on how she is doing across all dimensions of openness and she will be motivated to improve her openness performance in other areas.

In the expanded version of the framework in Table 2 below, which has been improved by the interviewed experts who had the possibility of questioning and commenting through a wiki platform, we are defining what the activities are that characterise an educator in each cell.

Table 2

The Open Educators Factory Framework in Details

A. Design	B. Content	C. Teaching	D. Assessment
Open designer Shares his/her course design ideas and curriculum openly through social media, including with colleagues and with students.	**OER expert** Re-shares resources that he/she has reused openly through social media and OER repositories. Uses resources created by others. Searches for OER through social media and repositories. Shares and promotes resources produced by his/her students. Shares links and resources beyond the classroom, through an open online	**Open teacher** Encourages participation from non-enrolled students in his/her courses. Implements methods that foster co-creation of knowledge by students. Fosters students to contribute to public knowledge resources. Encourages learners to access freely available online content. Shares examples of	**Open evaluator** Uses open assessment practices such as peers assessment or e-portfolios. Engages communities of practices to assess students' work.

	identity.	teaching practice in open subject-related communities.	
Second transition phase: Transformation into Open Educator			
Collaborative designer Collaborates in designing his/her courses with close colleagues, either from the same university or from international subject-related teams.	**OER novice** Re-shares resources that he/she has reused among close colleagues. Produces and share his/her own resources under open licences. Reuses resources recommended by trusted people.	**Engaging teacher** Adopts seminars-like strategies, either offline or through restricted online spaces. Uses "flipped-classroom" methodologies. Uses the university LMS, to share links and resources with the students of her courses.	**Innovative evaluator** Experiments with peers-based assessments methods.
First transition phase: Awareness about openness			
Individual designer Designs his/her courses on his/her own, based on previous knowledge and experience.	**New to OER** Might use digital resources found on the web to enhance teaching and learning. Does not produce openly licensed content.	**Traditional teacher** Adopts traditional trasmissive pedagogy	**Traditional evaluator** Uses traditional assessment methods such as tests or classwork.

Analysis: The Importance of Transition Phases

The definition and the framework presented above are based on the assumption that all areas of an educator activity could and should be improved by adopting open approaches. On the other hand, all the interviewed experts agreed that changing the way educators plan their courses, license their materials, support knowledge creation among students, and evaluate learners' progress means changing all aspects of their professional activities, and is therefore an extremely difficult and delicate process. The introduction of technology within an educator's work is already problematic, mainly because, as suggested by Bates, most educators in higher education have never been trained to teach (Bates, 2015). If this *learning by doing* approach works for traditional teaching, when we move to ICT-intensive teaching a much higher standard of pedagogic capacity for faculty and lecturers is needed: "The use of technology needs to be combined with an understanding of how students learn, how skills are developed, how knowledge is represented through different media and then processed, and how learners use different senses for learning." (Bates, 2015, p. 420). The introduction of open practices within education brings in another set of tensions which go more in depth and have to do with a major cultural shift within the educators' attitudes and self-perception, related to the need of rethinking and reshaping the roles played by teachers and students within the learning process and the underpinning knowledge production process, working in an open and transparent environment where all traditional implications of learning design, delivery, and assessment are questioned (Crook & Harrison, 2008; Orr et al., 2015; Rivoltella & Rossi, 2014). These cultural barriers represent the biggest obstacle for the transformation of HE professors, lecturers, and instructors into open educators. When asked to list the main barriers to an effective transformation of teachers into open educators, the interviewed experts agreed on the importance of cultural aspects, mentioning as main challenges the low recognition of open education practices from leaders and peers and the ownership-related fears connected to the peers-scrutiny anxiety of sharing design and educational materials. The issue of transparency was quoted several times during the interviews (Nerantzi, personal communication, October 30, 2015; Teixeira, personal communication, October 7, 2015). “The increased transparency brought by Open Education is the most dramatic change for teachers and students. For teachers because opening up their classroom to anyone means losing control of the processes going on there, and for students because knowing that everyone can watch what they do is a big problem” (Teixeira, personal communication, October 7, 2015).

These problems are further exacerbated by the generalised low level of adoption of social media in teaching settings (Jaschik & Lederman, 2013). Among the few studies have been looking into the use of social media by educators in universities, Manca and Ranieri (2015), reporting on a 2015 survey targeting the whole HE teaching population in Italy, conclude that the great majority of respondents never use Twitter (94,5%), Slideshare (84,5%), or Researchgate/Academia.edu (74,4%) for teaching purposes and that “Social Media tools are mainly perceived as a waste of time, as a great concern about privacy and as a risk to weaken the traditional roles of teacher and student” (p. 110).

