University of Reading

Predictive validity of state versus trait challenge and boredom for career aspirations

Article

Published Version

Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0

open access

Krannich, M., Goetz, T., Roos, A.-L., Murayama, K., Keller, M. M., Bieg, M. and Lipnevich, A. A. (2022) Predictive validity of state versus trait challenge and boredom for career aspirations. Learning and Instruction, 81. 101596. ISSN 0959-4752 doi: https://doi.org/10.1016/j.learninstruc.2022.101596 Available at https://centaur.reading.ac.uk/104569/

It is advisable to refer to the publisher's version if you intend to cite from the work. See Guidance on citing.

To link to this article DOI: http://dx.doi.org/10.1016/j.learninstruc.2022.101596

Publisher: Elsevier

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the End User Agreement.

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Learning and Instruction 81 (2022) 101596

Contents lists available at ScienceDirect

Learning and Instruction

journal homepage: www.elsevier.com/locate/learninstruc

Predictive validity of state versus trait challenge and boredom for career aspirations

Maike Krannich [a,*], Thomas Goetz [b], Anna-Lena Roos [c], Kou Murayama [d], Melanie M. Keller [e], Madeleine Bieg [f], Anastasiya A. Lipnevich [g]

[a] *Department of Psychology, Faculty of Arts and Social Sciences, University of Zurich, Zurich, Switzerland*
[b] *Department of Developmental and Educational Psychology, Faculty of Psychology, University of Vienna, Vienna, Austria*
[c] *Institute for Research and Development of Collaborative Processes, School of Applied Psychology, University of Applied Sciences and Arts Northwestern Switzerland FHNW, Olten, Switzerland*
[d] *Hector Research Institute of Education Sciences and Psychology, University of Tübingen, Tübingen, Germany*
[e] *IPN - Leibniz Institute for Science and Mathematics Education, Kiel, Germany*
[f] *Department of Forensic Psychiatry and Psychotherapy, Centre for Psychiatry Reichenau, Reichenau, Germany*
[g] *Queens College and the Graduate Center, City University of New York, New York, USA*

ARTICLE INFO

Keywords:
Challenge
Classroom
Boredom
Career aspiration
Trait/state assessment

ABSTRACT

This study focused on students' perceived challenge, its direct links to career aspirations along with indirect links to career aspirations via boredom. We extended previous findings by differentiating state and trait assessments of challenge and boredom and by investigating within- and between-person relations. We hypothesized over-challenge to go along with reduced career aspirations. Furthermore, boredom should occur due to both over- and underchallenge and should reduce those aspirations. We expected stronger effects of trait challenge and boredom on career aspirations as compared to the respective state reports. The hypotheses were tested in a sample of $N =$ 753 high-school students ($M_{age} = 15.72$) from 43 classes by a questionnaire and an experience-sampling approach. Multilevel analyses showed overchallenge being linked to reduced career aspirations; this direct effect was equally strong for trait and state reports. Furthermore, the indirect effect of trait non-optimal challenge (over- or underchallenge) indicated a decrease in career aspirations via trait boredom.

1. Theoretical background

Every classroom includes students of heterogeneous ability and therefore calls for differentiated tasks. It is already known that non-optimal alignments between person factors and environmental factors adversely impact students' outcomes, for example, their wellbeing, depression, performance, and persistence (e.g., Pekrun, Hall, Goetz, & Perry, 2014; Richards, 1993; Spokane, Meir, & Catalano, 2000). In any instructional setting, student challenge, operationalized as the match between students' abilities and the task at hand is of a particular importance (Krannich et al., 2019). Despite indications that non-optimal alignments of abilities and task demands may have long-term negative effects on students' career aspirations (Le, Robbins, & Westrick, 2014; Niles, 1993), there is limited research examining these links. In fact, most of the previous studies examining student challenge did not explicitly focus on this link, but rather, on a more general concept of the person-environment fit (for a meta-analysis see Kristof-Brown, Zimmerman, & Johnson, 2005).

Furthermore, existing investigations did not differentiate the direction of non-optimal challenge (with the exception of Krannich et al., 2019). Theoretically, one can construe non-optimal challenge as falling into different extremes on a continuum: being overchallenged when task demands exceed personal capabilities, and being underchallenged when task demands are lower than personal capabilities (Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010). Non-optimal challenge in the direction of being overchallenged should be negatively linked to students' career aspirations. More specifically, students interpret overchallenge as the domain being too difficult for their individual abilities and hence, lower their expectations for success and avoid going into the corresponding field (Kolvereid, 1996; Lent, Brown, & Hackett, 1994; Lent, Paixao, Da Silva, & Leitão, 2010).

Beyond expectations for success, students' emotions play a pivotal

* Corresponding author. Department of Psychology, University of Zurich, Binzmühlestrasse 14/Box 33, CH-8050, Zurich, Switzerland.
E-mail address: maike.krannich@uzh.ch (M. Krannich).

https://doi.org/10.1016/j.learninstruc.2022.101596
Received 14 August 2020; Received in revised form 30 April 2021; Accepted 1 February 2022
Available online 26 March 2022
0959-4752/© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

role in explaining the link between challenge and career aspirations. Various emotional experiences along with students' momentary perceptions of challenge accumulate over time and exert long-term influence on their outcome expectations and, consequently, career aspirations (Epstein, 1983; Nett, Bieg, & Keller, 2017; Pekrun, 2006). Boredom is of a particular relevance, with previous studies showing that student experiences of non-optimal challenge – both over- and underchallenge – were key antecedents of this academic emotion (e.g., Goetz, Hall, & Krannich, 2019; Ringmar, 2017). However, earlier research did not consider the underlying links among challenge, boredom, and career aspirations in combination. Moreover, previous studies did not systematically differentiate between over- and underchallenge. Hence, we will explore the direct effect of non-optimal challenge (over- or underchallenge) on students' career aspirations together with the indirect effect on these aspirations via boredom.

Studies comparing the impact of situational versus global perceptions of challenge and boredom are lacking. That is, students' challenge can either be conceptualized and assessed as a situational state of being challenged (*state* assessment) during a specific task, or as a general tendency to be challenged in a specific school domain (*trait* assessment) over a longer period of time (Chaplin, John, & Goldberg, 1988). The same is true for boredom. Studies have shown that trait emotions could be considered as more predictive for future expectations compared to state emotions (e.g., Levine, Lench, & Safer, 2009; Robinson & Clore, 2002a, 2002b; Wirtz, Kruger, Scollon, & Diener, 2003). To our knowledge, no studies to date have systematically differentiated between state and trait challenge and boredom to disentangle their respective predictive power with regards to career aspirations. Our focus on both state and trait assessments of challenge and boredom will allow us to investigate both within-person functional relationship (i.e., intraindividual relations) based on state assessments as well as between-person covariation of the two constructs (i.e., interindividual relations) based on trait assessments (e.g., Daschmann, Goetz, & Stupnisky, 2011). These analyses have different theoretical and practical implications (i.e., referring to within and between person relations; Murayama, Goetz, Malmberg, Pekrun, Tanaka, & Martin, 2017).

In sum, our study focuses on two important precursors to career aspirations, namely, students' perceived challenge and boredom. Thereby the present study contributes to research by examining the interrelations of these variables with students' career aspirations while taking into account both trait and state assessments. To this end, we investigated whether between- and within-person relations of perceived challenge and boredom as the two antecedents of career aspiration converge. Students' challenge and their experiences of boredom in the classroom are domain-specific (e.g., Goetz, Pekrun, Hall, & Haag, 2006). Therefore, in this study we investigated the effects of challenge and boredom in the domain of mathematics on students' math-related career aspirations.

1.1. Definition of students' challenge

In the educational and psychological literature the concept of challenge has multiple meanings and definitions (e.g., Kanevsky & Keighley, 2003). Students' challenge at school is described by their perceived fit between task difficulty and their ability (e.g., Kristof-Brown et al., 2005; Ostroff & Zhan, 2012). According to this definition, students' non-optimal challenge arises if students experience a poor fit between the difficulty level of a task and their ability in either direction (i.e., under – and overchallenge). We label this type of non-fit *non-directional non-optimal challenge [UC|← →|OC]*. On the other hand, students' challenge can be conceptualized as dependent on the direction of non-fit. Hence, one can have a look at students' level of challenge as a continuum ranging from students' being extremely underchallenged (via optimal challenge) to extremely overchallenged. We label this type *directional non-optimal challenge [UC→OC]* (for a graphical depiction of students' challenge as *non-directional non-optimal challenge* and *directional non-optimal challenge* see Fig. 1).

These two conceptualizations of challenge as either independent of the direction of non-fit (*non-directional non-optimal challenge, UC|← →|OC*) or dependent upon this direction (*directional non-optimal challenge, UC→OC*), provide us with the opportunity to investigate whether the direction of non-fit may differentially impact students' behavior (Cable & DeRue, 2002; Park, Beehr, Han, & Grebner, 2012).

1.2. Challenge and students' career aspirations

Students' perception of challenge[1] plays an important role for future outcomes and choices (Bandura & Health, 1986) and, hence, should also impact students' career aspirations. In a school context, these aspirations represent one of the most important outcomes of students' academic career directly influencing their future occupational choices (Schoon & Parsons, 2002; Trice & McClellan, 1993). Links between perceived challenge and career aspirations can be explained by social cognitive theory which states that students' performance and their choices are not only dependent on their actual skills, but also on their self-beliefs about their ability and performance (Bandura & Health, 1986; Lent, Brown, & Hackett, 2000). That is, student beliefs about their own performance are incorporated into their ratings of challenge (Lent et al., 1994). Therefore, students' perceived challenge functions as a cognitive appraisal of fit that directs individuals' estimation of the expected outcome on future tasks (Lent et al., 1994). Whenever students interpret their abilities as being below task difficulty they experience overchallenge, and, consequently, a low expected probability to successfully manage upcoming demands of a future career (Buckert, Meyer, & Schmalt, 1979; Kolvereid, 1996; Nauta, Epperson, & Kahn, 1998). A high level of overchallenge (i.e., high directional non-optimal challenge) in a specific school domain might therefore negatively impact students' respective career aspirations (Le et al., 2014) due to low outcome expectations (Lent et al., 1994, 2010). Conversely, according to our definition of the directional non-optimal challenge, a high level of underchallenge should be positively related to these aspirations due to high outcome expectations (see Fig. 2).

