Predicating from an early age: edusemiotics and the potential of children's preconceptions

Stud Philos Educ
DOI 10.1007/s11217-016-9526-3

Predicating from an Early Age: Edusemiotics and the Potential of Children's Preconceptions

Alin Olteanu[1] · **Maria Kambouri**[2] · **Andrew Stables**[1]

Abstract This paper aims to explain how semiotics and constructivism can collaborate in an educational epistemology by developing a joint approach to prescientific conceptions. Empirical data and findings of constructivist research are interpreted in the light of Peirce's semiotics. Peirce's semiotics is an anti-psychologistic logic (CP 2.252; CP 4.551; W 8:15; Pietarinen in Signs of logic, Springer, Dordrecht, 2006; Stjernfelt in Diagrammatology. An investigation on the borderlines of phenomenology, ontology and semiotics, Springer, Dordrecht, 2007) and relational logic. Constructivism was traditionally developed within psychology and sociology and, therefore, some incompatibilities can be expected between these two schools. While acknowledging the differences, we explain that constructivism and semiotics share the assumption of realism that knowledge can only be developed upon knowledge and, therefore, an epistemological collaboration is possible. The semiotic analysis performed confirms the constructivist results and provides a further insight into the teacher-student relation. Like the constructivist approach, Peirce's doctrine of agapism infers that the personal dimension of teaching must not be ignored. Thus, we argue for the importance of genuine sympathy in teaching attitudes. More broadly, the article also contributes to the development of postmodern humanities. At the end of the modern age, the humanities are passing through a critical period of transformation. There is a growing interest in semiotics and semiotic philosophy in many areas of the humanities. Such a case, on which we draw, is the development of a theoretical semiotic approach to education, namely edusemiotics (Stables and Semetsky, Pedagogy and edusemiotics: theoretical challenge/practical opportunities, Sense Publishers, Rotterdam, 2015).

The following abbreviations are used in the text when referring to Charles S. Peirce's work. Please see the References for full details.
CP: The Collected Papers of Charles Sanders Peirce
W: Writings of Charles S. Peirce, A Chronological Edition, Volume 8

✉ Maria Kambouri
m.kambouri@reading.ac.uk

[1] University of Roehampton, London, UK

[2] University of Reading, Berkshire, UK

Published online: 07 May 2016

Keywords Semiotics · Constructivism · Prior knowledge · Preconceptions/misconceptions · Agapism · Icon

Introduction

This paper develops a framework for teaching practices based on the assumption that knowledge acquisition is a complex phenomenon of signification. As such, learning does not consist of merely the addition or replacement of information to and with existing information. The study is based on understanding findings deriving from early childhood education doctoral study (Kambouri 2012) from the perspective of an edusemiotic framework (Stables and Semetsky 2014, 2015). The main argument is that the practice of teaching requires mutual learning on behalf of the student and of the teacher. Learning presupposes a reshaping of one's phenomenal world, being a restructuring of complex meaning phenomena.

The aim of this paper is to illustrate this compatibility by analysing findings from empirical constructivist research from the perspective of Charles Peirce's semiotics. The specific research focused on understanding how teachers respond to young children's preconceptions, referring to those scientific concepts which do not always agree with what is generally accepted by the scientific community (Kambouri 2012), when teaching science. The data collection included recordings of lesson observations and teacher interviews. We analyse teachers' ways of engaging with pupils' prior knowledge and preconceptions (also known as 'misconceptions') by bringing together Peirce's realist semiotics and psychological constructivism. We explain how these two frameworks are epistemologically compatible for two reasons: (1) they are both underpinned by the assumptions of realism and (2) they both have an evolutionary perspective on knowledge, wherein new knowledge is developed upon existing knowledge, and not *invented.*

The argument is developed in 4 stages: (1) the epistemological background is set by explaining the compatibility of a joint semiotic and constructivist analysis which promotes the possibility of mutual learning explained in the context of suprasubjective ontology (overlapping of phenomenal worlds, Stables 2012), (2) the phenomenon of (having a) *preconception* is identified with iconic learning (spontaneous learning by means of discoveries of similarity), (3) fragments of the empirical data from Kambouri's study (2012, 2015) are qualitatively meta-analysed in the perspective of Peircean semiotics and (4) we conclude by arguing that the teacher and the learner are learning from each other, enhancing the possibilities of learning by acknowledging the learner's preconceptions. The possibility of teaching as mutual learning is explained as *agapic (=love)* (CP 6.287-317; Hausman 1974) evolution of signification.

On this account, the teacher does not merely add information or change the information of the learner, but instead they are both engaged in learning from each other. While the student is learning the knowledge of the teacher, the teacher is learning the knowledge of the student: this makes their pedagogical dialogue possible. By emphasising the scientific potential of the learner's understanding prior to the teaching process, the paper promotes a teaching attitude that aims at preserving the learner's personal creative potentiality.

By means of Charles Peirce's phenomenological categories and his notion of semiosis (triadic cooperation of signs, CP 5.484)[1] the paper explains that a child's background

[1] All dynamical action, or action of brute force, physical or psychical, either takes place between two subjects [whether they react equally upon each other, or one is agent and the other patient, entirely or partially] or at any rate is a resultant of such actions between pairs. But by "semiosis" I mean, on the

knowledge, which was acquired prior to the teaching process, is an essential part of the learning phenomenon (Johnston 2005; Kambouri 2012). The learner's pre-teaching understanding should not be ignored by the teacher (Schmidt 1997) and the aim of teaching should be to develop signification upon existing knowledge.

Edusemiotics (Semetsky 2009; Stables and Semetsky 2015) is defined as a new theoretical sub-discipline of semiotics which grounds philosophy of education in semiotics. Semiotics and education have a long common history, as for a long historical period semiotics underpinned the medieval liberal curriculum (Olteanu 2014). The decline of interest for semiotics during modernity and the modern dualist mindset separated semiotics from philosophy of education, favouring cognitive and social approaches to pedagogy. The project of a semiotic foundation for education (Stables 2005) began in the context of a growing interest in semiotics, in the humanities, in the context of the rediscovery of Charles Peirce's semiotics (Pietarinen 2006; Stjernfelt 2007). Contemporary semiotics of education brings insights that were not possible at the time of the (Medieval) semiotic age of education (on the Medieval, Latin semiotic age: see Deely 2001).

So far edusemiotic research has been mostly theoretical. The present study brings a semiotic analysis of empirical data and findings from a study (Kambouri 2012, 2015) regarding teachers' attitudes towards children's preconceptions. When doing so, we acknowledge that there have been various schools of constructivism which have been lumped together for the purposes of this paper. However, we mainly focus on the social constructivist pedagogical tradition of Vygotsky (1986) to argue for a reorientation of teachers' attitudes towards children's preconceptions. The findings deriving from the doctoral study (Kambouri 2012, 2015) can serve as an argument for the reorientation of schooling from skill training to a liberal education programme. As the history of ideas suggests, a semiotic consciousness (Deely 2001; Deely and Sbrocchi 2009) underpins a liberal curriculum, bringing an implicit argument for teaching the subjects which are valuable intrinsically by opening up possibilities for further learning.

Setting the Background

On a Peircean account, learning is a spiral structured phenomenon of abduction (advancement of hypothesis), deduction, and induction. As we are engaged in learning as long as we are alive (Stables 2005), a learner changes her knowledge continuously at all times. The assumed change of opinion is a result of the learner's retrospection and teachers should be careful not to force this change on learners. The change should come naturally through a number of different experiences offered to the learner by the 'more experienced' teacher. The teacher should not rush children from one experience to another because they will have little opportunity to "try out their developing ideas and build upon existing ones" (Johnston 2005, p. 3). Peirce's student, John Dewey, developing a pragmatic philosophy of education, essentially agreed with this:

> What avail is it to win prescribed amounts of information about geography and history, to win ability to read and write, if in the process the individual loses his own soul: loses his appreciation of things worth while, of the values to which these things

Footnote 1 continued
contrary, an action, or influence, which is, or involves, a cooperation of *three* subjects, such as a sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs. (CP 5.484).