These barriers are particularly dangerous when an educator has to go through the transition phases of the framework presented above. If we consider for example the transitions connected to the learning content column, these cultural barriers translate in a number of practical problems, dealing with discoverability of OER, quality control, and contextual adaptation (Kortemeyer, 2013). Here is when the institutional support should play a role (Teixeira, personal communication, October 7, 2015), by facilitating the process of openness capacity building of educators by removing institutional barriers such as the lack of time to explore and learn about OER and the low institutional and social reward systems (Arendt & Shelton, 2009; CERI-OECD, 2007).

In order to facilitate the overcoming of these barriers, we should make sure that some clear motivating messages are delivered to educators when they are about to go through a transition phase. To overcome the first transition, which deals with awareness of openness, we would need for example to pass the message that adopting open approaches would have a positive impact on teaching practices and on learning achievements in many ways, stressing that adopting open approaches “is likely to lead to more transparency in terms of how our educational provision is designed, delivered, supported and evaluated. It should result in better sharing and discussion of learning and teaching, leading ultimately to a cultural change in practice” (Conole, 2013, p. 205). To overcome the second barrier, we should focus on the different ways through which openness can impact on educators careers and on their appreciation by peers, in terms of increased audience for their work, increased efficiency with lower cost for content production, increased students access, increased possibilities for experimentation to enhance the students’ learning experience, increased reputation (McGill, 2012; Weller, 2014). At the same time, we need to make clear that openness requires work: “We need to recognise that open is harder than close if we want to reach mainstream change” (Macintosh, personal communication, July 21, 2015).

Conclusions

In order to facilitate the transition process that university teachers have to go through is we want them to embrace openness in their teaching activities, we have developed an original definition of

Open Educator which aims to go beyond the use of OER, taking into account both the teaching resources and the teaching practices - learning design, pedagogical, and assessment approaches - of teachers' activities. We have then developed the definition into a practical framework that presents development paths for Higher Education teachers along four dimensions: learning design, teaching resources, teaching strategies, and assessment methods. By working on the definition and on the framework with a number of experts in the field, we have reached three main conclusions. First, a holistic definition of Open Educator would be useful for the Open Education policy and research community, since it would help defining a target for capacity development actions in the field. Second, a strong relation exists between the use of open approaches and the networking and collaboration attitude of university teachers, where open online identities seem to be a key to develop open teaching strategies. Third, in order to overcome the technical and cultural barriers that hinder the use of open approaches in Higher Education it is important to work on the transition phases that teachers have to go through in their journey towards openness, in terms of awareness raising as well as of capacity building. These considerations will guide the second phase of our research, which will focus on piloting the above framework among university teachers, to test its acceptance level and its relevance in the eyes of educators, and to validate the idea – proposed with the Open Educator definition and detailed with the self-development framework – that a real transformation into an Open Educator must tackle at the same time all the areas of a teachers' work, leaving time and space for learning and valorising the areas where teachers are more advanced in terms of openness and networking.

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15 Nascimbeni, F., Alonso, J., Sanz, O., & Burgos, D. (2019, June). Read, Watch, Do: Developing Digital Competence for University Educators. In International Workshop on Higher Education Learning Methodologies and Technologies Online (pp. 80-93). Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-31284-8_7

Read, Watch, Do: Developing Digital Competence for University Educators

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Abstract. The paper presents and discusses the pilot experience of the EduHack course as it was developed in Spain by the Universidad Internacional de La Rioja (UNIR) in the first half of 2019. The EduHack course is proposing an active, participative and open approach to university teachers training in the use of digital approaches, that lets teachers experiment with ICT for learning strategies. Following an online learning phase, where participants were exposed to a set of ICT-enhanced teaching strategies and tools, a number of ideas on how to practically implement those strategies were collected among participants. AQ1
Then, through the organisation of an EduHackathon, a hackathon targeted to university educators, participants had the chance to work in interdisciplinary groups to practically develop those ideas. The pilot experience of the course within UNIR has demonstrated that such an approach can be a valid complement to traditional teachers' training activities in the field of learning innovation and ICT for learning. Participants have actively contributed to all phases of the course, evaluating positively the course approach. Also, the teams formed during the EduHackathon have confirmed their commitment to keep on working on their ideas in the future. AQ2

Keywords: Digital teaching · Higher education · Teachers training · E-learning

1 Introduction: How to Train University Educators in Open and Digital Societies

Within Higher Education, the increasing use of Information and Communication Technologies (ICT) and the rising mainstreaming of blended and online teaching practices is challenging educators to be able to meaningfully use ICT within their teaching work. Specifically, new technology-based developments such as social networks and artificial intelligence are fostering collaborative and peer to peer learning, that seems to be a most effective way of learning with respect to traditional lecture-based dynamics [1]. In line with this, the traditional role of educators, as the ones who master the knowledge that needs to be transferred to students, is increasingly being questioned by educational researchers, who appreciate the possibilities offered by open and networked teaching approaches provided by ICT. New forms of active and social

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learning are emerging that challenge the traditional role of teachers [2] towards the one of critical friends, mediators and facilitators [3].