To our knowledge, links between students' perceived challenge in the classroom and their career aspirations differentiating between over- and underchallenge have only been investigated by Krannich et al. (2019). The researchers operationalized students' challenge by two

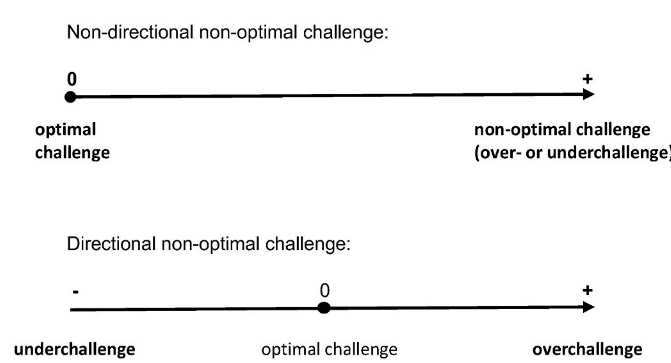

Fig. 1. Graphical depiction of students' non-directional non-optimal challenge [UC|← →|OC] and directional non-optimal challenge [UC→OC].

[1] Referring to the aforementioned definition of challenge, this concept is similar, but not identical to the students' perceived competence. Whereas the former is defined as the perceived ability-difficulty fit, the latter is a broader concept referring to the general "potential for effective action" (Heckhausen, 2005, p. 240). Students' perceived competence in mathematics could therefore be considered as a concept leading to either perceived over- or underchallenge (Heckhausen, 2005).

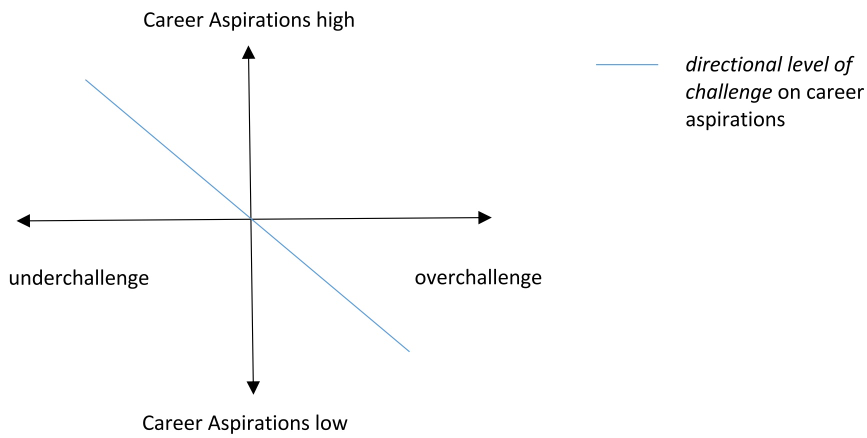

Fig. 2. Graphical depiction of the effect of students' directional level of challenge [UC→OC] on their career aspirations.

dummy-variables assessing overchallenge and underchallenge separately, with the optimal challenge serving as the reference category. Therefore, they were unable to disentangle specific effects of non-optimal challenge on career aspirations as dependent on and independent of the direction of the non-fit.

Other studies examined the person-environment fit and its impact on career choices and job satisfaction without explicitly focusing on non-optimal challenge. For example, Kristof-Brown et al. (2005) conducted a meta-analysis investigating the ability-demand fit in specific occupations and its impact on applicants' job satisfaction. They included studies assessing this fit through various methods, but all of them focused on how well personal (ability) and environmental (job demands) characteristics were matched (for detailed descriptions of the inclusion criteria and operationalizations of aspects of the person-environment fit of single studies see Kristof-Brown et al., 2005). Overall, the data revealed relatively strong correlations of 0.48 between ability-demands fit and job satisfaction (Kristof-Brown et al., 2005). Furthermore, a number of older studies investigating Holland's (1973; 1997) person-environment theory of vocational behavior supported the impact of person-environment congruence on vocational satisfaction, stability, and achievement (for meta-analytic results see Assouline & Meir, 1987; Spokane, 1985). Nevertheless, the vast majority of existing studies neither explicitly focused on students' career aspirations nor differentiated the direction of non-optimal challenge, both of which represent a clear limitation in light of the aforementioned theoretical considerations.

In sum, theoretical considerations support the assumption that students with perceived overchallenge in specific school domains are unlikely to choose occupations related to these domains due to low levels of outcome expectations. There is a gap in the literature exploring the effects of non-optimal challenge dependent upon its direction, i.e. differentiating between students' over- and underchallenge, and in this study we will attempt to provide initial evidence towards closing it.

1.3. Challenge and students' boredom experiences

Students' challenge as ability-difficulty fit impacts their affective experiences. In a school context, over- or underchallenge is a key antecedent of students' boredom (Daschmann, Goetz, & Stupnisky, 2014; Fisher, 1993; Goetz & Frenzel, 2010; Ringmar, 2017). Boredom is a unique emotional reaction considered to be unpleasant and aversive (Harris, 2000; Mikulas & Vodanovich, 1993; van Tilburg & Igou, 2012) and characterized by one's perception of time passing slowly (Vodanovich & Watt, 2016), specific physical expressions (van Tilburg & Igou, 2012), and disengagement (Eastwood, Frischen, Fenske, & Smilek, 2012). This inability to engage is considered to be one of the core features of boredom and it is caused by a mismatch between individuals' needs and the current level of environmental stimulation (Eastwood et al., 2012; Mugon, Danckert, & Eastwood, 2019; Westgate & Wilson, 2018). In line with this, many theories of boredom use the person-environment-fit framework and show that boredom is highly sensitive to the non-fit (e.g., Csikszentmihalyi & Csikszentmihalyi, 1975/2000; Westgate & Wilson, 2018). According to the control-value theory (CVT; Pekrun et al., 2010), boredom in achievement settings arises when students perceive tasks to be underchallenging due to task demands being below students' perceived ability (very high control) or, conversely, when students are overchallenged due to task demands being above individuals' perceived ability level (very low control; Acee et al., 2010; Daschmann et al., 2011). Hence, non-optimal challenge in both directions should enhance boredom (see Fig. 3).

In a workplace context, Fisher (1993) described the relation of over- and underload (or over- and underchallenge) and boredom experiences of employees. Similarly, in an interview study in schools, Kanevsky and Keighley (2003) explored gifted students' boredom experiences related to homework and found that easy, repetitive tasks and the lack of challenge were construed by students as antecedents of their boredom and resulted in their choices to skip homework. Larson and Richards (1991) also found that high ability was positively correlated with boredom experiences in a sample of fifth to eighth graders in the U.S., suggesting underchallenge as an antecedent of student boredom experiences, and van Tilburg and Igou (2012) found a positive link between boredom and perceived underchallenge across three different studies.

In addition to these results, several studies raveled that overchallenge also lead to increased boredom experiences. Acee et al. (2010) investigated students' academic boredom in either over- or underchallenging situations detecting a general boredom factor in underchallenging situations in addition to a self-focused (for example characterized by frustration) and a task-focused (for example

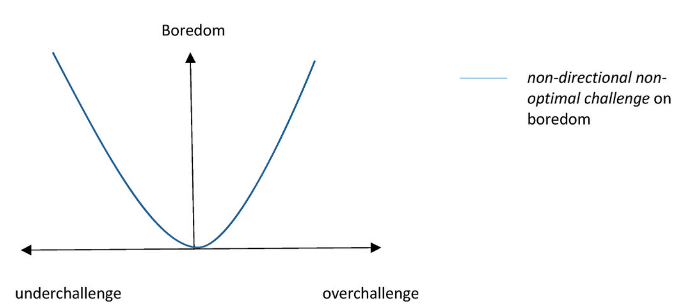

Fig. 3. Graphical depiction of the effect of students' non-directional non-optimal challenge [UC|← →|OC] on boredom.

characterized by a perceived tediousness of the task) boredom factor in overchallenging situations. Furthermore, Daschmann et al. (2011) administered the precursors to boredom scale to 1380 German students (M_{age} = 12.56 years) and showed that both extremes of challenge served as antecedents of boredom in the investigated sample. Asseburg and Frey (2013) directly investigated the objective ability-difficulty fit of mathematics tasks in a sample of N = 9425 German ninth-graders and observed a negative linear relation between the fit and students' boredom experiences. Finally, correlational and even experimental evidence from Westgate and Wilson (2018) revealed 1) a curvilinear relationship of psychology students' perceived difficulty (i.e., over- and underchallenge) with boredom and showed that 2) overstimulation (and not just understimulation as in the studies of van Tilburg and Igou, 2012) lead to an increase in boredom.

1.4. Boredom and students' career aspirations

Boredom in school settings is experienced as an unpleasant emotional state (e.g., Goetz et al., 2019; van Tilburg & Igou, 2012). When students are unable to engage in satisfying activities and when they attribute this disengagement to their environment (Eastwood et al., 2012), those who experience boredom frequently are unlikely to select a career related to the boredom-inducing school subject. Surprisingly, whereas numerous studies investigated students' boredom experiences and their negative effects on various outcomes, such as academic achievement and motivational variables (e.g., Tze, Daniels, & Klassen, 2016), only one study examined links between boredom and students' career aspirations in a sample of N = 662 Swiss 11th grade high-school students in the domains of German, French, and mathematics (Krannich et al., 2019). The results revealed negative relations for all domains. Research into decision making supports the assumption that boredom as an unpleasant emotion negatively impacts individuals' career choices. That is, decision-making processes and the formation of future aspirations are guided by one's past momentary affective experiences (e.g., Fredrickson, 2000; Peters, Västfjäll, Gärling, & Slovic, 2006). More specifically, frequent boredom experiences in specific school subjects may be negatively connected to students' career aspirations (i.e., to their desire to work in related occupations later due to emotion-related memories and cognitions; Baumeister, Vohs, Nathan DeWall, & Zhang, 2007; Rusting, 1998).

Overall, it seems plausible that *directional non-optimal challenge*, especially overchallenge, could be directly connected to students' career aspirations based on the expected probability of success or failure in the future occupations. Furthermore, students' perceived non-optimal challenge should not only impact their behavior directly, but indirectly influence their aspirations via boredom.