> are relative; if he loses desire to apply what he has learned and, above all, loses the ability to extract meaning from his future experiences as they occur? (Dewey 1997, p. 49).

Thus, children (as much as anyone) learn through trial and error and this takes time and patience. They learn best when offered varied activities because they have different types of intelligence and learning needs (Johnston 2005). The teacher, who usually has more experience, will *guide* the learner, who usually has less experience, to *explore*; this leads to the construction of the learner's own concepts which will differ from the teacher's concepts.

The attempt of bringing constructivism into a semiotic perspective is a recent, ongoing project. It consists in readapting Bruner's (1978) notion of *scaffolding*, which can be understood as grounded in Vygotsky's (1986) notion of *zone of proximal development* (ZPD), with the purpose of offering a more insightful understanding of *semiosis*. In this way, we contribute to the theoretical development occurring especially in the area of biosemiotics, where the concept of *semiotic scaffolding* emerged with the purpose of formulating a semiotic theory of evolution (Hoffmeyer in Barbieri 2008; Hoffmeyer 2015; Favareau et al. 2012). As a theory of learning, constructivism can be traced to the eighteenth century when the philosopher Giambattista Vico stated that humans can understand only what they have constructed by themselves (Fosnot 1996; Wilson 1996). Constructivism has roots in all areas of the humanities—philosophy, psychology, sociology, education, etc. It is the label given to a set of theories about learning, which fall somewhere between cognitive and humanistic views (Steffe and Gale 1995). The social constructivist pedagogical tradition of Vygotsky assumes that knowledge is only built upon knowledge (Atherton 2009; Kambouri 2012, 2015). The opinion that "…knowledge is not transmitted directly from one knower to another, but is actively built up by the learner" is shared by a wide range of different research traditions (Driver et al. 1994, p. 5).

Peirce's semiotics accounts for this as well (CP 1.374). For instance, Nöth (2014) and Semetsky (Chapter 2, p. 16–31 in Stables and Semetsky 2015) consider that Peirce's semiotics overcomes the learning paradox presented in Plato's *Meno*: we can learn new information because we can fit it onto existing relations of signification. Nothing that has being can be absolutely unknown. Signification is relational and learning is a phenomenon of signification which begins with some of its termini being unknown. It is never the case that all the termini of the relation of signification are entirely unknown to the learner. This is an implication of the semiotic understanding of ontology as relational and reality as suprasubjective (Deely 2001; Bains 2006). In its incipient stage, the constructivist assumption that humans only understand their own construction might seem solipsistic. In the contemporary semiotic perspective this assumption does not fall in a vicious solipsistic circle: we can learn something *new* as nothing that can be potentially apprehended is entirely strange to what we already know. If reality is understood as an interwoven web of signs, no element of reality can be absolutely estranged to an organism's experience. In this regard, semiotics and constructivism are compatible and complementary.

The concept of scaffolding was firstly introduced in the literature by Wood et al. (1976) when describing the interaction between early years educators and preschool children while the adults were helping the children to find a way to solve a reconstruction problem (while playing with blocks). This notion is very similar to Vygotsky's (1986) notion of ZPD, and it is rather common for the two terms to be used interchangeably (McLeod 2008). Both terms have influenced the development of a *semiotic scaffolding* which designates "what makes history matter to an organism (or a cultural system)" (Hoffmeyer 2015, p. 154). The taught object is

always accessible in some regard to a learner, as a possibility to be discovered. In his exploration of Peirce's approach to the self Colapietro argues that the external world is discovered, rather than instituted, by the mind (Colapietro 1989, p. 21). Also, Stjernfelt explains that, on account of Peirce's schematic semiotics, to learn is to discover a potential relation, rather than inventing it (Stjernfelt 2007, p. 57). This discovery occurs and is aided by certain "well-adjusted semiotic tools" (Hoffmeyer 2015, p. 153), by which a scaffolding is constructed. The scaffolding, understood as semiotic, is not an artificial construction, but a set of phenomena of signification, which are discovered, not invented. Thus, in a certain sense, the learner has a prior understanding of the object, at least even for the fact that the learner can refer to it. Nothing that is metaphysically possible is completely foreign to an existing consciousness. Semiotics thus explains that knowledge is not simply added in chunks upon or instead of previous knowledge. To learn is to interpret, to achieve a new understanding; the ability to apply the new understanding at different contexts is implicit (Anderson et al. 2001). By adding termini of relations of signification to an existing web of relations the structure of the whole web might change, in order for the new signification to fit. The entire phenomenological world of a life form changes as soon as it has learnt something new. Learning is continuous throughout an organism's life and it is circular (or rather spiral, as it evolves by repetition). By deducing and inducing something new, and thus expanding its phenomenal world (environment), a living being also inevitably performs abduction. A new finding presupposes the revision and reshaping of hypotheses.

Cognition, Body and Experience

A semiotic theory of knowledge inevitably assumes a philosophy of the body. Semiotics, by its account of relational ontology, dismisses mind/body or material/ideal dualisms (Deely 2001). Knowledge, which in modern philosophy used to be thought of as a matter of mind, is a matter of the mind-body whole from a semiotic perspective. Mind and body are synonymous from this perspective. Cognitive theory recognises the importance of the mind in making sense of the environment and the material with which it is presented and it presupposes that the primary role of the learner is to assimilate whatever the teacher presents (Atherton 2009). This opposes the typical modern perspective of the organism as a black box. Likewise, the first attempt to a unified semiotic theory criticised behaviourism for its narrow understanding of signification (Eco 1976). We consider that embracing a fully holistic philosophy of education is a challenging task in a philosophical age which is not only preceded by centuries of dualistic philosophy, but also educational practices are deeply rooted in a vision that essentially separates mind and body. Educational theory is particularly problematic, as here mind/body dualism generated a separation between theoretical knowledge and practical action (Stables and Semetsky 2015, p. 154).

Cognitive linguistics (Lakoff and Johnson 1999) and cognitive semiotics (Nöth 2006; Stjernfelt 2007, 2014) have undertaken a phenomenology of embodiment, wherein the concepts of mind and body are not in dichotomy. On this account mind and body can be regarded as synonymous (at the most each evokes a slightly different semantic focus), as a semiotic body implies a semiotic mind and vice versa. These cognitive approaches to signification facilitated the development of biosemiotics as a semiotic theory of life (Kull 2003; Kull et al. in Emmeche and Kull 2011, p. 1–21), explaining life in terms of relations of signification. On a semiotic account, Kull defines life as "local plurality" (Kull in Bundgaard and Stjernfelt 2009, p. 116). Such a biosemiotic perspective entirely overcomes the mind/-body dualism by reclaiming life itself, vitality with epistemological bearing, as the subject of biology (see Hoffmeyer in Henning and Scarfe 2013 and Cahoone in Henning and Scarfe

2013). On this account, as well, the organism is not a black box: we are not brains in vats (Bains 2006, p. 21). We do not either think or feel; we think and feel. Descartes' famous quote, 'I think therefore I am', is refuted by semiotics and replaced by 'I experience, therefore I am'. Experience is here understood in the broadest sense, not only as empirical experience, but including, for example, experiencing thought. Realist (Peircean) semiotics and constructivism agree on this and one can employ the other as a method of analysis. It is particular of biosemiotics to approach semiosis occurring on various, time scales, both individual and supra-individual. As semiosis makes history matter to the cell, developing a scaffolding of the organism-environment, according to Colapietro "semiotic consciousness encompasses historical consciousness" (p. 41). This is because "we are beings with an incredibly complex and ultimately unfathomable history. We are bearers of the past: History speaks through us in ways we just barely comprehend." (p. 41) Our scaffolding of semiotic reality, and, with it, the evolution of our very self, goes beyond our consciousness. Thus, our personal history is at all times and instances unique, but embedded in our environmental circumstances, our "generation", as Peirce mentioned (MS 299, 00021 in Colapietro, p. 21).