This new role of teachers has strong implications on the way educators perceive themselves and interact with their learners. First, considering that learners today have a much easier and fast access to ideas, resources, and environments that can support their learning interests and choices, contemporary teaching should engage the learner in a social process knowledge co-creation instead of just letting them use the learning material presented by the teacher. Second, contemporary teaching should consider learners as individuals and autonomous agents within the learning process, allowing them to operate independently and learn at their own pace, in their own direction, and using their own connections. Third, contemporary teachers should look at their classroom as a learning network, where each connection between students represents a possibility for learning, using peer-to-peer pedagogies and group assignments over self-study and classroom-based didactic learning ped-agogies. Fourth, they should focus their courses design on the learning process rather than on specific outcomes or competencies, since this will empower learners to think in terms of problems and solutions and will provide the possibility to inspire new perspectives and ideas. Fifth, learners should be encouraged to make learning choices and allowed to make mistakes, since choosing often leads to unexpected and unpredictable results, and while there is risk associated with the unknown, there is even greater reward and goodness.

In summary, contemporary teachers should be able to take full advantage of the possibilities offered by the open web, including social media platforms, through an increased degree of socialization and interactivity, access to open environments, and opportunities for peer-to-peer collaboration [3]. Ultimately what is at stake is the redefinition of both what it means to be an educator in the context of contemporary educational contexts and institutions and of how students can best learn in contemporary networked societies.

Redefining the role of teachers means changing the way educators plan their courses, license their materials, support knowledge creation among students, and evaluate learners' progress, and is therefore an extremely difficult and delicate process. Meaningfully introducing technology in teaching clashes with the fact that most university educators have never been trained to teach [2]. "The use of technology needs to be combined with an understanding of how students learn, how skills are developed, how knowledge is represented through different media and then processed, and how learners use different senses for learning." [2, p. 420]. This process is even more complicated since it has to do with a major cultural shift within the educators' self-perception, related to the need of rethinking and reshaping the roles played by teachers and students within the learning process and the underpinning knowledge production process, working in an open and transparent environment where all traditional implications of learning design, delivery, and assessment are questioned [4].

Against this background, universities are experimenting innovative ways to build competences of educators to modernise their teaching approaches by meaningfully using ICT in line with the emerging open and networked teaching paradigms. The challenge is to build skills and attitudes starting – in many cases – from very low ICT-skilled teachers. In particular, the research accompanying the Opening Up Education Communication of the European Commission found that 50%–80% of students in EU countries never use digital textbooks, exercise software, broadcasts/podcasts, simulations or learning games, that most teachers do not consider themselves as 'digitally confident' or able to teach digital skills effectively, and that 70% of teachers would like more training in using ICTs [5].

This paper aims to contribute to the debate on how to build capacity of university educators to meaningfully change their teaching strategies through the use of ICT, by presenting a rather innovative attempt to build university ICT for learning teachers' capacity designed by an international consortium of universities. Part 2 presents the approach and its innovation potential. Part 3 describes the way the approach has been applied in a real-life setting in the Universidad Internacional de La Rioja in Spain. Part 4 analyses the experience, looking for the acceptance rate of the approach among participants and for possible improvement strategies. Finally, Sect. 5, concludes the paper with a summary of the findings and potential future research directions.

2 The EduHack Approach to Teachers Training on ICT-Enabled Pedagogy

The EduHack.eu initiative, which is put forward by a consortium of universities and research centres from Belgium, Italy, Malta, Spain and the UK with the support of the European Commission, has developed a capacity building course for university educators, based on the idea that to be able to meaningfully teach in an open and networked society, educators need not only to *learn* how to teach with technology, but to *experiment* with it, in an open and collaborative way [6].

The starting point of EduHack is the need for educators to be able to critically use ICT beyond their teaching subject, so as to become examples of digital citizenship for their learners [7]. Many training initiatives are in fact failing in empowering teachers to transfer to students (also by example) the necessary skills that every citizen should master to actively be part of our open and participatory societies. We are talking for example of online identity and personal data management, capacity to legally use open content, ability to engage in intercultural dialogues, critical view on media, capacity to deal with ethical and privacy issues. In order to take these competences into account, EduHack is built on principles of co-creation, collaborative learning and student/learner engagement. In terms of general approach, the EduHack.eu course is drawing on educational paradigms such as networked learning [8], participatory cultures [9], connected learning [10], hybrid pedagogy [11] and Open Education [12].