1.5. Trait versus state challenge and boredom and its connection to students' career aspirations

1.5.1. Inter-versus intraindividual relations between challenge and boredom

Students' challenge and their boredom experiences in specific school domains could be either conceptualized as a general tendency of a person to feel challenged or bored in specific domains (*trait* concept; e.g., Nett et al., 2017; Pekrun et al., 2011) or as a situational state of feeling challenged or bored in specific situations (*state* concept; e.g., Ahmed, van der Werf, Minnaert, & Kuyper, 2010; Nett, Goetz, & Hall, 2011). Thus, students' *state* challenge and *state* boredom depend on the momentary situation, whereas their *trait* challenge and *trait* boredom reflect evaluations of being over- or underchallenged or being bored over expended period of time. Assessing challenge and boredom not as trait construct exclusively is rather meaningful as both constructs can be assumed to clearly vary across specific situations.

Situational *state* assessments that repeatedly gauge students' momentary challenge and their boredom experiences in class enable the investigation of the relation of these constructs within- and between-person, hence, on an intraindividual as well as an interindividual level (Hamaker, Nesselroade, & Molenaar, 2007; Murayama et al., 2017). Conversely, trait assessments of challenge or boredom focus on between-person relations of those variables; hence, they only allow for interindividual analyses (Murayama et al., 2017). Pekrun's control-value theory as well as some other, more general theories explaining boredom through the person-environment non-fit tend to focus on intraindividual dynamics (Csikszentmihalyi & Csikszentmihalyi, 1975/2000; Pekrun et al., 2010; see also Goetz et al., 2016). These theories suggest that for a specific student, *state* boredom occurs in situations when this student experiences situational *state* of being over- or underchallenged. In other words, variance in over- or underchallenge within a person across situations can lead to variations in experiences of boredom across those situations within this person. However, existing empirical studies take a purely interindividual approach to examine the relation of trait over- and underchallenge with trait boredom. In other words, these studies investigate whether existing variance in over- or underchallenge across persons leads to the variance in boredom across those persons (e.g., Daschmann et al., 2012; Larson & Richards, 1991; van Tilburg & Igou, 2012). It is important to note that interindividual analyses can be highly important with respect to corresponding research questions on the between-person level. As such, it would be misleading to argue in favor of one of the two approaches.

As far as we know, studies examining *state* challenge and *state* boredom on an intraindividual level are still lacking. Consequently, we do not know yet if the relations of being over- and underchallenged with boredom experiences are comparable within and between-person. However, initial theoretical and empirical evidence suggests that there is a positive connection of over-, and underchallenge with boredom both on an intra- as well as interindividual level. This means that on the one hand, students' situational experience of over- or underchallenge should enhance their situational boredom (within-person) and on the other hand, under- and overchallenged students should be more likely to get bored compared to students who are optimally challenged (between-person). Studies in related fields found intra- and interindividual analyses to converge. For example, Goetz et al. (2016) showed similar relations between achievement goals and academic emotions on an inter- and intraindividual level.

1.5.2. Interindividual relations between challenge, boredom, and career aspiration

As compared to challenge and boredom, career aspiration as a future oriented perspective can be assumed to be rather stable across specific situations. Consequently, it only makes sense to assess this construct as a *trait*. Hence, the impact of state challenge and state boredom on trait career aspirations is done from a multi-level perspective on the between-person level (i.e., interindividual analyses) exclusively (i.e., L2 person level, L1 level of single state assessments).

With respect to the impact of challenge and boredom on trait career aspiration, the more stable *trait* challenge and boredom are more predictive of aspirations than the in-situ *state* challenge and boredom. This assumption is based on the accessibility model of emotional self-report by Robinson and Clore (2002a). From the perspective of this model, trait assessments of boredom (and other emotions) can be seen as individuals' general evaluation of boredom which is influenced by their judgment of self. Trait assessments of boredom gauge generalized self-views (i.e., beliefs about oneself) retrieved from individuals' semantic memory networks (Kihlstrom, Beer, & Klein, 2003; Robinson & Clore, 2002a, 2002b; Robinson & Sedikides, 2009) and thus are more predictive of future outcomes (Amelang, Bartussek, Stemmler, & Hagemann, 2006; Bieg, Goetz, & Hubbard, 2013). Students' career aspirations represent a distal outcome and should therefore more strongly depend on students' self-beliefs about their boredom experiences as compared to their actual situational states (Robinson & Sedikides, 2009). With respect to the quality of this relation, higher boredom in specific school subjects should reduce the probability of students' aspirations to pursue a career in a subject, in which these boredom experiences occurred.

We propose that the mechanism described by the accessibility model of emotional self-report could also be applied to students' challenge. This construct can be assumed to vary across situations. Thus, we will assess challenge as a situational state (*state* assessment) in a specific task or a specific momentary situation – in addition to more traditional assessments of perceived levels of challenge related to a specific school domain (*trait* assessment). Similarly to students' boredom, students' career aspirations should be more strongly related to students' *trait* as compared to their *state* challenge.

2. The present study

In the current study we conceptualized students' perceived challenge in two different ways. On the one hand, we defined challenge as (1) students' *non-directional non-optimal challenge* (i.e., being over- or underchallenged) and (2) on the other hand as students' *directional non-optimal challenge* on the continuum ranging from one's extreme underchallenge to extreme overchallenge (and including an optimal level of challenge). Furthermore, we examined the impact of both operationalizations on students' career aspirations and boredom experiences. Based on theoretical considerations from the person-environment fit, social cognitive, and appraisal theories as well as considering existing empirical results, we hypothesized that (H1) a higher level of directional non-optimal challenge would be negatively linked to students' career aspirations due to their interpretation of the domain as being too difficult. We do not have an explicit assumption about links between students' non-directional non-optimal challenge and their career aspirations. (H2a) We hypothesized that a higher level of non-directional non-optimal challenge, on the other hand, would function as an antecedent of students' boredom experiences, so that higher levels of either over- or underchallenge would be positively related to students' boredom on both intraindividual and interindividual levels. When considering correlations between students' directional level of non-optimal challenge and boredom, we hypothesized no significant correlation when looking at intra- as well as interindividual relations. (H2b) We also expected boredom to be negatively related to students' mathematics-related career aspirations, and (H3) we hypothesized an indirect effect of non-directional non-optimal challenge on students' career aspirations via boredom, which should not hold true in case of the directional non-optimal challenge. Additionally, we hypothesized (H4) that the expected relation of directional non-optimal challenge with career aspirations and the connection of boredom with these aspirations (Hypothesis 1 and 2b) as well as the proposed indirect effect (Hypothesis 3) should be stronger in case of trait assessments as compared to state assessments of challenge and boredom (for a graphical depiction of the hypotheses see Fig. 4).

3. Methods

3.1. Ethical statement

Data collection, data protection, and ethical issues of the present study were handled according to the guidelines of the German Association for Psychology (Deutsche Gesellschaft für Psychologie (DGPs) (2016) and the American Psychological Association (2010). Student participation was voluntarily, parents signed an informed consent, and data analyses were conducted on anonymized data.

3.2. Sample and procedure

The sample consisted of $N = 753$ German students from 43 classes in 21 schools with a mean age of 15.72 years ($SD = 0.89$). 55.4% of the students of the final sample self-identified as girls. Students were in the ninth and tenth grade of the highest track of the German school system (i.e., Gymnasium; around 40% of the German students attend this school track; Federal Statistical Office, 2020).

Perceived trait challenge, trait boredom, students' career aspirations, and demographic data were assessed in mathematics classes using a standardized questionnaire. This questionnaire was presented to the students at the end of the third trimester of the school year. Students' state challenge and state boredom were assessed via a personal diary, designed as a short questionnaire to be filled out by each student after each mathematics lesson for the duration of three consecutive weeks. Only students with at least three diary entries were included in the final analyses, which resulted in $N = 4374$ state assessments with an average of 6.02 ($SD = 2.49$; range: 3–14) diary entries per student.

3.3. Study measures

3.3.1. Perceived trait and state challenge

To measure perceived trait as well as state challenge in mathematics, single items were used. These were constructed and tested in a qualitative as well as a quantitative study (Haag & Götz, 2012; Schnell, 2009). Previous research suggested that single items are sufficient for measuring subjective experiences that are generally unambiguous (see Ainley & Patrick, 2006; Gogol et al., 2014; Nagy, 2002; Robins, Hendin, & Trzesniewski, 2001). The trait challenge item gauged students' perceived general difficulty level in mathematics (*Mathematics classes are usually … for me.*) on a 5-point Likert scale, ranging from 1 (*too easy)* to 5 (*too difficult)* with a middle category of 3 *(optimal)*. The item wording of the state item was constructed parallel to the trait item, but focusing on the specific situational mathematics lesson (*Today's mathematics lesson was … for me.*). As such, students answering the question with 1 or 2 (*too easy, a little bit too easy*) were labeled as "being underchallenged", whereas students answering the question with 4 or 5 (*a little bit too difficult, too difficult*) were labeled as "being overchallenged".

3.3.2. Trait and state boredom

For the assessment of trait boredom two items were used. These items were developed for a study that examined learning and achievement in mathematics (PALMA; Götz, 2004; Pekrun, Goetz, & Frenzel, 2005; *"In my mathematics classes, I generally feel bored."* and *"I usually experience boredom in mathematics classes."*). For the state assessment two parallel items *("In today's mathematics lesson, I felt bored."* and *"In today's mathematics lesson, I experienced boredom."*) were administered. A five-point Likert scale was used for both boredom types ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

3.3.3. Students' career aspirations

To measure students' career aspirations in mathematics, items were constructed based on items from the TIMSS 2011 (Mullis, Martin, Foy, & Arora, 2012) and PISA 2006 (OECD, 2009) studies. The final scale consisted of four items (e.g., "*I can imagine having a job that requires a lot of math skills.*"*)* reported on a Likert scale that ranged from 1 *(strongly disagree)* to 5 *(strongly agree)* with a Cronbach's alpha of .93.