Peirce's theory of evolution, the cornerstone for Peirce's teleological semiotics (Olteanu 2015), offers a starting point for a semiotic theoretical background for education and immediate practical advices that regard the teacher-student relation. From Peirce's teleological evolutionary perspective, since signification evolves continuously, the teacher's main aim should not be to change the learner's understanding, but instead the aim of teaching should be that the very knowledge of the learner grows. As a result, the aim should be that the learner herself expands as sign, as a self-aware phenomenon of signification. On a semiotic account (Colapietro, pp. 21–22, CP 6.344) the self is a sign (or a web of signs). According to Peirce "a sign is something, A, which denotes some fact or object, B, to some interpretant thought, C" (CP 1.346). Semiosis is "an action, or influence, which is, or involves, a coöperation of *three* subjects, such as a sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs" (CP 5.484). Peirce's non-dualism stands in his understanding of the triadic sign not as a sum of three dyadic relations, but as a genuine and simultaneous cooperation of three elements, which do not have existence individually or in pairs, outside of the triad. The phenomenon of such cooperation is Peirce's notion of semiosis.

Experience (semiosis, which life forms perform) is subjective. Subjectivity always assumes intersubjectivity to some extent and, therefore, it trumps the objective. It is in the overlapping of subjectivities that experience proceeds (Stables 2012). Intersubjectivity, sharing, is possible in a suprasubjective reality. Such is the semiotic Universe in Peirce's account (Deely 2001; Deely and Sbrocchi 2009). As Kull explains, semiosis, that is life, is locally plural (2009, p. 82). Peirce himself found semiosis to be the best explanation, at least so far, for the emergence of life:

> In short, the problem of how genuine triadic relationships first arose in the world is a better, because more definite, formulation of the problem of how life first came about; and no explanation has ever been offered except that of pure chance, which we must suspect to be no explanation, owing to the suspicion that pure chance may itself be a vital phenomenon. In that case, life in the physiological sense would be due to life in the metaphysical sense (CP 6.322).

Both constructivism and realist semiotics engage with life in terms of activity. Experience (including knowledge and concepts) does not spring out of nothing, it is an engagement, always embedded in the life of the environment. Even the very consciousness of any living organism, its life, starts in an already existing world, from some ancestors

which pass on a specific mode of embodiment. This is the common epistemological ground of contemporary constructivism and semiotics on which the present study develops.

Constructivism and Semiotics

Bringing constructivism and semiotics together in one framework might seem to be contradictory in some regards, especially when the account of semiotics considered is the legacy of the strong anti-psychologist realism of Peirce. However, we explain that a cooperation is possible on the basis of each of these schools' insistence upon action. For instance, both have a pragmatist commitment. This is the theoretical advancement that the present paper develops.

Constructivism understands all knowledge to be instrumental (von Glasersfeld 1974). Its central idea is that children's learning is constructed and learners build new knowledge upon the foundation of previous learning (von Glasersfeld 2005). Thus, the learner is much more actively involved in a joint enterprise with the teacher constructing new concepts. On this account, learning is not thought of as a passive transmission of information from one individual to another (Atherton 2009; Hoover 1996; Jaworski 1993). Peirce's sign (the main concept of semiotics) is not an instrument; its defining characteristic is not its instrumentality. Constructivism emphasizes that the learner is an active 'maker of meanings'. Arguably, for Peirce a semiotic agent is rather a discoverer of meanings which are already potentially real (see Stjernfelt 2007, 2014). The focus, however, falls on *activity*: it is a central idea for Peirce's pragmatism that "A sign is only a sign *in actu* by virtue of its receiving an interpretation, that is, by virtue of its determining another sign of the same object" (CP 5.569). On this level a collaboration of these two frameworks can be possible and proves fertile.

The argument advanced is that the learner interacts with the environment and, thus, gains an understanding of its characteristics in order to construct conceptualisations and find solutions to problems; this leads to autonomy and independence (Steffe and Gale 1995). From this point of view, classroom learning should include practical activities that challenge the learners' conceptions, encouraging them to reorganise their theories, to engage in advancing new critical hypotheses, namely to practise abduction (the logical operation preceding deduction and induction, by which hypotheses are advanced and redefined, CP 2.96).

That in a suprasubjective reality life is characterized by intersubjectivity suggests that children should be involved in group activities that will evoke learning. Our phenomenal worlds overlap (Stables 2012), and in this intersection of environments semiosis and the possibility of learning are enhanced. Constructivist learning environments have some main characteristics even if there is a range of processes by which knowledge construction takes place (Driver et al., 1994). For example, a constructivist learning environment aims to allow multiple possibilities of interpretations, which avoid oversimplification and represent the complexity of the real world. They also give emphasis to knowledge construction and not to knowledge reproduction, and they provide learning environments such as real-world setting or case-based learning instead of predetermined sequences of instruction. These kinds of environments are ones that encourage thoughtful reflection on experiences and support collaborative construction of knowledge through social negotiation rather than through competition among learners for recognition. Finally, constructivist learning environments emphasize authentic tasks in a context (and contexts are meaningful) rather than abstract instruction out of context (Jonassen 1991; Steffe and Gale 1995; Vrasidas 2000). This recognition of the importance of contextuality in learning is coextensive with the Peircean

perspective that meaning is discovered (Stjernfelt 2007), not "made-up". A certain environment might present more clearly to a knowing subject certain signification, a certain understanding. This is not an intrinsic quality of the environment, but a quality of the relation between learner and environment. In section 2 it will be explained that this is coherent with Peirce's idea that only iconic signs can be used as predicates.

The main characteristics of the constructivist theory stand in contrast to the objectivist view. The main difference is that the objectivist view sees knowledge as something that can be transferred from teacher to children or from some form of technology (including books) to children, whereas, the constructivist view holds that individuals construct knowledge based on their interpretations of their experiences in the world (Jonassen 1991; Vrasidas 2000). This is encompassed in Peirce's doctrine of anancastic evolution (CP 6.307). According to Peirce objective existence is a relation between two individual entities (monads). As a dyadic, and not triadic relation, objective existence lacks mediation and can only be an unsaturated phenomenon of signification. By anancasm Peirce meant objectification, the not yet saturated phenomenon of sign growth, the incomplete semiosis which metaphysically accounts for objective existence. Anancasm, according to Peirce, consists "of new ideas adopted without foreseeing whither they tend, but having a character determined by causes either external to the mind, such as changed circumstances of life, or internal to the mind as logical developments of ideas already accepted, such as generalizations." (CP 6.307) Therefore, Peirce's critique to the objectivist view is coherent with that coming from constructivism: objectivism does not properly take into consideration the relation between the inner life, the personality, of the learner and the environment, but can only account for either external or internal circumstances. That interpretation is based upon our experiences in the world, and, thus, has a personal dimension, is the main claim of Peircean semiotics. This is what constitutes a cornerstone for a Peircean approach to education and edusemiotics generally: "Experience is our only teacher" (CP 5.50).

Peirce's semiotics is an anti-psychologist, non-constructivist logic and this might seem an impediment in uniting the social constructivist and Peircean semiotic approach to education. Peirce's semiotics is anti-psychologistic in that, like Edmund Husserl, Peirce refuted the idea that logic is strictly cognitive (CP 2.252; CP 4.551, see also Stjernfelt 2007, pp. 86–87 and Colapietro, p. 19). Peirce did not argue against a science of psychology by any means, as he proved to be a pioneer in experimental psychology (see Peirce and Jastrow 1885 in CP 7.21-48, CP 7.21). It can be argued that Vygotsky also foresaw the importance of sign use in memory and learning when stating that "the very essence of human memory is that human beings actively remember with the help of signs." (1930, p. 51). In the paper which coined the term *edusemiotics*, Danesi (in Semetsky 2009) noted Vygotsky's awareness of sign activity in cognition. Between Vygotsky's constructivism and Peirce's strong realism there is a common ground in that convention always needs to be embedded in something. Certainly, their accounts are different, the main difference consisting in that while for Peirce the entire Universe is constituted of relations of signification, for Vygotsky signs only come to the aid of learning, memory, and so on. For Peirce signs mediate between signs, there is no other ontological entity; relations relate relations. However, this does not obstruct the possibility of applying Peirce's semiotics in a constructivist psychological framework.