The Competences at the Core of EduHack

The EduHack.eu learning experience starts with an online course, where learners can browse and select among 19 different activities in four areas: digital resources, teaching and learning, assessment and empowering learners. These four areas represent the core of DigCompEdu [13], a competence framework produced by the European Commission that targets educators at pan-European level with the aim to inspire and national and institutional teachers training initiatives [14].

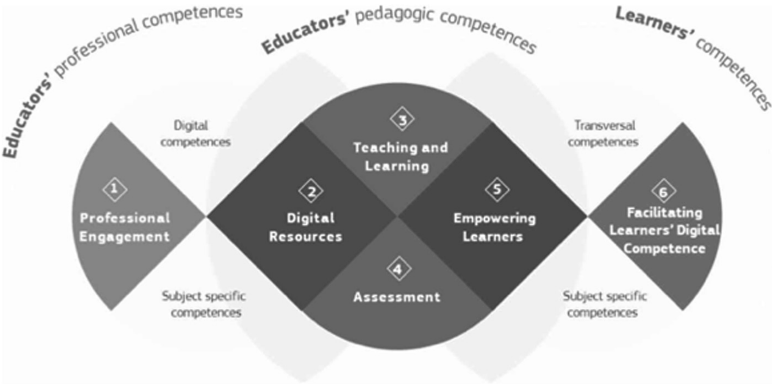

Fig. 1. The DigCompEdu competences framework.

The DigCompEdu structure has been selected as a starting point since it is grounded on a rather holistic understanding of educators' digital literacy. The framework does so by connecting the digital competences that 21st century educators should master (in the centre of Fig. 1) with their professional engagement activities (on the left) and with the impact that teachers can have on their learner's digital literacy (on the right). In other words, the frameworks connects the teacher's professional development path with the needed competences they shall master and with the impact that these competences shall have on their learners.

By taking such an approach, the DigCompEdu framework does indeed suggest a change in the role of teachers, by introducing meta-cognitive and self-development teachers' competences that will be key in contemporary learning settings based on critical thinking and participation [15]. The framework is built around six areas of competence: (1) to work effectively in an ICT-rich professional environment (2) to find, create and share digital resources, (3) to effectively use digital tools for teaching and learning, (4) to enhance learning assessment through ICT, (5) to empower learners and to foster learners-centred strategies through the use of digital tools and (6) to create digital literacy among learners, in terms of active citizenship and media literacy. The EduHack course is based on areas 2 to 5, that focus on practical knowledge, skills and attitudes that educators need to put in place successful ICT teaching strategies.

Online Activities: Read, Watch, Do… and Reflect

Each activity is composed by three components: Read, Watch, Do. The *Read* section corresponds to a short text with hyperlinks that gives an overview of the specific topic, the *Watch* section presents 2–3 videos (selected among existing openly available resources) that go deeper on the issue, and the *Do* part presents a practical task of the duration of around one hour that aims at putting in practice the knowledge acquired in the first two parts, most of the times thanks to the use of a specific online tool (such as Wikipedia, Socrative, Kahoot or Padlet). Also, each activity is providing a set of additional resources for learners who want to dig deeper in that specific theme. Examples of activities, taken from the Digital resources area, are: Search for Open Educational Resources, Modify existing digital content by using wikis, Create digital educational resources, Curate and organise digital resources and Apply open licenses to your resources. In order to complete the activity, learners are then requested to reflect on their learning experience in an open way, so to develop also web publishing and blogging skills. Learners can do that through individual blogging or through a common blogging space that is provided by EduHack called the *Wall*.

The Hands-on Experience of the EduHackathon

Following the online course phase, where participants were exposed to a number of possibilities to meaningfully use ICT in teaching and for developing critical capacities of students, learners are invited to gather in presence for an EduHackaton. This event is a hands-on session where participants work, typically in small interdisciplinary groups, on a set of specific ideas to improve their teaching through digital means, based on and inspired by the activities they have run though the online course. The Eduhackathon can take different shapes and have different characteristics depending on the preferences and context of the organising university: it can last one or more days, it can focus on ICT pedagogies in general or on a specific challenge such as open education or innovative assessment, it can be focussed on newbies or on expert teachers, etc. The only requirement of the event is its hands-on nature: during the Eduhackathon, participants are in fact expected to collaborative plan and possibly produce mock-ups or beta versions of the ideas they have selected, so to demonstrate the feasibility of their ideas and their potential impact on their daily teaching.

The EduHackathon methodology has been borrowed from the world of rapid-prototyping, business-incubation and acceleration of innovation activities. In particular, the methodology is inspired by hackathon events, that are typically focussing on computer programming, where coders meet for a period of time to develop prototype products, which are then implemented by funders. Most famously, Facebook uses this method to develop nearly all its products and features. Also, the following kind of events have inspired the EduHack methodology: business accelerator events, which have eventually led to the creation of several well-known startups such as Dropbox, Game-Jams, where developers meet to collaborative develop online games, and problem-based learning approaches, which challenge students to learn through engagement in a real problem.