3.4. Data analyses

All analyses were conducted with M*plus* 7.11 (Muthén & Muthén, 1998–2017). Structural equation modeling procedures were used to test direct and indirect effects of students' challenge on career aspirations. The model parameters were estimated by the MLR estimator, which is a maximum likelihood estimator robust to non-normality and non-independence of observations (Yuan & Bentler, 2000) and in the case of the measurement models of the latent constructs, we applied an effect-coding procedure to circumvent a stronger impact of the first item (Little, Rhemtulla, Gibson, & Schoemann, 2013; Little, Slegers, & Card, 2006). Model fit was determined by using the Comparative Fit Index (CFI; Bentler, 1990), the Tucker-Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA). In case of CFI and TLI, values greater than 0.95 or 0.90 were classified as excellent or acceptable fit of

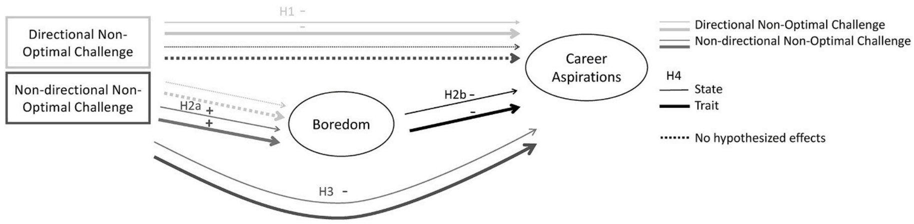

Fig. 4. Graphical depiction of the proposed hypotheses.

the data (Hu & Bentler, 1999), and RMSEA values lower than 0.06 or 0.08 were considered as additional indicators of good or acceptable model fit.

3.4.1. Multilevel modeling approach and operationalization of students' challenge

Multilevel structural equation modeling was used to test our hypotheses including trait and state measures of challenge and boredom as well as the measure of students' career aspirations. The tested model included linear as well as quadratic effects of the variable measuring students' challenge. This procedure enabled us to investigate effects of *directional non-optimal challenge* (linear effect ranging from underchallenge via optimal challenge to overchallenge) and *non-directional non-optimal challenge* (curvilinear, quadratic effect ranging from optimal challenge to strong non-fit – either over- or underchallenge) on students' boredom experiences and their career aspirations. This is especially important as we expect a higher level of boredom in the case of students' non-directional non-optimal challenge (being over- or being underchallenged), but lower career aspirations only in the case of a higher level of overchallenge (hence, positive relations of the directional non-optimal challenge and students' career aspirations). As such, we recoded Likert-scaled variables measuring trait and state challenge. Hence, the original variables ranging from 1 (labeled as being underchallenged) to 5 (labeled as being overchallenged) were recoded into −2, −1 (labeled as being underchallenged), 0 (labeled as optimally challenged), and 1, 2 (labeled as being overchallenged; *directional non-optimal challenge*). These recoded variables were included into the model together with the same variables with exponentiated values resulting in a coding scheme of 0 (labeled as perfectly challenged), 1 (labeled as slight non-fit), 4 (labeled as strong non-fit; quadratic effect: *non-directional non-optimal challenge*; for a graphical depiction see Fig. 5). All resulting recoded variables (linear trait challenge, quadratic trait challenge, linear state challenge, quadratic trait challenge) were directly included into the model as manifest variables.

3.4.2. Hierarchical data structure

Our dataset had a nested data structure with measurement points ($M = 6.31$, $SD = 2.35$) nested within students ($N = 753$) within classes ($N = 43$). We used the "type is complex" option of *Mplus* to correctly estimate standard errors considering that students were nested within classes and then implemented a two-level general multilevel mediation modeling approach suggested by Preacher, Zyphur, and Zhang (2010) accounting for the special data structure (within- and between measures of challenge and boredom, predicting between-measures of career aspirations[2]). As such, the effects of both types of state challenge (linear and quadratic) on state boredom were modeled on the within- and between-levels. On the other hand, the direct paths of state as well as trait challenge (linear and quadratic) and state and trait boredom on students' career aspirations were modeled on the between-level, together with the indirect effects. This was due to the assessment of students' career aspirations only as a trait, hence, as the between-level construct, which enables us to compare state (between) effects with trait (between) effects of challenge and boredom on students' career aspirations. Since we wanted to compare the relations of both trait and state data with the outcome variable, we tested the hypothesized intercorrelations in one model including the trait as well as state data. We *z*-standardized all variables beforehand, and used the "model indirect" option to calculate standardized indirect effects for the trait variables (Muthén & Muthén, 1998–2017). Furthermore, we calculated additional coefficients by multiplying the regression coefficients of challenge on boredom and boredom on career aspirations of the state data to obtain indirect effects of the state variables (see also Appendix A1 for the model syntax of the final multilevel structural equation model).

4. Results

4.1. Preliminary analyses

Analyses of frequencies of students' perceived over- and underchallenge as a situational state revealed that 15.1% of students felt underchallenged, 22.6% were overchallenged, and 60.2% reported an optimal level of challenge. For trait challenge, 14.5% of the students reported being underchallenged, 50% being overchallenged, and 32.1% reported an optimal level of challenge (see also Figure A2 of the Appendix). Descriptive statistics revealed a manifest mean score of 2.32 ($SD = 1.10$) for state boredom and 2.59 ($SD = 0.99$) for trait boredom with a missing rate of 1.1% and 6.7%, respectively. On average, students experienced a medium level of boredom in mathematics. Intra-class correlations of the two state boredom items were ICC = 0.400 and ICC = 0.386, respectively. Cronbach's alpha for the state boredom scale was $\alpha = 0.88$ across all measurement points and $\alpha = 0.85$ for trait boredom. The manifest mean score for the students' math-related career aspirations was 2.31 ($SD = 1.20$) with a missing rate of 8.6%. Cronbach's alpha for the career aspirations scale was $\alpha = 0.94$. Manifest inter-correlations of the study variables on the between- and within-level are presented in Table 1.

4.2. Multilevel model

Our final multilevel model showed acceptable fit with CFI = 0.97, TLI = 0.95, and RMSEA = 0.03 (Hu & Bentler, 1999); 32.4% of variance in students' career aspirations was explained in the respective model. For an overview of coefficients see Table 2 and Figures A3 and A4 of the Appendix).

Consistent with hypothesis 1, we found negative direct effects of *directional non-optimal challenge* in mathematics classes on students' math-related career aspirations for both state and trait assessments of challenge ($\beta_{\text{lin\_State}}$ = -.34, $p < .001$; $\beta_{\text{lin\_Trait}}$ = -.32, $p < .001$). Furthermore, there was no significant effect of *non-directional non-optimal challenge* on career aspirations for the state assessment ($\beta_{\text{quad\_State}}$ = -.09, $p = .256$). Surprisingly, our data shows a positive effect of non-directional non-optimal challenge on career aspirations for

[2] With the measurement model being defined as $\mathbf{Y}_{ij} = \mathbf{\Lambda}\boldsymbol{\eta}_{ij}$, the within structural model being defined as $\boldsymbol{\eta}_{ij} = \boldsymbol{\alpha}_j + \mathbf{B}_j\boldsymbol{\eta}_{ij} + \boldsymbol{\xi}_{ij}$, and the between structural model being defined as $\boldsymbol{\eta}_j = \boldsymbol{\mu} + \boldsymbol{\beta}\boldsymbol{\eta}_j + \boldsymbol{\xi}_j$ with $\boldsymbol{\xi}_{ij} \sim MVN(\mathbf{0},\mathbf{\Psi})$ and $\boldsymbol{\xi}_j \sim MVN(\mathbf{0},\boldsymbol{\psi})$ (see also Preacher et al., 2010 and Appendix B of Preacher et al., 2010 for the detailed equations of the 1-1-2 multilevel structural equation model).

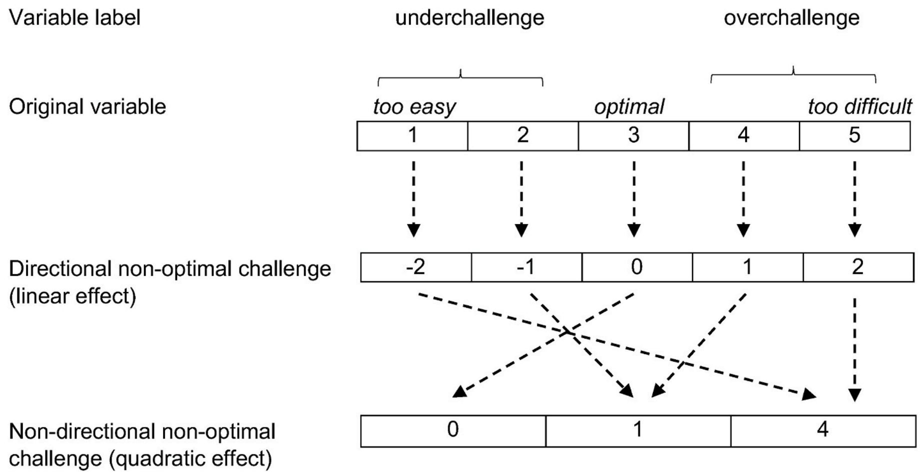

Fig. 5. Operationalization of students' challenge as directional non-optimal challenge [UC→OC] and non-directional non-optimal challenge [UC|← →|OC].

Table 1
Manifest correlations between challenge, boredom, and career aspiration of the state and trait assessment.

		1	2	3	4	5	6	7	8	9	10	11	12
1	$Chall_{State\_linear}$	–	-.254	.016	-.024	.610	.081	.056	-.014	-.396	-.423	-.349	-.387
2	$Chall_{State\_quadratic}$	.068	–	.288	.312	-.110	.393	.141	.188	.081	.066	.060	.067
3	$BO1_{State}$	.007	.196	–	.964	.111	.206	.508	.503	-.084	-.063	-.076	-.079
4	$BO2_{State}$	.013	.187	.667	–	.090	.197	.497	.512	-.079	-.039	-.069	-.075
5	$Chall_{Trait\_linear}$	–	–	–	–	–	.273	.202	.133	-.474	-.462	-.448	-.428
6	$Chall_{Trait\_quadratic}$	–	–	–	–	–	–	.353	.352	-.096	-.103	-.051	-.076
7	$BO1_{Trait}$	–	–	–	–	–	–	–	.740	-.221	-.183	-.159	-.204
8	$BO2_{Trait}$	–	–	–	–	–	–	–	–	-.158	-.141	-.161	-.141
9	$CA1_{Trait}$	–	–	–	–	–	–	–	–	–	.827	.777	.876
10	$CA2_{Trait}$	–	–	–	–	–	–	–	–	–	–	.704	.811
11	$CA3_{Trait}$	–	–	–	–	–	–	–	–	–	–	–	.763
12	$CA4_{Trait}$	–	–	–	–	–	–	–	–	–	–	–	–

Note. Chall = $Chall_{State\_linear}$ = State directional non-optimal challenge; $Chall_{State\_quadratic}$ = State non-directional non-optimal challenge; $Chall_{Trait\_linear}$ = Trait directional non-optimal challenge; $Chall_{State\_quadratic}$ = Trait non-directional non-optimal challenge; BO_{State} = Academic state boredom; BO_{Trait} = Academic trait boredom; CA = Career Aspirations; Correlations above the diagonal are between person correlations (level 2, person); correlations below the diagonal are within person correlations (level 1, situation); $N_{\text{Level 1}}$ = 4.372 (assessments within students), $N_{\text{Level 2}}$ = 753 (students).

trait assessment ($\beta_{quad\_Trait} = 0.10$, $p < .01$).