The endeavour is, according to Peirce, an idioscopic science (CP 1.238–CP 1.272) which observes its subject by "some assistance to the senses, either instrumental or given by training, together with unusual diligence" (CP 1.242). Such is the case, as well, of Peirce's experimental studies. The present study is a phenomenological semiotic approach to educational psychology. As such, it approaches the psychology of teaching and learning in terms of phenomena of signification (signs).

Preconceptions and Iconic Learning

We cannot and we do not proceed with most of our lives by doubting everything. We accept (which is distinct from *approve*). We consider that Peirce's philosophy accounts for this view. It overcomes scepticism and modern solipsistic philosophy by accepting the relevance of common-sense (CP 4.540) and the insights of critical common-sense logic (CP 5.494). As explained above, Peirce identified being with the genuine triadic relation, namely signification. It is a cornerstone finding or Peirce that "meaning is obviously a triadic relation" (CP 1.345). As such, the Universe for Peirce is constituted of signs: to be is to be in relation of signification. Signification has a triadic structure and progresses infinitely. Stjernfelt (2007) describes the Peircean semiotic Universe as a "physiology of arguments". The argument, according to Peirce, is the fully developed sign, having as main characteristic its tendency towards truth (CP 2.263). If the Universe is a physiology of signs, truth is to be found in signs. This relational ontology does not assume a binary logic of excluded middle (Semetsky in Stables and Semetsky 2015). Sign relations are not categorically true or false, but they tend to the truth. Their mode of tending to the truth is their mode of signification. According to Peirce's metaphysics of presence, perennial, absolute Truth defines and is inherent in reality, but it is always infinitely distant (CP 6.33). On this account, knowledge is not considered to be a fixed, unchanging state of affairs. If the very facts we encounter via experience are ephemeral and contingent, a continuous tendency, we cannot pretend to have a stable knowledge about them. Knowledge, by its nature, changes.

As mentioned before, by 'preconceptions' we here mean early years children's ideas about science which differ from conventional scientific explanations or classifications (Kambouri 2012). Such ideas have been developed, most likely, autonomously in relation with the children's experiences and without much exposure to formal models or theories through education. However, since knowledge constantly changes, we cannot definitely state whether children's preconceptions are wrong as much as we cannot argue that they are right; we can only judge based on what is currently known and accepted by the scientific community. Research into children's preconceptions has at least one important characteristic in common with constructivism which is that "it takes the child's view of the world seriously" (Black and Lucas 2002, p. 20). Children develop their own logical ideas (based on previous ideas and experiences) rather than discovering factually existing ideas (their own or others'). The structures of scaffoldings that constitute a child's history cannot simply be removed and replaced with a teacher's scaffoldings. Since ideas are not monadic entities that merely exist 'out there', they cannot just be discovered in the sense of being objectively identified because exposed. Within this framework, preconceptions are part of children's future knowledge. Teachers need to acknowledge that children do not come to school as a "tabula rasa"; they do not arrive before teachers as empty books awaiting to be filled with information by them (Pine et al. 2001).

On Peirce's account as well, while we only learn by experience, the doctrine of *tabula rasa* is refuted:

> Far be it from me to enunciate any doctrine of a tabula rasa. For […] there manifestly is not one drop of principle in the whole vast reservoir of established scientific theory that has sprung from any other source than the power of the human mind to originate ideas that are true. But this power, for all it has accomplished, is so feeble that as ideas flow from their springs in the soul, the truths are almost drowned in a flood of false notions; and that which experience does is gradually, and by a sort of

> fractionation, to precipitate and filter off the false ideas, eliminating them and letting the truth pour on in its mighty current (CP 5.50).

Thus teachers should be aware of their pupils' pre-schooling ideas and organise activities in early years schools which will be devoted to challenge and doubt current knowledge of science and phenomena (Ravanis and Bagakis 1998). Certainties that one lives by can be restructured, even refuted. Education challenges certainties we have been used to operating by, on the grounds that reappraisal will lead to a different way of tending to the truth. This is the cycle of abduction-deduction-induction, the structure of semiosis.

Semiotics opposes the modern dualism of right and wrong, true and false. These dualisms stem from modern philosophy's separation of mind and matter (*ens rationis*/*ens reale*, see Deely 2001; Deely and Sbrocchi 2009). Of course, from a given perspective certain things are right or wrong, true or false, mental or physical, seen or imagined. Actually, none of these distinctions is absolute. A straight stick that appears bent under water produces a real visual experience. What can be imagined always has an element of feasibility about it. That something can be thought of implies the respective thing's real possibility of existing. We can think of a table and the referent of our thought might have actual existence, we can think of an unicorn, which proves that unicorns are real possibilities even if their existence is strictly fictional, and not actual, but we cannot think of a 'round square' (Stjernfelt 2007, p. 87). The sign that signifies pure possibility is the sign that signifies due to similarity. Peirce named this sign *Icon*:

> An *Icon* is a sign which refers to the Object that it denotes merely by virtue of characters of its own, and which it possesses, just the same, whether any such Object actually exists or not. It is true that unless there really is such an Object, the Icon does not act as a sign; but this has nothing to do with its character as a sign. Anything whatever, be it quality, existent individual, or law, is an Icon of anything, in so far as it is like that thing and used as a sign of it (CP 2.247).

An icon of the 'round square' is not possible because qualities of 'round' cannot be applied to qualities of 'square,' or vice versa, so that a similarity can occur between 'round' and 'square.' Certainly, 'round' and 'square' have similarities: both are thought of as bi-dimensional and as geometrical figures, but the way in which their qualities can be identified does not allow the construction of a logical predicate by means of similarity. This is what the teacher needs be aware in her relation to her student: the student has her own iconic knowledge which might be very different to the teacher's. If the teacher can apply his icon of 'nuclear' to that of 'family' the student might be confused by the 'nuclear family' concept and would need to perform new abductions so that 'nuclear family' is not a meaningless abstraction. A scaffolding must be similar to what it supports and to what it is supported by. When hearing the teacher saying that 'Today we are going to learn about nuclear families' the student might need to restructure her knowledge (see Sheeran and Barnes 1991). The learner might understand the concept of 'nuclear family' iconically by the thought that "there are all sorts of explosions in our families." Such a manipulation of her knowledge makes the 'nuclear family' concept iconic, and, therefore operational. However, it is an altogether different sign than what the teacher is trying to refer to. Such manipulations of signification have been termed 'interpretations' (signification leading to an Interpretant) in semiotics and 'constructions' in constructivism. We argue that these two concepts are similar and compatible.

An icon is something operational. The icon is the phenomenon of signification that presents its object in a relation of resemblance that makes it useful. I recognize a hammer

because I can hammer with it: the perceptible 'hammer' is similar to the action of hammering. The same perceptible might be recognized as the letter 'T', assuming an artist is trying to elaborate a creative typographical style. This recognition consists in discovering the similarity between two perpendicular bars (a hammer) and the letter 'T'. It is this discovery of similarities that can be used further on to construct a logical predicate. Only iconic signs can be used as predicates:

> The only way of communicating an idea is by means of an icon; and every indirect method of communicating an idea must depend for its establishment upon the use of an icon. Hence, every assertion must contain an icon or set of icons, or else must contain signs whose meaning is only explicable by icons. The idea which the set of icons (or the equivalent of a set of icons) contained in an assertion signifies may be termed the predicate of the assertion (CP 2.278).