The Underlying Course Online Ecosystem

In order to support the Hackathon process and to allow a certain degree of virtuality in moving from the online course to the Hackathon organisation, a platform has been developed, based on a SPLOT system [16], to collect and discuss all the ideas proposed by participants as well as to gather, after the event, the digital artefacts created. Further, all the content produced by learners during the course, both in its online and in its face to face phases, are collected in a specific web environment, called *Hub*, that allow appreciating the connections between what learners have learnt during the online course phase and how they have put this in practice during the hackathon. As illustrated in Fig. 1, the EduHack course ecosystem is composed of tree platforms: the online course platform, the Hub and the Hackathon web space. Those environments are connected through tagging system, so to allow to search for specific material and to highlight connections between teachers that share the same interests, skills, and areas of focus (Fig. 2). AQ3

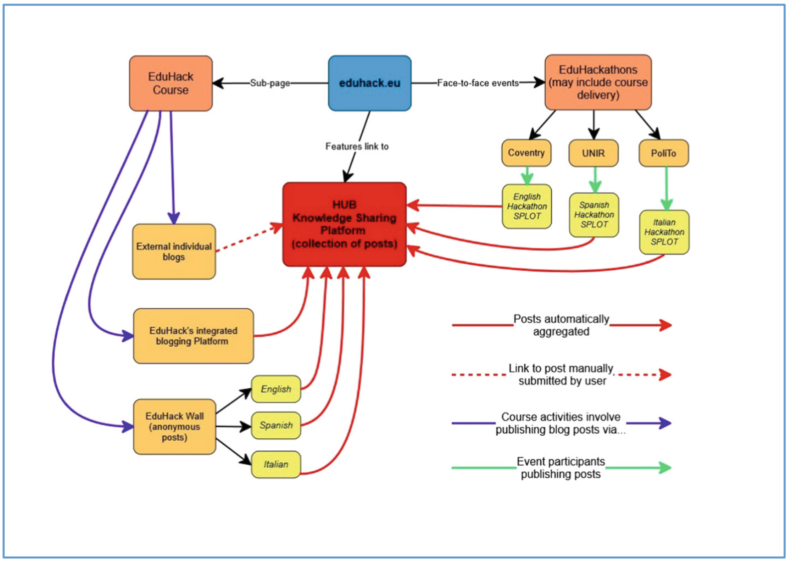

Fig. 2. The EduHack web ecosystem.

3 Description of the Course Pilot

This section will present the first pilot of the EduHack course, that was organised in Spain by the Universidad Internacional de La Rioja (UNIR) in the period April-May 2019. During the period 2019–2020, the project will be organising two more pilot courses in Italy and in the UK, to test the project approach in real-life university settings.

Course Design and Preparation
UNIR is a fully online university, therefore – in line with the flexible approach of EduHack – the online course and especially the EduHackathon were tailored to the characteristics of the institution and especially of the capacity and preferences of perspective participating learners. In the case of UNIR, potential participants are used to teach online, but they do so through the rather uniform approach of the university and are interested in exploring new ways of using ICT tools to enrich their teaching practice. Because of this, the course was designed with the aim to inspire participants to explore potential new tools, to be adapted – during the Hackathon – to the UNIR teaching environment.

During the course design phase, a number of meetings with key stakeholders within the university were organised to plan the course in line with the motivations, the learning styles, and the existing capacity of the target participants. In order to accommodate the preferences of the UNIR teachers. These meetings resulted in two conclusions: the EduHackathon could have been organised attached to the main conference organised every year by UNIR, and at the same time it would have been problematic to have teachers participating for more than one day. Because of these considerations, it was decided to organise a *blended EduHackathon*, where the first typical phase of work of a hackathon (that deals with presenting, selecting and fine-tuning the ideas), was run online, through the organisation of a discussion Webinar and through collaborative work on the EduHackathon online platform.

Following this design phase, the timing and characteristics of the three phases of the course were designed, as shown in Fig. 3. First, four weeks of online course were held, paced by four webinars aiming at keeping the participants motivated and at answering to their doubts and questions. This phase was followed by an online collaborative moment during which the ideas proposed by the participants for the EduHackathon were discussed and teams were created: seven ideas were presented out of which four were selected to be brought forward by learners' teams. Finally, the EduHackathon took place.