In line with hypothesis 2a, there were no linear effects of students' directional non-optimal challenge on boredom for either state (both, within- and between-person) or trait assessments ($\beta_{lin\_State\_Within}$ = -.01, p = .833; $\beta_{lin\_State\_Between} = 0.10$, p = .208; $\beta_{lin\_Trait} = 0.08$, p = .056). When it comes to the quadratic effects, a higher *non-directional non-optimal challenge* (being over- or underchallenged) significantly related to the higher state and trait boredom for both state and trait challenge assessments ($\beta_{quad\_State\_Within} = 0.17$, $p < .001$; $\beta_{quad\_State\_Between} = 0.40$, $p < .001$; $\beta_{quad\_Trait} = 0.33$, $p < .001$). Overall and in line with our expectations, higher non-optimal challenge (independently from the direction of non-fit) was associated with higher boredom for both assessment methods as well as on the within and the between level. In other words, students' non-directional non-optimal challenge enhanced their experienced boredom on an interindividual level (between students) as well as on an intraindividual level (within students).

Examining the effects of boredom in mathematics on students' math-related career aspirations, we found no significant (between) effect of state boredom on students' career aspirations ($\beta_{State} = 0.08$, p = .266), but trait boredom was significantly negatively linked to their career aspirations (β_{Trait} = -.22, $p < .001$) supporting hypothesis 2b.

When it comes to the proposed indirect effect of students' *non-directional non-optimal challenge* in mathematics on students' math-related career aspirations via state boredom, it was insignificant for state assessments ($\beta_{quad\_State\_Between\_ind} = 0.03$, p = .252). This was also true for indirect effects of students' *directional non-optimal challenge* on career aspirations via state boredom ($\beta_{lin\_State\_Between\_ind} = 0.01$, p = .435). The results were different for trait assessments. In line with hypothesis 3, we showed a significant negative indirect effect for students' *non-directional non-optimal challenge* ($\beta_{quad\_Trait\_ind}$ = -.07, $p < .001$). Again, there was no significant indirect effect for *directional non-optimal challenge* ($\beta_{lin\_Trait\_ind}$ = -.02, p = .067). Thus, only a higher level of non-optimal trait challenge was indirectly and negatively linked to students' career aspirations via trait boredom.

With respect to the differentiation of state and trait assessment of challenge and boredom (Hypothesis 4), there was no indirect effect of the quadratic state challenge variable (state *non-directional non-optimal challenge*) on students' career aspirations via state boredom (as already described in the section above; $\beta_{quad\_State\_Between\_ind} = 0.03$, p = .252), but a significant indirect effect of the quadratic trait challenge variable (trait *non-directional non-optimal challenge*) on career aspirations via trait boredom ($\beta_{quad\_Trait\_ind}$ = -.07, $p < .001$). Furthermore, the regression coefficient of state boredom on students' career aspirations was not significant ($\beta_{State} = 0.08$, p = .266), whereas for trait boredom it was significant (β_{Trait} = -.22, $p < .001$). This is consistent with our hypothesis that trait emotions (i.e., boredom) are more important for career aspirations than situational, state boredom experiences. This pattern was not found with respect to state and trait challenge: The effect of state directional non-optimal challenge on career aspirations (β_{lin_State} = -.34, $p < .001$) was similar in size to the effect of trait directional non-optimal challenge on career aspirations (β_{lin_Trait} = -.32, $p < .01$). Hence, our results supported the hypothesis of the greater impact of trait compared to state reports on career aspirations

Table 2
Total, direct, and indirect within and between effects of the general two-level model.

Directional Non-Optimal Challenge	*B*	*SE*
Within		
Direct BO_{State} on $Chall_{State\_linear}$	−.01	(.03)
Between		
Direct BO_{State} on $Chall_{State\_linear}$	.10	(.08)
Direct BO_{Trait} on $Chall_{Trait\_linear}$	−.08	(.04)
Direct CA on $Chall_{State\_linear}$	−.34***	(.07)
Direct CA on $Chall_{Trait\_linear}$	−.32***	(.05)
Indirect CA on $Chall_{State\_linear}$ via BO_{State}	.01	(.01)
Indirect CA on $Chall_{Trait\_linear}$ via BO_{Trait}	−.02	(.01)
Total CA on $Chall_{Trait\_linear}$	−.34***	(.05)
Non-directional Non-Optimal Challenge		
Within		
Direct BO_{State} on $Chall_{State\_quadratic}$	.17***	(.02)
Between		
Direct BO_{State} on $Chall_{State\_quadratic}$	.40	(.09)
Direct BO_{Trait} on $Chall_{Trait\_quadratic}$	.33***	(.04)
Direct CA on $Chall_{State\_quadratic}$	−.09	(.08)
Direct CA on $Chall_{Trait\_quadratic}$	.10**	(.04)
Indirect CA on $Chall_{State\_quadratic}$ via BO_{State}	.03	(.03)
Indirect CA on $Chall_{Trait\_quadratic}$ via BO_{Trait}	−.07***	(.02)
Total CA on $Chall_{Trait\_quadratic}$	.03	(.03)
Boredom		
Between		
CA on BO_{State}	.08	(.08)
CA on BO_{Trait}	−.22***	(.05)

Note. $Chall_{State\_linear}$ = State directional non-optimal challenge; $Chall_{State\_quadratic}$ = State non-directional non-optimal challenge; $Chall_{Trait\_linear}$ = Trait directional non-optimal challenge; $Chall_{State\_quadratic}$ = Trait non-directional non-optimal challenge; BO_{State} = Academic state boredom; BO_{Trait} = Academic trait boredom; CA = Mathematical Career Aspiration. Sample size was $N = 619$. All regression coefficients are standardized; standard errors are displayed in brackets.
$^{**}p < .01$; $^{***}p < .001$.

in the case of students' boredom, but not for students' challenge (for an overview of the total, direct, and indirect within and between effects of the two-level model see Table 2).

5. Discussion

This study examined students' perceived challenge in the domain of mathematics and its effect on students' boredom in mathematics and their math-related career aspirations. We investigated these relations with the help of a differentiated operationalization of students' challenge, combined with trait and state assessments of challenge and students' boredom. By including state measures for the variables of challenge and boredom we were able to investigate both interindividual and intraindividual relations. It is important to note that beyond the relation between challenge and boredom, all analyses were run on the between-person level (i.e., interindividual analyses).

The focus on students' perceived challenge and its effects on boredom and students' career aspirations is important to understand, given the general striving toward achieving optimal alignments of the classroom environment to students' individual needs. The results of our study supported the key role of students' perceived challenge in predicting their career aspirations. Further, the study showed to the prominent role of boredom arising from non-optimal challenge for career aspirations and demonstrated higher predictive power of trait as compared to state boredom (Schuster, Bieg, & Hubbard, 2016; Wirtz et al., 2003). We thereby took into consideration students' non-optimal challenge which could be either operationalized as a linear construct (*directional non-optimal challenge*) ranging from the one extreme (underchallenge) to the other (overchallenge) as well as a quadratic construct conceptualizing non-optimal challenge independently from the direction of non-fit (*non-directional non-optimal challenge*). Whereas students' *non-directional non-optimal challenge* was related to higher boredom experiences in both state and trait assessments, the effect of boredom on students' career aspirations was only significant and negative in case of the trait boredom.

More specifically, our study showed that directional state and trait non-optimal challenge was a negative predictor of students' career aspirations. Hence, both an increased level of situational (i.e. state) overchallenge over a series of mathematics lessons as well as students' more general perceptions of overchallenge (i.e. trait) in the domain of mathematics were linked to reduced career aspirations. We assessed the construct of challenge as a self-evaluation of the fit between the students' perceived abilities and the imposed demands of the mathematics lesson (Malmberg & Little, 2007; Nicholls, 1984). Hence, it is logical that those students' who evaluated their level of overchallenge in mathematics as relatively high did not want to go into mathematics-related domains as they presumably cognitively appraised their abilities in those fields as insufficient (e.g., Lent et al., 1994).

Furthermore, the situational as well as habitual *directional non-optimal challenge* was not significantly related to students' boredom experiences, but the level of *non-directional non-optimal challenge* was. Therefore, our results, combined with experimental evidence from van Tilburg and Igou (2012) and Westgate and Wilson (2018) showed that a mismatch between environmental demands and students' abilities in both directions (i.e., over- or underchallenge) lead to boredom. In our study students with a higher level of *non-directional non-optimal challenge* reported higher levels of boredom. This holds true for the situational *non-directional non-optimal challenge* which was related to higher situational boredom on the within-person as well as on the between-person level. Also, a more stable, habitual *non-directional non-optimal challenge* enhanced in all three cases habitual mathematics-related boredom experiences.