Children (as well as anyone) can only predicate with signs that they can operate with, icons that they discovered by themselves at some point. This knowledge characterized by iconic signification is the basis for learning and creativity. A child develops preconceptions mostly via iconic signification, as learning, like signification generally, is first experienced iconically: discovering a similarity between two things. Anything may be similar to anything else, but being aware of a similarity, experiencing it in some way, allows the use of that similarity as a predicate. Until Archimedes noticed the similarity between him entering the water and the level of the water rising there was no thorough understanding of this phenomenon. A similarity is the sharing of a quality. In this example Archimedes discovered the shared quality: the level of the rising of water was equal to his body's volume–volume is the shared quality. The icon is the phenomenon of signification that sets the relation between the sign and its object due to similarity. By simply being in a world where anything is similar to anything else each living being uniquely discovers such relations of similarities. This shapes one's own environment, one's own subjective reality. This phenomenon is the scaffolding of reality. By simply being aware of reality children develop an understanding of the world, according to the relations of similarities they discover. We can only predicate with these relations that we discovered ourselves. The simple explanation of Archimedes' laws might lead one to understanding, to discovering herself, these laws or not. In order for a child to understand these laws, similarities need to be discovered first between his/her own understanding of the world, taking into consideration the entire knowledge, all preconceptions, and the object that is being taught.

There is always an element of chance in learning, as in signification generally. This element of chance is found at the basic level of signification, namely iconicity. That the first modes of signification are subject to chance reveals a principle of evolution for Peirce. According to Peirce (CP 4.3) signification can be analyzed under three phenomenal categories. These are Firstness, populated by monadic qualities, Secondness, populated by individual objects constituted by dyadic relations among qualities and Thirdness, populated by the general tendencies (laws) that occur among objects. Icons belong mostly to the phenomenological category he termed "Firstness". Since the sign has three termini there are nine types of signs, as each terminus can be analyzed under each category. The termini of the sign are categorical as well, which means that Thirdness is the category of signification (meaning) *par excellence* (as mentioned previously in section 2, see CP 1.345). This implies that, for Peirce, objectivity on its own is meaningless, this being a hypothesis embraced by constructivism as well. Iconic signification concerns the relation of similarity between Representamen and Object. Firstness is driven by chance. In discovering a similarity there is always an element of chance. The teacher has to admit that pupils' learning

cannot be controlled. Actually, we cannot control our own learning and being in the world, chance is always present to some extent.

Acknowledging that the learner is not in charge of the learning phenomenon should inspire a non-authoritative, egalitarian attitude on behalf of the teacher. Admitting that the other, be it the case of an inexperienced child, has a unique understanding of the world, should humble the teacher. The potential for growth of the knowledge of the inexperienced child is unknown. There is no universally set destination for learning, as there is no predetermined destination for knowledge generally. We discover what we need to pursue while learning. It is an essential aspect of Peirce's semiotics that the sign's Interpretant supplies at part of the signs meaning (CP 5.448), leaving room for *new understanding*, and thus dismissing the assumption of there being a fixed, objective information to be acquired (Hausman 1974; Nöth 2014). It was explained above that constructivism also contradicts the assumption of fixed knowledge. The learner does not need to become the teacher, as the teacher cannot become the learner. This is generally the case of relations between children and adults. There is no established adulthood labelled as full humanity, and there is no established level of knowledge that makes a learner a master of a subject:

> Aspiration to full humanity is far more humbling on this than on the standard humanist account, whereby we are imbued with a human essence that we might betray but can generally only express rather than improve (Stables 2012, p. 96).

On the account of Peircean semiotics education must not pursue to achieve a relation of identity between the knowledge of the student and that of the teacher. Identity is impossible, while similarity of signification is not only possible, but always present, waiting to be discovered.

Fragments of the Empirical Data are Qualitatively Analysed in the Perspective of Peircean Semiotics

Our knowledge of the world begins with chance, or at least by something out of our control, which permeates throughout the continuous evolution of signification that determines our own environment. Therefore, each of our environments is unique, as each organism is an evolving sign in a unique environment. At least from the point of view of the individual, her presence in a particular environment is largely due to chance. Because chance is always present in signification we do not coincide. The self acknowledges the other, their phenomenal worlds overlap, but they never coincide, the self is merely an other.

Peirce found a profound error in dismissing any metaphors which others discover and further on construct their environments by. For instance, he criticised the spread psychological account of his age that would not understand the relevance of a blind man's icons for colours:

> One of the old Scotch psychologists, whether it was Dugald Stewart or Reid or which other matters naught, mentions, as strikingly exhibiting the disparateness of different senses, that a certain man blind from birth asked of a person of normal vision whether the scarlet was not something like the blare of a trumpet; and the philosopher evidently expects his readers to laugh with him over the incongruity of the notion. But what he really illustrates much more strikingly is the dullness of apprehension of those who, like himself, had only the conventional education of the

> eighteenth century and remained wholly uncultivated in comparing ideas that in their matter are very unlike (CP 1.312).

Peirce's text is mainly aimed at explaining similarities among modalities. However, it also makes a statement about his experience based educational thinking. A blare of a trumpet is potentially similar with the colour scarlet: one simply has to discover some similarity. The whole experience that a human person lives when experiencing scarlet or the blare of a trumpet is intimate and ultimately impossible to communicate. The web of relations of signification that constitutes one's self at a moment in time-space is unrepeatable. This is why the account of learning as discovery of similarities accounts for creativity as well. Even if some similarities are obvious and not particularly insightful, the most revealing developments are, as well, discoveries of similarities:

> The fact that it has never before been asserted that this orange on the table before me is similar in shape to the moon (given a certain granularity of similarity classes), might cause sensible souls to see me as a genius for creating metaphors, but, modestly, it seems strange that this similarity should be something created by me. I merely discover (no great effort) this similarity by applying a certain *tertium comparationis* (a circle, give or take a certain rate of deformation). In rare cases, of course, it may take great pains to establish a new complicated *tertium comparationis* to see a similarity (Newton discovering the similarity between the movement of the apple and of the heavenly bodies, Eliot discovering the similarity between cruelty and the growth of April flowers; Stjernfelt 2007, p. 57).

If the possibility of discovering a relevant, insightful similarity between scarlet and the blare of a trumpet appears to be false and useless, so are the similarity between a falling apple and the movement of celestial bodies and between cruelty and April flowers. The *tertium comparationis* that affords establishing this relation between a trumpet's sound and scarlet might be hidden to a knowing subject. However, as soon as one discovers the similarity herself, the icon becomes impossible to deny. Until the moment of discovery the icon is ungraspable and no predicate can be constructed by applying *blare of trumpet* to *scarlet*. Once with the discovery, the iconicity becomes undeniable. When presented afresh with a relation of similarity, such as that between cruelty and flowers, we might at first be suspicious of its truth. However, after we become accommodated with it, it is impossible to deny it. For example, in the age of quantum physics we still commonly think in Newton's terms of classical mechanics because an already discovered relation of similarity (force of gravity interpreted as the similarity between falling apples and the movement of celestial bodies) is impossible to deny.

Collected data (Kambouri 2012, 2015) suggests that teachers do not acknowledge the potential for insightful discovery and creativity of the child's knowledge which differs from theirs and from the formulations accepted by the scientific community. The assumption for which Peirce criticized the Scottish psychologists is present in the teachers' attitude towards young children. For example, one of the teachers interviewed stated that "Children believe that water is white and you have to put a glass of milk next to it for them to realise that it is not white. They really believe that it is white" (Kambouri 2012: interview, teacher 1). In this case the teacher is simply assuming that children do not understand that transparency is colourless. A white physical object is opaque. However, what the teacher is failing to take into account is that children have a different experience and understanding of *white*. The concept (experience) of *white* of a child is not the *white* of an adult, as *white* is never experienced identically by any two distinct individuals. When

the teacher has the child facing the situation of comparing the *whiteness* of milk with *transparency* of water, the child might be redefining (abducting on) her notion of *white* rather than that of *water*. Until this experience these two individuals meant different things by *white*. This makes the teachers' argument a sophism as the teacher is not aware of the homonymy between her *white* and another's *white*. The argument that the teacher aims at, by the comparison between milk and water, based on a perceptual judgement, is as follows:

Milk is white.
The colour of water it not the colour of milk.
Therefore water is not white.