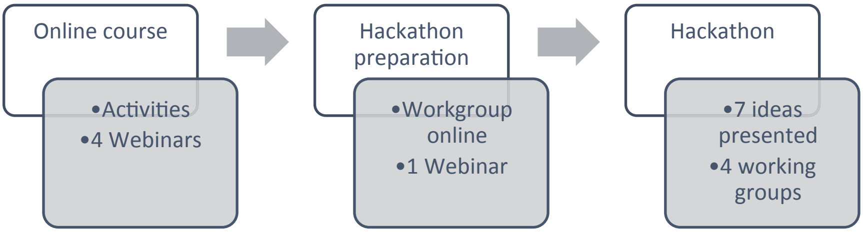

Fig. 3. The EduHack course within UNIR

Recruiting the right participants was key to the course success. This was done through a campaign among the educators community of UNIR, composed of strategic meetings with internal decision makers to motivate them to promote the course among the teaching population of their faculties, complemented by direct mailing to the UNIR faculty members (a total of 3.500 email messages were sent) and by a social media campaign. These activities resulted in a group of 52 registered participants, the majority of them (76%) being from the faculty of education. 8% was from the engineering school, 6% was from the UNIR branch in Ecuador and 10% was from other Spanish universities.

Online Course Phase

During the online course phase, participants were free to select their activities depending on their needs and preference. All the activities were available from day one, even if it was suggested to focus on one area per week. In line with the project approach, in order for an activity to be considered completed, participants had to reflect on the work done with a post on the EduHack online Wall. We registered a total of 165 reflective posts, plus 72 comments for a total of 237 interactions. The great majority of the posts actually reflected the work done within the various activities, providing a number of ideas on how to implement the proposed solutions in the context of the participants' daily work.

Looking at the most-liked activities can help understanding the learning needs of the participants and can help to better targeting the content of the online course for future editions. Even if it is too early to make a judgement on whether some activities should be restructured or improved, it is in fact important to keep track of the learners preferences. In area *Digital resources*, the three most selected activities were *Search for Open Educational Resources* (taken 20 times) followed by *Curate and organize digital resources* (8), by *Modify existing digital content by using Wikis* (7) and by *Create digital educational resources* (6). In the *Teaching* area, the first activity was *Implement ICT-supported collaborative learning* (13) followed by *Design your own eLearning intervention* (7), *Foster knowledge co-creation among students* (6) and *Use games to improve learners engagement* (6). In the *Assessment* area, the two preferred activities have been *Use digital technologies to provide targeted feedback to learners* (14) and *Experiment with different technologies for formative assessment* (12). Finally, all four activities of the *Empowering Learners* area were taken: *Critically evaluate online tools* (11), *Appreciate opportunities and risks of personalization in learning* (10), *Check technical accessibility of platforms and resources* (9) and *Discover the cost of "free" commercial social media platforms* (7). Two main results emerge from the analysis of which activities were actually taken by the learners. First, all the four areas received a rather balanced attention, showing that the course content approach is in line with the areas of need of the UNIR learners. Second, learners privileged the activities that dealt with fostering learners collaboration, engagement and co-creation. As we will see later, this trend was confirmed by the ideas selected for the EduHackathon.

As said before, in order to demonstrate they had taken an activity, participants were requested to publicly reflect on what they had learnt through the *EduHack Wall,* that has therefore operated as a common open portfolio enabling course participants to show their progresses. As visible from Fig. 4, that presents the work done by participants on the Lino.it space prepared for the project for one of the course activities, the course participants were extremely active not only in exploring the proposed activities and tools, but also in reflecting on how these could be applied in their daily work.

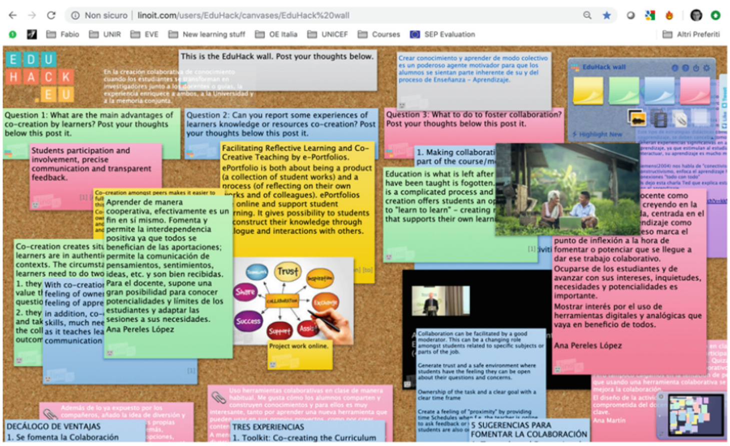

Fig. 4. The Lino.it space created for the course with participants posts

During the online course phase, continuous support was provided by the UNIR team, with 105 answered doubts by email, phone, or through face to face meetings.

Additionally four webinars were organised reaching over 100 attendees overall. While the first two webinars aimed at introducing the course content, the third and fourth webinars focussed on how to move from the course to the EduHackathon.