These findings are consistent with research that viewed non-optimal challenge as an antecedent of both situational state boredom (e.g., Csikszentmihalyi & Csikszentmihalyi, 1975/2000; Fahlman, Mercer-Lynn, Flora, & Eastwood, 2013) or of a more stable trait boredom (e.g., Acee et al., 2010; Daschmann et al., 2011; Goetz & Frenzel, 2010; Titz, 2001). These results expand previous studies by explicitly testing intraindividual relations of these constructs. Hence, when an individual student appraises a mathematics-related situation as either over- or underchallenging, this non-optimal challenge correlates with higher situational boredom for the student, which is in line with the concept of person-environment fit and Pekrun's control-value theory (Csikszentmihalyi & Csikszentmihalyi, 1975/2000; Pekrun, 2006; Pekrun et al., 2010). Additionally, we found this relation to be similar across persons, that is, when looking at interindividual relations. Accordingly, when looking at individuals' state challenge and state boredom in the subject of mathematics, our study showed stable relations on both within- and between-person levels. This is not a trivial result against the background of within-person processes being frequently different from results of between-person analyses (Molenaar, 2004; Molenaar & Campbell, 2009). Furthermore, we demonstrated that higher habitual boredom was negatively linked to students' career aspirations in mathematics. The effects of boredom on these aspirations remained significant even after controlling for the direct effect of students' perceived challenge on career aspirations. As such, the results of this study support prior findings that showed that boredom as a negative habitual emotion could influence students' career aspirations (Krannich et al., 2019).

Our study did not reveal any structural differences between the trait and state assessments, but the results of our study supported the assumption that trait boredom had a stronger relation to students' future career choices than situational state boredom. This result is consistent with earlier studies indicating higher predictive power of trait assessments for future behavior and choices compared to state assessments (e.g., Levine et al., 2009; Wirtz et al., 2003). Although trait assessments do not capture students' actual momentary emotional experiences and situational fluctuations and do not account for intra-individual variability (e.g., Bieg, Goetz, & Lipnevich, 2014; Schwarz, 2012), these assessments are of key importance for students' career aspirations and, presumably, other outcomes that are based on individuals' expectations and beliefs about themselves (e.g., Amelang et al., 2006; Robinson & Sedikides, 2009). Interestingly, we did not find a greater role of trait assessments compared to state assessments for challenge in predicting math-related career aspirations. However, this result might be explained by considering situational state challenge as a cognitive variable that might be more stable than situational state boredom. That is, semantic memories and situation-specific beliefs about students' own abilities may have come into play while the students rated their perceived situational challenge (Robinson & Clore, 2001; 2002a). On the contrary, for situational state assessment of emotional states (i.e., boredom) students may have been directly accessing their situational boredom experiences via current and experiential information and episodic memory (Robinson & Clore, 2002b).

A surprising result of our study was the slightly positive effect of *non-directional non-optimal challenge* on students' career aspirations for trait assessments, which means that a higher general ability-difficulty non-fit in the domain of mathematics could enhance students' aspirations in related domains. This goes contrary to theoretical considerations offered by the person-environment fit theory (e.g., Edwards & Shipp, 2007; Holland, 1997; Spokane et al., 2000). However, this effect has to be interpreted cautiously as it only reflects the quadratic effect of challenge on students' career aspirations and more importantly, careful examination of this trajectory reveals the impact of this effect to be quite weak (see also Figure A5 of the Appendix). Therefore, it is safe to conclude that a higher level of overchallenge was linked to a decrease in students' career aspirations (or, conversely, a higher level of underchallenge was related to an increase in students' career aspirations). The additional slight increase in career aspirations, when being strongly overchallenged should not be over-interpreted. It needs further investigation before attempting to establish the practical meaning of this effect.

5.1. Limitations of the study and future directions

Important limitations of this study are the cross-sectional nature of the data when it comes to the trait assessment and the restricted focus on the domain of mathematics. Theoretically, it seems reasonable to presume that students' career aspirations would be impacted by their level of challenge and their academic boredom (e.g., Le et al., 2014; Peters et al., 2006; Schuster & Martiny, 2017). Nevertheless, the inclusion of longitudinal data to corroborate correlational patterns of trait challenge and boredom with students' career aspirations is needed to corroborate the proposed relations. The focus on mathematics allows us to draw conclusions related to this field as a key STEM-domain (English, 2016; Milaturrahmah, Mardiyana, & Pramudya, 2017): The more overchallenged the students' were in mathematics classes, the less they wanted to go into related fields. Based on theoretical considerations and previous studies showing links between challenge and boredom as well as between emotions and career aspirations in other school domains and at the university level (Acee et al., 2010; Daschmann et al., 2011; Krannich et al., 2019; Schuster et al., 2016), we suggest that the investigated relations can be generalized to other school domains, but empirical evidence is needed. Furthermore, the question remains if students' perceived and self-evaluated overchallenge is at least similar to their "true" overchallenge as assessed by competence tests. As this result pattern occurred in case of the state and the trait assessment of students' level of challenge, it seems reasonable that the correlation is based on realistic evaluations of the students' level of ability representing their "true" challenge (e.g., Goetz et al., 2013), although the state assessment still was a self-reported measure. Investigating students' level of challenge with tests constructed via IRT-based scaling methods (e.g., Embretson & Reise, 2000) in addition to self-reports would be a fruitful avenue of research. This way, studies will be able to compare the impact of students' challenge (perceived trait and state measure as well as an objective measure) on students' academic boredom experiences. Finally, in addition to the assessment of challenge, future studies into career aspiration may assess academic self-concept and/or measures of perceived competence. Although both measures may play a crucial role in the individual judgement of challenge, its role with respect to predicting emotions and career aspirations (see Guo, Parker, Marsh, & Morin, 2015) above and beyond perceived challenge as operationalized in our study might be investigated in future studies.

5.2. Practical implications

Our study demonstrated that students' non-optimal challenge is frequently experienced at school. In addition to the strong relevance of this variable for students' situational boredom on an intra- as well as interindividual level together with its relevance for students' habitual boredom (e.g., Goetz et al., 2019), we showed the negative influence of overchallenge on students' career aspirations. This negative effect of overchallenge also occurred in the case of a situational state challenge. This is a highly relevant finding when it comes to how students choose their future occupation (e.g., Schoon & Parsons, 2002; Trice & McClellan, 1993) as it suggests that students' generally experienced challenge in specific school domains as well as students' situational challenge have long-term impact on career decisions.

Students' boredom was negatively linked to students career aspirations. This negative emotion should be prevented or reduced, for instance, by teaching students to reappraise the boring situation as valuable. This technique has been proven to be an effective cognitive approach strategy for the reduction of boredom (Daniels, Tze, & Goetz, 2015; Nett, Goetz, & Hall, 2011). In addition, fostering students' individual needs and avoiding non-optimal fit between students' abilities and task demands, particularly in the direction of overchallenge, seems to be a difficult, but a vital responsibility of teachers and educational practitioners (Rogalla & Vogt, 2008).

There are three ways that help to avoid high levels of over-, and underchallenge. First, teachers should be provided with professional development on how to develop excellent diagnostic competencies to recognize the needs of students (Ohle & McElvany, 2015) and consequently adapt their instruction and learning tasks to avoid over- or underchallenge. Second, teachers should support students active involvement in the classroom by fostering a positive and open learning environment, where students have to actively think about the lesson and are encouraged to ask questions (Reeve, 2002). Third, on a more structural level, using self-regulated learning approaches and consistently integrate e-learning or blended learning elements into the classroom would be helpful (e.g., Cavanaugh, Sessums, & Drexler, 2015; Vaughan, 2014) as they allow to optimally support each student individually based on his or her needs and thereby avoid negative effects on their career aspirations via academic boredom.

CRediT author statement

Maike Krannich: Conceptualization, Methodology, Formal Analysis, Data Curation, Writing – Original Draft, Writing – Review & Editing. Thomas Goetz: Validation, Writing – Original Draft, Writing – Review & Editing. Anna-Lena Roos: Writing – Original Draft, Writing – Review & Editing. Kou Murayama: Methodology, Formal Analysis. Melanie M. Keller: Data Curation, Writing – Review & Editing, Project Administration. Madeleine Bieg: Conceptualization, Writing – Review & Editing, Project Administration. Anastasiya A. Lipnevich: Writing – Original Draft, Writing – Review & Editing.

Funding

This research was supported by a grant from the Committee on Research (AFF) at the University of Konstanz awarded to Thomas Goetz, Melanie Keller, and Madeleine Bieg. The study was additionally partly funded by the Alexander von Humboldt Foundation (the Alexander von Humboldt Professorship to Kou Murayama endowed by the German Federal Ministry of Education and Research).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.learninstruc.2022.101596.

References

Acee, T. W., Kim, H., Kim, H. J., Kim, J.-I., Chu, H.-N. R., Kim, M., … Group, B. R. (2010). Academic boredom in under-and over-challenging situations. *Contemporary Educational Psychology, 35*, 17–27. https://doi.org/10.1016/j.cedpsych.2009.08.002

Ainley, M., & Patrick, L. (2006). Measuring self-regulated learning processes through tracking patterns of student interaction with achievement activities. *Educational Psychology Review, 18*, 267–286. https://doi.org/10.1007/s10648-006-9018-z

Amelang, M., Bartussek, D., Stemmler, G., & Hagemann, D. (2006). *Differentielle Psychologie und Persönlichkeitspsychologie [Differential Psychology and Personality Psychocholy]*. Stuttgart, Germany: Kohlhammer.

American Psychological Association. (2010). *Publication manual of the American psychological association*. Washington, DC: American Psychological Association.

Asseburg, R., & Frey, A. (2013). Too hard, too easy, or just right? The relationship between effort or boredom and ability-difficulty fit. *Psychological Test and Assessment Modeling, 55*(1), 92–104.

Assouline, M., & Meir, E. I. (1987). Meta-analysis of the relationship between congruence and well-being measures. *Journal of Vocational Behavior, 31*, 319–332. https://doi.org/10.1016/0001-8791(87)90046-7

Bandura, A., & Health, N. I.o. M. (1986). *Prentice-Hall series in social learning theory. Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Baumeister, R. F., Vohs, K. D., Nathan DeWall, C., & Zhang, L. (2007). How emotion shapes behavior: Feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review, 11*, 167–203. https://doi.org/10.1177/1088868307301033

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*, 238–246. https://doi.org/10.1037/0033-2909.107.2.238

Bieg, M., Goetz, T., & Hubbard, K. (2013). Can I master it and does it matter? An intraindividual analysis on control–value antecedents of trait and state academic emotions. *Learning and Individual Differences, 28*, 102–108. https://doi.org/10.1016/j.lindif.2013.09.006

Bieg, M., Goetz, T., & Lipnevich, A. A. (2014). What students think they feel differs from what they really feel–academic self-concept moderates the discrepancy between students' trait and state emotional self-reports. *PLoS One, 9*, 102–108. https://doi.org/10.1371/journal.pone.0092563

Buckert, U., Meyer, W.-U., & Schmalt, H.-D. (1979). Effects of difficulty and diagnosticity on choice among tasks in relation to achievement motivation and perceived ability. *Journal of Personality and Social Psychology, 37*, 1172–1178. https://doi.org/10.1037/0022-3514.37.7.1172

Cable, D. M., & DeRue, D. S. (2002). The convergent and discriminant validity of subjective fit perceptions. *Journal of Applied Psychology, 87*, 875–884. https://doi.org/10.1037//0021-9010.87.5.875

Cavanaugh, C., Sessums, C., & Drexler, W. (2015). A call to action for research in digital learning: Learning without limits of time, place, path, pace… or evidence. *Journal of Online Learning Research, 1*(1), 9–15. Retrieved from https://www.learntechlib.org/primary/p/149851/.