The child's argument might be essentially different, such as, for instance:

Water is white.
Milk is white.
White has many shades.

The Interpretant 'White has many shades' supposes not only a deduction and an induction but also an abduction, a restructuring of hypothesis. This is creativity, taking into consideration a wider spectrum which the premises (determined by deduction and induction) afford. Construction is not (pre-)determined in the argumentation, it gives space for creativity, by allowing a further discovery. Another conclusion which the child might come to is 'White is not a colour.' Even more interesting would be a conclusion of a child having a concept of 'manifestation' (phenomenon) such as 'White is manifested differently in different objects'. The fallacy of the teacher's argument stands in that it assumes that there is a correct notion of 'white' which is the universally accepted notion of 'white'. Following the teacher's argument milk and the skin of a Caucasian human being cannot both be *white*. If the teacher would simply realise that the child is a distinct consciousness from itself, inhabiting a different phenomenal world, the fallacy can be easily avoided. Admitting that the other developed a different web of significations, which is potentially scientific, leads to investigating the other's knowledge. As such, an experienced teacher has much to learn from a less experienced child. Accepting the other's knowledge on its own terms broadens the horizons of creativity (abductive reasoning). For teaching his notion of *water* the teacher should learn the children's notion of *white*. This becomes evident by acknowledging that *a concept* (such as the concept of *white*) is not a purely mental entity, having a clear and distinct cognitive correlate. *White*, *milk*, *water* are signs. They signify according to their use, within the syntax of a web of signs. Different users have different syntaxes. Applying the predicate *white* to *milk* or *water* implies the use of this signs iconically. *White* is a predicate applied to a subject. *Milk* and *water* are unsaturated predicates, icons that can evolve into predicates. If a child knows the similarity between *white* and *milk* and *water* in the same time, his icon of *white* is a richer signification than that of a teacher who can only apply this predicate to either *milk* or *water*.

One of the teachers stated: "they might say that a cloud is crying when it is raining, especially when there is something like that in the fairy tale. But, I think most children, especially 5-year-olds, know that this is not true and that it is just part of the fairy tale language, even if they use it." (Kambouri 2012: interview, teacher 2). Like the previous example this as well demonstrates a rigid and sterile theory of knowledge on the part of the teacher. The teacher's difficulty, in this case, stands in confusing fictionality and value of truth. The teacher obviously assumes that things have binary and definite value of truth. This is a typical assumption of objectivism, a doctrine that fundamentally identifies existence and reality. On the Peircean account phenomenal reality is broader that existence,

which belongs within reality, actual and possible. As mentioned in section 2, semiotics is not a binary logic as it does not follow the principle of excluded third (see Semetsky 2005). On the teacher's account, the proposition "It is raining therefore the cloud is crying" is false. In the same time the teacher supposes that children "know that this is not true and that it is just part of the fairy tale language". The teacher does not acknowledge that there are models of logic that attribute value of truth to both non-fictional and fictional statements. According to Peirce, while the Universe is constituted entirely of signs (CP 5.448), signs refer to Universes of Discourse, linking Universes of Discourse together (CP 3.573; Stjernfelt 2007, Chapter 17; Stjernfelt 2011). Therefore, it is correct to assume that the proposition "Donald Duck wears a sailor's shirt" is true (Stjernfelt 2011), and so is "The cloud is crying". If April flowers grow cruelly then clouds might as well be able to cry. The teacher fails to apply value of truth to fictional statements. However, the teacher's remark refers also to children confusing fictional and non-fictional Universes of Discourse. The teacher claims that explaining the physical phenomenon of rain on the basis of the similarity that children discover between raining and crying is delusional. It can be argued that while Eliot's *Wasteland* is a Universe of Discourse that has the rationale of expressing feelings, a natural sciences school lesson explaining rain has a different rationale. We argue that this dichotomy between scientific and non-scientific value of truth is a fallacy of modern philosophy. The biological development of a child implies a cognitive development by which the distinction between fictional and non-fictional is acknowledged. Teacher 2 was aware that 5 year old children know that their assumption about clouds crying is fictional. However, the teacher did not allow the children to express their knowledge by the predicate "to cry". This is ultimately unjustified and it narrows down the real possibilities of learning for the child. The very scientific potential that the teacher should enhance is narrowed down by imposing on children an artificial dichotomy.

We argue that the phenomenon of learning essentially depends on the teacher's understanding that a child's preconceptions are not true or false *strictu sensu*. They are structures of signification embedded in a complex web of relations of signification, the continuously on-going result of years of being alive and (self-) conscious.

Learning is a mutual phenomenon. It is a mediation, which is triadic, not a dyadic relation. Both the teacher and the learner have to learn from each other. In a suprasubjective reality mutuality is intersubjectivity. The interviewed teachers showed an understanding of knowledge and language as representations of otherwise-existing objective entities. Therefore, they tended to regard the process of teaching as one of conveying objective truth, via language, into the subjective world of the learner. From this perspective teaching aims at delivering objective and fixed information to learners who are subjective and unreliable via language, which is a tool for reflecting objective existence. On this account, there is a fixed subject to be learned, something *noumenal*, which-is-to-be-learned.

The sign is not merely a representation of an otherwise-existing entity. Learning does not consist in acquiring information about a *noumenal* thing which-is-to-be-learnt (such as the physical phenomenon of rain, equations, or knitting). The physical phenomenon of rain is understood by the learning subject in relation with everything else the learner knows. It might resemble crying, in which case the learning subject will apply her predicate of *crying* to *rain*. It would be wrong to forbid the natural evolution of signification, from existing, already developed icons to more complex signification. Science, according to Peirce, needs "an experimenter of flesh and blood" (CP 5.424) to perform it. A scientist can only be a human being, and, therefore the scientific claim for objectivity is only valid within the suprasubjectivity of life, of semiotic existence.

The Teacher and the Learner are Learning from Each Other: The Art of Agapism Enhancing the Possibilities of Learning on the Ground of the Learner's Preconceptions

As mentioned, learning is gained when the learner's interaction with the environment develops an understanding of its characteristics in order to construct conceptualisations and find solutions to problems (Steffe and Gale 1995). This is an interpretation of one's own environment. Its result might be survival, but also a better life, not in terms of merely keeping one's breath, but a happier as more insightful existence within the environment. Based on the study's results, teachers believe that the most appropriate way to teach early years children is through activities that will offer hands-on experiences and will give to children the opportunity to actively engage in the learning process, ask questions and test their ideas and preconceptions which helps them develop their knowledge. As one of the teachers stated 'When children experience something through their senses, they believe it and learn it' (Kambouri 2012: interview, teacher 7). Constructivism demands that the learning environment should focus on knowledge construction and not on knowledge reproduction. This idea should be inspired by the learning environment that will aim to support thoughtful reflection on experiences and support collaborative construction of knowledge. Peirce echoes this, in his discussion on the development of consciousness, by declaring that learning should embrace activities that will offer to children the opportunity to be engaged practically in a way that will challenge their current knowledge and preconceptions and encourage them to reorganise their theories: "A very young child may always be observed to watch its own body with great attention. There is every reason why this should be so, for from the child's point of view this body is the most important thing in the universe. Only what it touches has any actual and present feeling; only what it faces has any actual color; only what is on its tongue has any actual taste" (CP 5.229).