Ideas Collection Phase and EduHackathon

Following the four weeks of the online course, participants were requested to propose embryonic ideas that could be developed during the EduHackathon. A fifth webinar was organised to support the ideas elaboration process, during which a possible structure on how to present a project idea was provided. Seven ideas were proposed by participants and posted in the EduHackathon online space. During this phase some interesting dynamics took place: two ideas were merged following an agreement among the two promoters, one idea spontaneously gathered a team of three promoters, and all participants prioritised two ideas among the available ones. At the end of the process, four ideas, that had in common an interest for gamification and for learners collaborative knowledge production, were selected by the community to be worked out during the EduHackathon.

The EduHackathon took place in Logroño, La Rioja, Spain, on May, 15th, 2019, engaging 26 university teachers from UNIR. As previously mentioned, the objective of Hackathon was to encourage participants to apply the competences they had acquired through the online course with the objective to collaboratively design new digitally-supported learning experiences, experimenting with creative models and approaches to teaching. The four ideas selected during the previous phase were discussed in details during the event in small groups with the support of the organising staff. Each group was able to produce two things: a mock-up version of the tool or resource that the idea was about and a plan to further develop the idea.

As said before, the ideas generation and discussion phase was run online: this allowed focussing, from the very beginning of the EduHackathon, on practical work around the selected ideas. The EduHackathon was structured along two sessions: one aiming at finalising the ideas in details in a sort of *project form*, also identifying what would be needed to make them viable, and one aimed at preparing a mock-up of the idea to give an understanding of how the project and its outcome would look like. Following these two sessions, the groups rapporteurs presented the state of advancement of their work to the overall participants. All four ideas were presented with a view on a possible future exploitation, either within UNIR or as possible national and international projects. The EduHack team at UNIR will follow up with the teams in charge of these ideas in order to support them to make these developments a reality.

At the end of the EduHackathon, a total of 19 course participants, who had completed at least 8 project activities and had actively participated in the event, received a certificate of participation corresponding to 2 European credits (ECTS).

4 Analysis of the Experience

The EduHack course pilot at UNIR was assessed through two methods: teachers structured feedback, received through an online questionnaire, and participant observation by the UNIR project team. Both methods had in common five analysis dimensions: (a) acceptance of the innovative model, (b) barriers to participation, (c) main dynamics during the event, (d) collaboration patterns emerging among participants, (e) future improvements.

Learners' Evaluation

Here we are presenting the results of the participants' evaluation of the online course and of the Hackathon, based on 13 responses received from participants.

As far as the online course is concerned, the most important result for the UNIR organising team is that all participants stated that thanks to the online course they had improved their digital skills and their capacity to use ICT in their teaching, and all but one participants stated that they will apply the knowledge they acquired through the course in their professional life. As detailed in Fig. 5, nine participants rated the course active and collaborative approach as very good, four as good, while no negative response was recorded.

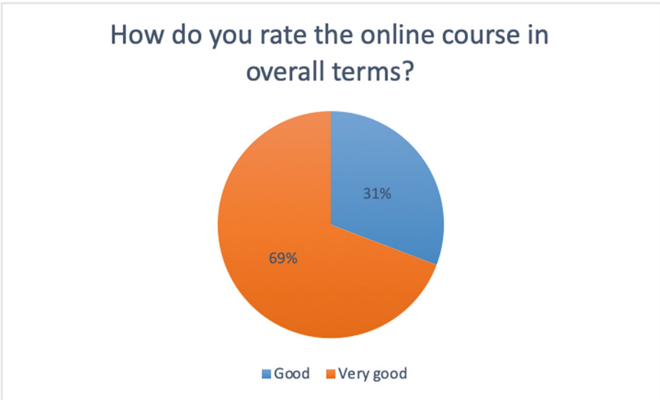

Fig. 5. Participants feedback on the online course

In qualitative terms, participants rated the content quality as well as the *read-watch-do* approach as well-fitting for their needs. Notably, three participants stated that they will use the course materials in the future as a repository of good teaching practices and tools. Also, participants appreciated the possibility to publicly reflect on their learning process and of reading the others' experiences: this confirmed that the reflective approach taken by the course was a valid one. The only negative comment was the lack of time to browse and complete all course activities prior to the EduHackathon, which shows actually a good motivation to explore all the activities of the course.

As far as the EduHackathon is concerned, all participants evaluated the experience positively, with 8 participants stating the EduHackathon approach and the collaborative work during the event was very good and 5 stating it was good. This data is fully confirmed by the UNIR team observation, that noted a very collaborative and creative atmosphere during the event. The feeling was that participants enjoyed a different way to discuss about ICT-supported learning innovation and that they appreciated being *in* *charge* of both deciding which activities to take and of choosing which idea to develop or to participate into (Fig. 6).