Chaplin, W. F., John, O. P., & Goldberg, L. R. (1988). Conceptions of states and traits: Dimensional attributes with ideals as prototypes. *Journal of Personality and Social Psychology, 54*(4), 541–557.

Csikszentmihalyi, M., & Csikszentmihalyi, I. (1975/2000). *Beyond boredom and anxiety*. San Francisco, CA: Jossey-Bass.

Daniels, L. M., Tze, V. M., & Goetz, T. (2015). Examining boredom: Different causes for different coping profiles. *Learning and Individual Differences, 37*, 255–261. https://doi.org/10.1016/j.lindif.2014.11.004

Daschmann, E. C., Goetz, T., & Stupnisky, R. H. (2011). Testing the predictors of boredom at school: Development and validation of the precursors to boredom scales. *British Journal of Educational Psychology, 81*, 421–440. https://doi.org/10.1348/000709910X526038

Daschmann, E. C., Goetz, T., & Stupnisky, R. H. (2014). Exploring the antecedents of boredom: Do teachers know why students are bored? *Teaching and Teacher Education, 39*, 22–30. https://doi.org/10.1016/j.tate.2013.11.009

Deutsche Gesellschaft für Psychologie (DGPs). (2016). *Richtlinien zur Manuskriptgestaltung [Guidelines for research manuscripts]*. Göttingen: Hogrefe.

Eastwood, J. D., Frischen, A., Fenske, M. J., & Smilek, D. (2012). The unengaged mind: Defining boredom in terms of attention. *Perspectives on Psychological Science, 7*, 482–495. https://doi.org/10.1177/1745691612456044

Edwards, I. R., & Shipp, A. I. (2007). The relationship between person-environment fit and outcomes: An integrative theoretical framework. In C. Ostroff, & T. A. Judge (Eds.), *Perspectives on organizational fit* (pp. 209–258). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Embretson, S. E., & Reise, S. P. (2000). *Item response theory for psychologists*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

English, L. D. (2016). Advancing mathematics education research within a STEM environment. In K. Makar, S. Dole, J. Visnovska, M. Goos, A. Bennison, & K. Fry (Eds.), *Research in mathematics education in Australasia 2012-2015* (pp. 353–371). Singapore: Springer.

Epstein, S. (1983). Aggregation and beyond: Some basic issues on the prediction of behavior. *Journal of Personality, 51*(3), 360–392. https://doi.org/10.1111/j.1467-6494.1983.tb00338.x

Fahlman, S. A., Mercer-Lynn, K. B., Flora, D. B., & Eastwood, J. D. (2013). Development and validation of the multidimensional state boredom scale. *Assessment, 20*, 68–85. https://doi.org/10.1177/1073191111421303

Federal Statistical Office Statistisches Bundesamt. (2020). *Schnellmeldungsergebnisse zu Schülerinnen und Schülern der allgemeinbildenden und beruflichen Schulen-Schuljahr 2019/20 [Preliminary results of general and vocational school students: 2019-20 academic year]*. Retrieved from https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Schulen/Publikationen/Downloads-Schulen/schnellmeldung-schueler-5211003208004.htm.

Fisher, C. D. (1993). Boredom at work: A neglected concept. *Human Relations, 46*, 395–417. https://doi.org/10.1177/001872679304600305

Fredrickson, B. L. (2000). Extracting meaning from past affective experiences: The importance of peaks, ends, and specific emotions. *Cognition & Emotion, 14*, 577–606. https://doi.org/10.1080/026999300402808

Goetz, T., & Frenzel, A. C. (2010). Über-und Unterforderungslangeweile im Mathematikunterricht [Boredom due to being over- or underchallenged in math classes]. *Empirische Pädagogik, 24*(2), 113–134.

Goetz, T., Hall, N. C., & Krannich, M. (2019). Boredom. In K. A. Renninger, & S. Hidi (Eds.), *Cambridge handbook on motivation and learning* (pp. 465–486). Cambridge: Cambridge University Press.

Goetz, T., Pekrun, R., Hall, N., & Haag, L. (2006). Academic emotions from a social-cognitive perspective: Antecedents and domain specificity of students' affect in the context of Latin instruction. *British Journal of Educational Psychology, 76*, 289–308. https://doi.org/10.1348/000709905X42860

Goetz, T., Sticca, F., Pekrun, R., Murayama, K., & Elliot, A. J. (2016). Intraindividual relations between achievement goals and discrete achievement emotions: An experience sampling approach. *Learning and Instruction, 41*, 115–125. https://doi.org/10.1016/j.learninstruc.2015.10.007

Gogol, K., Brunner, M., Goetz, T., Martin, R., Ugen, S., Keller, U., … Preckel, F. (2014). "My questionnaire is too long!" the assessments of motivational-affective constructs with three-item and single-item measures. *Contemporary Educational Psychology, 39*, 188–205. https://doi.org/10.1016/j.cedpsych.2014.04.002

Götz, T. (2004). *Emotionales Erleben und selbstreguliertes Lernen bei Schülern im Fach Mathematik [Perceived emotions and self-regulated learning of students in mathematics]*. München: Utz Verlag.

Guo, J., Parker, P. D., Marsh, H. W., & Morin, A. J. (2015). Achievement, motivation, and educational choices: A longitudinal study of expectancy and value using a multiplicative perspective. *Developmental Psychology, 51*, 1163–1176. https://doi.org/10.1037/a0039440

Haag, L., & Götz, T. (2012). Mathe ist schwierig und Deutsch aktuell: Vergleichende studie zur Charakterisierung von Schulfächern aus Schülersicht [Math is difficult and German up to date: A comparative study on the characterization of subject domains from students' perspective]. *Psychologie in Erziehung und Unterricht, 59*, 32–46. https://doi.org/10.2378/peu2012.art03d

Hamaker, E. L., Nesselroade, J. R., & Molenaar, P. C. M. (2007). The integrated trait-state model. *Journal of Research in Personality, 41*(2), 295–315. https://doi.org/10.1016/j.jrp.2006.04.003

Harris, M. B. (2000). Correlates and characteristics of boredom proneness and boredom. *Journal of Applied Social Psychology, 30*, 576–598. https://doi.org/10.1111/j.1559-1816.2000.tb02497.x

Heckhausen, J. (2005). *Competence and motivation in adulthood and old age: Making the most of changing capacities and resources*. New York, NY, US: Guilford Publications.

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments*. Odessa, FL: Psychological Assessment Resources.

Hu, L.t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*, 1–55. https://doi.org/10.1080/10705519909540118

Kanevsky, L., & Keighley, T. (2003). To produce or not to produce? Understanding boredom and the honor in underachievement. *Roeper Review, 26*, 20–28. https://doi.org/10.1080/02783190309554235

Kihlstrom, J. F., Beer, J. S., & Klein, S. B. (2003). Self and identity as memory. In M. R. Leary, & J. P. Tangney (Eds.), *Handbook of self and identity* (pp. 86–90). New York, NY: Guilford Press.

Kolvereid, L. (1996). Prediction of employment status choice intentions. *Entrepreneurship: Theory and Practice, 21*, 47–58. https://doi.org/10.1177/104225879602100104

Krannich, M., Goetz, T., Lipnevich, A. A., Bieg, M., Roos, A.-L., Becker, E. S., et al. (2019). Being over- or underchallenged in class: Effects on students' career aspirations via academic self-concept and boredom. *Learning and Individual Differences, 69*, 206–218. https://doi.org/10.1016/j.lindif.2018.10.004

Kristof-Brown, A. L., Zimmerman, R. D., & Johnson, E. C. (2005). Consequences of individuals' fit at work: A meta-analysis of person-job, person-organization, person-group, and person-supervisor fit. *Personnel Psychology, 58*, 281–342. https://doi.org/10.1111/j.1744-6570.2005.00672.x