This signifies the need for early years teachers to identify ways to encourage and help these children to participate in learning in many different situations and contexts. This can be further reinforced by having children working together in groups. Social constructivism emphasises that learning from each other is the most powerful form of learning. Learning by oneself is mostly subject to chance, to what comes along within the scope of one's own consciousness. By joining in cooperation with another the horizon of the self can expand towards the horizon of the other. Working with others can also be helpful when dealing with preconceptions. This way, children can share their ideas and learn from each other while the teacher is guiding (indexical signification) and learning (discovering icons, developing predicates) with them. Small groups can give children the opportunity to see materials and experiment in their groups, discuss, present their results in the rest of the classroom, compare their results with the others and come to conclusions. This is the case because a small group contains an implicit index: here, among us (Stjernfelt 2014).

'Cognitive conflict' is also considered to be a very helpful method when it comes to eliminating the children's preconceptions and it refers to presenting children with something which is puzzling or unexpected and which will force them to stop to think (Shayer and Adhami 2004). It is not about presenting difficult material; it is more about leading to certain expectations which are then not met, so children will have to 'think again'. For Piaget cognitive conflict was one of the main drivers of cognitive development (Atherton 2009). If a child is always presented with work that can be easily done, there is little stimulation of the mind. Thus, 'cognitive conflict' is about organising activities that will offer the children the challenges which will be a little beyond their existing level of understanding, in order to

encourage and push children to achieve higher levels of thinking. To achieve this, the organised activities need to lie within the children's 'Zone of Proximal Development' (Leat and Nichols 1997). Thus, using a Vygotskian concept to support a Piagetian point, one could suggest that teachers will need to identify what a child can achieve without help and what with some leading questions and guidance.

'Cognitive conflict' has been proven to be beneficial of all children, no matter their level of abilities (Shayer and Adhami 2004). This means that lower ability children will not be disregarded when this method is used. According to Shayer (1999), children with different ability levels can benefit from activities which are based on 'cognitive conflict', as the activities allow children to enter different levels by encouraging them to think and work in higher levels, ones that they used to work and do what they feel comfortable to do.

To accommodate 'cognitive conflict', it is important for teachers to plan their teaching and prepare the learning environment on the basis of acknowledging the children's pre-conceptions. The teachers' aim should be to help children use their prior knowledge and make them question the concepts that they expressed and improve the understanding of their phenomenal world through observations, experiments, questioning and hypothesis checking. An experienced teacher should be able to guide the less experienced learner since the teacher knows what issues can be difficult to understand and what preconceptions are usually associated with what is being taught. It is important to create a relationship of trust that will allow the teachers to lead and the learner to follow, taking advantage of the several opportunities that appear throughout the day, as learning is continuous (for example during break time or play time) (Kambouri 2012).

On this account, it is more important for teachers to prepare themselves than to prepare the details of the lesson. This is particularly essential when teaching early years children, as their environment is generally different from an adult's environment. Usually, early years teachers do not have a scientific background and do not receive extended training on this issue, therefore, they need to study and be well-prepared in order to teach science. Their motive to do this will be their love for their students, namely *agapism*. The participants in the study agreed that early years teachers need to study the topics they are planning to teach in depth. The need for this comes from the responsibility that the teacher feels towards the learner. As one of the teachers said, 'When teachers know what they want to teach and have studied about it, they feel more confident and this will lead to a more successful and better lesson for their students. In contrast, when they are not sure about what they are teaching, there is a feeling of fear and children can sense this and the lesson will fail.' (Kambouri 2012: interview, teacher 3). In such a case, there is a danger of spreading teachers' preconceptions to children because of the teacher's misleading knowledge. The teacher is only another, more experienced learner, not an absolute, infallible knower of objective truth. If the teachers are not sure about something or if they hold the same preconceptions as children, the children will not manage to overcome their preconception (Kambouri 2012; Schmidt 1997).

Hence, the process of teaching involves learning not only for the learner but for the teacher as well. Teachers are learning continuously through teaching and they constantly search for new information that will help them better support their students by improving their own knowledge and overcoming their own ideas. The teacher is learning through exploring the learners' preconceptions; thus the teacher and the learner are learning from each other. Learning is bidirectional and develops based on the teacher-learner relationship. This is the only possibility of knowledge growth. The teacher will guide the learner but they will develop their understanding together and they will both learn from each other, resulting to the construction of new knowledge which will be different for each individual, but consensual.

Conclusion

The article shows how semiotics and constructivism are mutually beneficial regarding education, but not identical. The compatibility between these two paradigms is founded, first of all, on their shared realist assumption that our understanding of the world, at a certain moment, is based on previous understandings and that nothing is learnt in *tabula rasa* conditions. Constructivism developed in a rationalist direction at times, by ascribing proper ontological status to what the mind can construct. In a dualist philosophical background, the dismissal of the *tabula rasa* assumption leads to rationalism: if we do not start from blank, then it is implied that we start with some *a priori*, naturally given notions. If all knowledge is built upon something, *a priori* (innate) concepts are assumed. Semiotics can reintegrate constructivism in its non-dualist framework. As such, by the understanding that knowledge is not fixed and that it belongs to developing environments of evolving organisms, knowledge acquisition is understood as an act of interpretation, and, as such of adaptation (Gough and Stables 2012). Both semiotics and constructivism approach learning as interpretation.

In the time of Piaget and Vygotsky, Peirce and realist semiotics were still widely unknown. As a framework, Peirce's semiotics fertilizes all the more Vygotsky's social constructivism, placing it in a new light. In the same time, Vygotskian constructivism, through concepts such as scaffolding offer a deeper insight into the phenomenon of semiosis. Taking into consideration the recent growing interest in this semiotic approach in the humanities and social sciences, constructivism can be seen in a new, non-dualist light. 'Construction', as much as it is an internalized understanding to some extent, is not a purely mental conceptualization, about which no correspondence to a 'world out there' can be inferred. A construction is an interpretation of a being's environment at moment in time-space.

Our empirical senses and reasoning are inseparable and together constitute our whole semiosic being. It is our whole semiosic being that *knows,* that *learns*. Senses and thought do not either mislead us in our acquisition of knowledge or offer an objective comprehension of objective reality, because all we perform is an interpretation (semiosis). Our interpretative experiences do not lie to us any more than they reveal truth, as there is no objectivity to be grasped *as it is*. A construction (or interpretation) in and of the world does not obscure *noumena*, but rather it both reveals and obscures *phenomena,* as our constructing (interpreting) builds upon the already constructed (interpreted). As such, constructions are never absolutely plastic, but have certain elasticity, a disposition to change. On this account preconceptions can and must evolve. The main claim for education is that, however insightful and experienced, teachers will fail if they are considering an 'overcoming' of the child's preconceptions. The development of a construction consists in an evolution towards an (aesthetical, ethical and logical) evolution of phenomenal world (environment).

References

Anderson, Lorin, David Krathwohl, Peter Airasian, Kathleen Cruikshank, Richard Mayer, Paul Pintrich, James Raths, and Merlin Wittrock. 2001. *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*, Complete ed. New York: Longman.