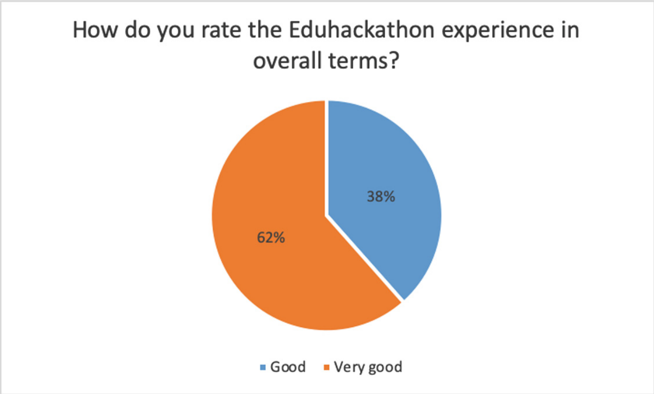

Fig. 6. Participants feedback on the EduHackathon

In qualitative terms, the features that participants liked the most about the EduHackathon were the possibility to get to know and to work with other professors, the interdisciplinarity of the working groups, the time allowed for the preparation process prior to the event and the possibility to further develop the ideas elaborated during the event. Notably, one participant reported that in these times of virtual contacts, taking one day to work hands-on with colleagues on shared problems is a luxury. On the negative side, the main weakness identified by the participants was the short time devoted to the Eduhackathon. This indication, which is somehow contradicting the fact that teachers are normally too busy to take more than one day for an activity such as the EduHackathon, will have to be considered for future editions of the course.

Participant Observation by the UNIR Team

Participant observation [17] has helped the UNIR team in charge of organising the EduHack course to both confirm the participants' feedbacks and to reflect on some important dimensions, that will be considered both by the next pilot courses and by the Guidelines that the project is producing to multiply the course use beyond the consortium can be reported. A first key question has to do with the acceptance of the EduHack innovative model. Participant observation confirmed that the course open and active approach was appreciated by participants. The aim of EduHack was to setup a learning experience that is Active, Open and Collaborative: we can say that the UNIR pilot stressed that such an approach is fitting with the preference of the UNIR participants. In particular, the requirement to reflect on the work done in each activity through an open blogpost did not represent a barrier for participation for learners, on the contrary it was appreciated since it allowed reflecting on strategies to implement the learnt approaches in educators' daily work. It must be noted that the most active participants in the first pilot were rather experienced and ICT-enthusiast teachers, not newcomers to the field of digital education. A second question deals with the quality and purposefulness of the course content. Participants browsed all the proposed activities and did not provide any negative comment about them. Also, the way the content is presented, in the form of a short text plus videos plus one activity, encountered the participants appreciation. Finally, some participants proposed some further activities to be included in the next course iterations, showing a good degree of ownership of the learning experience. A third issue had to do with the complexity of the course web ecosystem, which did work without any major problem, even if some space for improvement exists. All three course environments (the course contents page, the reflection posts Wall and the Edu-Hackathon web environment) were used appropriately and were rather well connected among themselves. Minor possible improvements were reported, connected to the fact that in an open environment such as the one proposed (where for example it is possible to post in an anonymous way) participants are not able to receive alerts when their posts get commented.

5 Conclusions and Future Work

The underlying hypothesis of the EduHack initiative was that by applying an active, participative and open approach to university teachers training in the use of digital approaches, teachers would not just acquire new knowledge, but rather would be able to experiment with practical activities, through an approach that we have codified as "Read, Watch, Do". The research run around the pilot experience of the course within UNIR has demonstrated that such an approach can be a valid complement to traditional teachers' training activities in the field of learning innovation and ICT for learning. In order to develop educators' digital competences, that are able to respond to the need of empowering students for open and participatory societies, we believe in fact that traditional teachers training and innovative hands-on experiences such as EduHack should coexist. "Digital literacy is not a new literacy. This is to say, if digital literacy is simply reading and writing in a digital environment, there is no need for the new terminology. (…) Let us then accept digital literacy as a genre, a format and tool to be found within the domain of standard literacy, rather than a concept standing at odds" [18, p. 535].

Participants active contributions to both the online course and the face to face event, as well as the connection between the course content and the ideas proposed and worked out during the Eduhackathon, are indeed promising results for the mainstream of innovative teacher training approaches. This confirms that educators' digital literacy, being a complex and socio-culturally sensitive issue, should be understood as a set of situated practices and attitudes. Digital literacy is in fact much more than the capacity to use ICT tools, and it should rather be considered as a set of capabilities associated with interacting with peers through digital tools, where the core is about communicating and collaborating with others and making sense of the available information [19]. The positive results and especially the participants' enthusiasm around the EduHack pilot course demonstrate a good readiness degree to engage in capacity building activities aimed not only at marginally improving their daily practices but also at transforming their role within contemporary open and collaborative learning settings.

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