Atherton, James S. 2009. Learning and teaching: Piaget's developmental theory. http://www.learningandteaching.info/learning/piaget.htm. Accessed 25 June 2015.
Bains, Paul. 2006. *The primacy of semiosis: An ontology of relations*. Toronto: University of Toronto Press Incorporated.
Barbieri, Marcello. 2008. *Introduction to biosemiotics*. Dordrecht: Springer.
Black, Paul Joseph, and Arthur Maurice Lucas (eds.). 2002. *Children's informal ideas in science*. London: Routledge.
Bruner, Jerome S. 1978. The role of dialogue in language acquisition. In *The child's concept of language*, ed. A.R. Sinclair, J.J. Jarvelle, and W.J.M. Levelt. New York: Springer.
Bundgaard, Peer, and Frederik Stjernfelt (eds.). 2009. *Signs and meaning: 5 questions*. New York: Automatic Press.
Colapietro, Vincent. 1989. *Peirce's approach to the self: A semiotic perspective on human subjectivity*. Albany: State University of New York Press.
Deely, John. 2001. *Four ages of understanding: The first postmodern survey of philosophy from ancient times to the turn of the twenty-first century*. Toronto: University of Toronto Press.
Deely, John, and Leonard Sbrocchi (eds.). 2009. *Semiotics 2008: Specialization, semiosis, semiotics*. Ottawa: Legas.
Dewey, John. 1997. *Experience and education*. New York: Touchstone.
Driver, Rosalind, Hillary Asoko, John Leach, Eduardo Mortimer, and Phillip Scott. 1994. Constructing scientific knowledge in the classroom. *Educational Researcher* 23(7): 5–12.
Eco, Umerto. 1976. *A theory of semiotics*. Bloomington: Indiana University Press.
Emmeche, Claus, and Kalevi Kull (eds.). 2011. *Towards a semiotic biology: Life is the action of signs*. London: Imperial College Press.
Favareau, Donald, Paul Cobley, and Kull Kalevi (eds.). 2012. *A more developed sign: Interpretering the work of Jesper Hoffmeyer*. Tartu: Tartu University Press.
Fosnot, Catherine. 1996. Constructivism: A psychological theory of learning. In *Constructivism: Theory, perspectives, and practice*, ed. C. Fosnot, 8–33. New York: Teachers College Press.
Gough, Steve, and Andrew Stables. 2012. Interpretation as adaptation: Education for survival in uncertain times. *Curriculum Inquiry* 42(3): 368–385.
Hausman, Carl R. 1974. Eros and agape in creative evolution: A Peircean insight. *Process Studies* 4(1): 11–25.
Henning, Brian G., and Adam Scarfe (eds.). 2013. *Beyond mechanism: Putting life back into biology*. Plymouth: Lexington Books.
Hoffmeyer, Jesper. 2015. Introduction: Semiotic scaffolding. *Biosemiotics* 8: 153–158.
Hoover, Wesley A. 1996. The practice implications of constructivism. *SEDL Letter* 9(3): 1–2.
Jaworski, Barbara. 1993. *Constructivism and teaching—The socio-cultural context*. http://www.grout.demon.co.uk/Barbara/chreods.htm. Accessed 26 June 2015.
Johnston, Jane. 2005. *Early explorations in science*. Maidenhead: Open University Press.
Jonassen, David H. 1991. Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development* 39(3): 5–14.
Kambouri, Maria. 2012. *Cypriot early-year teaching of science: Appreciation of young children's preconceptions.* Unpublished Ph.D. thesis. Coventry: University of Warwick.
Kambouri, Maria. 2015. Investigating early years teachers' understanding and response to children's preconceptions. *European Early Childhood Education Research Journal*. doi:10.1080/1350293X.2014.970857.
Kull, Kalevi. 2005. Semiotics is a theory of live. In *Semiotics 2003: Semiotics and national identity*, eds. Rodney Williamson, Leonard Sbrocchi, and John Deely, 15–31. New York: Legas.
Kull, Kalevi. 2009. Biosemiotics: To know, what life knows. *Cybernetics and Human Knowing*. 16(3/4): 81–88.
Lakoff, George, and Mark Johnson. 1999. *Philosophy in the flesh: The embodied mind and its challenge to western thought*. New York: Basic Books.
Leat, David, and Adam Nichols. 1997. Scaffolding children's thinking—doing Vygotsky in the classroom with National Curriculum assessment. In *Proceedings of the British educational research association annual conference*. University of York.
McLeod, Saul. A. 2008. *Bruner*. www.simplypsychology.org/bruner.html. Accessed 10 Apr 2016.
Nöth, Winfried. 2014. The semiotics of learning new words. *Journal of Philosophy of Education* 48(3): 446–456.
Olteanu, Alin. 2014. The semiosic evolution of education. *Journal of Philosophy of Education* 48(3): 457–473.

Olteanu, Alin. 2015. *Philosophy of education in the semiotics of Charles Peirce: A cosmology of learning and loving*. Oxford: Peter Lang.
Peirce, Charles S. 1931–1935 and 1958. *The collected papers of Charles Sanders Peirce*, electronic edition reproducing Vols. I–VI, eds. by Charles Hartshorne and Paul Weiss. Vols. VII–VIII, ed. Arthur W. Burks. Cambridge, MA: Harvard University Press.
Peirce, Charles S. 2010. *Writings of Charles S. Peirce, a chronological edition*, 8, 1890–1892. Bloomington: Indiana University Press.
Pietarinen, Ahti-Veikko. 2006. *Signs of logic*. Dordrecht: Springer.
Pine, Karen, David Messer, and Kate St. John. 2001. Children's conceptions of the changes of state of water. *Journal of Research in Science Teaching* 19(1): 79–96.
Ravanis, Konstantinos, and George Bagakis. 1998. Science education in kindergarten: Sociocognitive perspective. *International Journal of Early Years Education* 6(3): 315–327.
Schmidt, Hans-Jürgen. 1997. Students' misconceptions—Looking for a pattern. *Science Education* 81(2): 123–135.
Semetsky, Inna. 2005. Peirce's semiotics, subdoxastic aboutness, and the paradox of inquiry. *Educational Philosophy and Theory* 37(2): 227–238.
Semetsky, Inna (ed.). 2009. *Semiotics, education, experience*. Rotterdam: Sense Publishers.
Shayer, Michael. 1999. Cognitive acceleration through science education II: its effects and scope. *International Journal of Science Education* 21(8): 883–902.
Shayer, Michael, and Mundher Adhami. 2004. Realising the cognitive potential of children 5–7 with a mathematics focus. *International Journal of Educational Research* 39: 743–775.
Sheeran, Yanina, and R. Douglas Barnes. 1991. *School Writing: discovering the ground rules*. Milton Keynes: Open University Press.
Stables, Andrew. 2005. *Living and learning as semiotic engagement: A new theory of education*. Lewiston: Edwin Mellen Press.
Stables, Andrew. 2012. *Be(com)ing human: Semiosis and the myth of reason*. Rotterdam: Sense Publishers.
Stables, Andrew, and Inna Semetsky (eds.). 2014. *Pedagogy and edusemiotics: Theoretical challenge/practical opportunities*. Rotterdam: Sense Publishers.
Stables, Andrew, and Inna Semetsky. 2015. *Edusemiotics: Semiotic philosophy as educational foundation*. New York: Routledge.
Steffe, Lesslie, and Jerry Gale (eds.). 1995. *Constructivism in education*, 17–39. New Jersey: Lawrence Erlbaum Associates Inc.
Stjernfelt, Frederik. 2007. *Diagrammatology. An investigation on the borderlines of phenomenology, ontology and semiotics*. Dordrecht: Springer.
Stjernfelt, Frederik. 2011. Signs conveying information. On the range of Peirce's notion of propositions: Dicisigns. *International Journal of Signs and Semiotic Systems* 1(2): 40–52.
Stjernfelt, Frederik. 2014. *Natural propositions: The actuality of Peirce's doctrine of dicisigns*. Boston: Docent Press.
von Glasersfeld, Ernst. 1974. Piaget and the radical constructivist epistemology. In *Epistemology and education*, eds. C.D. Smock and E. von Glasersfeld, 1–24. Athens: Follow Through Publications.
von Glasersfeld, Ersnt. 2005. Thirty years constructivism. *Constructivist Foundations* 1(1): 9–12.
Vrasidas, Charalambos. 2000. Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education. *International Journal of Educational Telecommunications* 6(4): 339–362.
Vygotsky, Lev. 1986 [1934]. *Thought and language*. Cambridge: MIT Press.
Wilson, Brent Gale (ed.). 1996. *Constructivist learning environments*. New Jersey: Educational Technology Publications.
Wood, David, Jerome S. Bruner, and Gail Ross. 1976. The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry* 17(2): 89–100.