Larson, R. W., & Richards, M. H. (1991). Boredom in the middle school years: Blaming schools versus blaming students. *American Journal of Education, 99*, 418–443. https://doi.org/10.1086/443992
Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45*, 79–122. https://doi.org/10.1006/jvbe.1994.1027
Lent, R. W., Brown, S. D., & Hackett, G. (2000). Contextual supports and barriers to career choice: A social cognitive analysis. *Journal of Counseling Psychology, 47*, 36–49. https://doi.org/10.1037/0022-0167.47.1.36
Lent, R. W., Paixao, M. P., Da Silva, J. T., & Leitão, L. M. (2010). Predicting occupational interests and choice aspirations in Portuguese high school students: A test of social cognitive career theory. *Journal of Vocational Behavior, 76*, 244–251. https://doi.org/10.1037/0022-0167.34.3.293
Le, H., Robbins, S. B., & Westrick, P. (2014). Predicting student enrollment and persistence in college STEM fields using an expanded PE fit framework: A large-scale multilevel study. *Journal of Applied Psychology, 99*, 915–947. https://doi.org/10.1037/a0035998
Levine, L. J., Lench, H. C., & Safer, M. A. (2009). Functions of remembering and misremembering emotion. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition, 23*, 1059–1075. https://doi.org/10.1002/acp.1610
Little, T. D., Rhemtulla, M., Gibson, K., & Schoemann, A. M. (2013). Why the items versus parcels controversy needn't be one. *Psychological Methods, 18*, 285–300. https://doi.org/10.1037/a0033266
Little, T. D., Slegers, D. W., & Card, N. A. (2006). A non-arbitrary method of identifying and scaling latent variables in SEM and MACS models. *Structural Equation Modeling, 13*, 59–72. https://doi.org/10.1207/s15328007sem1301_3
Malmberg, L.-E., & Little, T. D. (2007). Profiles of ability, effort, and difficulty: Relationships with worldviews, motivation and adjustment. *Learning and Instruction, 17*, 739–754. https://doi.org/10.1016/j.learninstruc.2007.09.014
Mikulas, W. L., & Vodanovich, S. J. (1993). The essence of boredom. *Psychological Record, 43*(1), 3–12.
Milaturrahmah, N., Mardiyana, & Pramudya, I. (2017). *Science, technology, engineering, mathematics (STEM) as mathematics learning approach in 21st century. Paper presented at the AIP Conference, Sydney, Australia*.
Molenaar, P. C. (2004). A manifesto on psychology as idiographic science: Bringing the person back into scientific psychology, this time forever. *Measurement, 2*, 201–218. https://doi.org/10.1207/s15366359mea0204_1
Molenaar, P. C., & Campbell, C. G. (2009). The new person-specific paradigm in psychology. *Current Directions in Psychological Science, 18*, 112–117. https://doi.org/10.1111/j.1467-8721.2009.01619.x
Mugon, J., Danckert, J., & Eastwood, J. D. (2019). The costs and benefits of boredom in the classroom. In K. A. Renninger, & S. E. Hidi (Eds.), *The Cambridge handbook of motivation and learning* (pp. 490–514). Cambridge, UK: Cambridge University Press.
Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 international results in mathematics*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.
Murayama, K., Goetz, T., Malmberg, L.-E., Pekrun, R., Tanaka, A., & Martin, A. J. (2017). Within-person analysis in educational psychology: Importance and illustrations. *British Journal of Educational Psychology Monograph Series II, 12*, 71–87.
Muthén, L. K., & Muthén, B. O. (1998-2017). *Mplus user's guide* (8 ed.). Los Angeles, CA: Muthén & Muthén.
Nagy, M. S. (2002). Using a single-item approach to measure facet job satisfaction. *Journal of Occupational and Organizational Psychology, 75*, 77–86. https://doi.org/10.1348/096317902167658
Nauta, M. M., Epperson, D. L., & Kahn, J. H. (1998). A multiple-groups analysis of predictors of higher level career aspirations among women in mathematics, science, and engineering majors. *Journal of Counseling Psychology, 45*, 483–496. https://doi.org/10.1037/0022-0167.45.4.483
Nett, U. E., Bieg, M., & Keller, M. M. (2017). How much trait variance is captured by measures of academic state emotions? *European Journal of Psychological Assessment, 33*, 239–255. https://doi.org/10.1027/1015-5759/a0000416
Nett, U. E., Goetz, T., & Hall, N. C. (2011). Coping with boredom in school: An experience sampling perspective. *Contemporary Educational Psychology, 36*, 49–59. https://doi.org/10.1016/j.cedpsych.2010.10.003
Nicholls, J. G. (1984). Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. *Psychological Review, 91*, 328–346. https://doi.org/10.1037/0033-295X.91.3.328
Niles, S. G. (1993). The relationship between Holland types preferences for career counseling. *Journal of Career Development, 19*, 209–220. https://doi.org/10.1007/BF01353279
OECD. (2009). *PISA 2006 technical report*. Paris: OECD.
Ohle, A., & McElvany, N. (2015). Teachers' diagnostic competences and their practical relevance [Special issue editorial]. *Journal for Educational Research Online, 7*(2). Retrieved from https://www.pedocs.de/.
Ostroff, C., & Zhan, Y. (2012). Person-environment fit in the selection process. In N. Schmitt (Ed.), *The Oxford handbook of personnel assessment and selection* (pp. 252–273). New York, NY: Oxford University Press.
Park, H. I., Beehr, T. A., Han, K., & Grebner, S. I. (2012). Demands-abilities fit and psychological strain: Moderating effects of personality. *International Journal of Stress Management, 19*, 1–33. https://doi.org/10.1037/a0026852
Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, Corollaries, and implications for educational research and practice. *Educational Psychology Review, 18*, 315–341. https://doi.org/10.1007/s10648-006-9029-9
Pekrun, R., Goetz, T., Daniels, L. M., Stupnisky, R. H., & Perry, R. P. (2010). Boredom in achievement settings: Exploring control–value antecedents and performance outcomes of a neglected emotion. *Journal of Educational Psychology, 102*, 531–549. https://doi.org/10.1037/a0019243
Pekrun, R., Goetz, T., & Frenzel, A. C. (2005). *Achievement Emotions Questionnaire—Mathematics (AEQ-M): User's manual*. Unpublished manual (before University of Munich).
Pekrun, R., Hall, N. C., Goetz, T., & Perry, R. P. (2014). Boredom and academic achievement: Testing a model of reciprocal causation. *Journal of Educational Psychology, 106*, 696–710. https://doi.org/10.1037/a0036006
Peters, E., Västfjäll, D., Gärling, T., & Slovic, P. (2006). Affect and decision making: A "hot" topic. *Journal of Behavioral Decision Making, 19*, 79–85. https://doi.org/10.1002/bdm.528
Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods, 15*, 209–233. https://doi.org/10.1037/a0020141
Reeve, J. (2002). Self-determination theory applied to educational settings. In E. L. Deci, & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 183–203). Rochester, NY: University of Rochester Press.
Richards, J. M. (1993). Career development: A ten-year longitudinal study in population scientists. *Journal of Career Assessment, 1*, 181–192. https://doi.org/10.1177/106907279300100207
Ringmar, E. (2017). Attention and the cause of modern boredom. In M. E. Gardiner, & J. J. Haladyn (Eds.), *Boredom studies reader: Frameworks and perspectives* (pp. 193–202). New York, NY: Routledge.
Robins, R. W., Hendin, H. M., & Trzesniewski, K. H. (2001). Measuring global self-esteem: Construct validation of a single-item measure and the Rosenberg Self-Esteem Scale. *Personality and Social Psychology Bulletin, 27*, 151–161. https://doi.org/10.1177/0146167201272002
Robinson, M. D., & Clore, G. L. (2001). Simulation, scenarios, and emotional appraisal: Testing the convergence of real and imagined reactions to emotional stimuli. *Personality and Social Psychology Bulletin, 27*, 1520–1532. https://doi.org/10.1177/01461672012711012
Robinson, M. D., & Clore, G. L. (2002a). Belief and feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin, 128*, 934–960. https://doi.org/10.1037//0033-2909.128.6.934
Robinson, M. D., & Clore, G. L. (2002b). Episodic and semantic knowledge in emotional self-report: Evidence for two judgment processes. *Journal of Personality and Social Psychology, 83*, 198–215. https://doi.org/10.1037//0022-3514.83.1.198
Robinson, M. D., & Sedikides, C. (2009). Traits and the self: Toward an integration. In P. J. Corr, & G. Matthews (Eds.), *The Cambridge handbook of personality psychology* (pp. 457–472). New York, NY: Cambridge University Press.
Rogalla, M., & Vogt, F. (2008). Förderung adaptiver Lehrkompetenz: Eine Interventionsstudie [Promotion of adaptive teaching skills: An intervention study]. *Unterrichtswissenschaft, 36*, 17–36. https://doi.org/10.18747/PHSG-coll3/id/142
Rusting, C. L. (1998). Personality, mood, and cognitive processing of emotional information: Three conceptual frameworks. *Psychological Bulletin, 124*, 165–196. https://doi.org/10.1037/0033-2909.124.2.165
Schnell, J. S. (2009). *CHADO-Studie. Charakterisierung von Schulfächern. Eine qualitative Interviewstudie [CHADO-study. Characterization of subjects. A qualitative interview study]* (Unpublished master's thesis). Konstanz, Germany: University of Konstanz.
Schoon, I., & Parsons, S. (2002). Teenage aspirations for future careers and occupational outcomes. *Journal of Vocational Behavior, 60*, 262–288. https://doi.org/10.1006/jvbe.2001.1867
Schuster, C., Bieg, M., & Hubbard, K. (2016). *Trait, state and anticipated emotions predict STEM career intentions. Paper presented at the Annual Meeting of the American Educational Research Association, Washington, DC*.
Schuster, C., & Martiny, S. E. (2017). Not feeling good in STEM: Effects of stereotype activation and anticipated affect on women's career aspirations. *Sex Roles: Journal of Research, 76*, 40–55. https://doi.org/10.1037/t05410-000
Schwarz, N. (2012). Why researchers should think "real-time": A cognitive rationale. In M. R. Mehl, & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 22–42). New York, NY: Guilford.
Spokane, A. R. (1985). A review of research on person-environment congruence in Holland's theory of careers. *Journal of Vocational Behavior, 26*, 306–343. https://doi.org/10.1016/0001-8791(85)90009-0
Spokane, A. R., Meir, E. I., & Catalano, M. (2000). Person–environment congruence and Holland's theory: A review and reconsideration. *Journal of Vocational Behavior, 57*, 137–187. https://doi.org/10.1006/jvbe.2000.1771
van Tilburg, W. A. P., & Igou, E. R. (2012). On boredom: Lack of challenge and meaning as distinct boredom experiences. *Motivation and Emotion, 36*, 181–194. https://doi.org/10.1007/s11031-011-9234-9
Titz, W. (2001). *Emotionen von Studierenden in Lernsituationen [Students' emotions in context of learning]*. Münster, Germany: Waxmann Verlag.
Trice, A. D., & McClellan, N. (1993). Do children's career aspirations predict adult occupations? An answer from a secondary analysis of a longitudinal study. *Psychological Reports, 72*, 368–370. https://doi.org/10.2466/pr0.1993.72.2.368
Tze, V. M., Daniels, L. M., & Klassen, R. M. (2016). Evaluating the relationship between boredom and academic outcomes: A meta-analysis. *Educational Psychology Review, 28*, 119–144. https://doi.org/10.1007/s10648-015-9301-y
Vaughan, N. (2014). Student engagement and blended learning: Making the assessment connection. *Education Sciences, 4*, 247–264. https://doi.org/10.3390/educsci4040247
Vodanovich, S. J., & Watt, J. D. (2016). Self-report measures of boredom: An updated review of the literature. *Journal of Psychology, 150*, 196–228. https://doi.org/10.1080/00223980.2015.1074531

Westgate, E. C., & Wilson, T. D. (2018). Boring thoughts and bored minds: The MAC model of boredom and cognitive engagement. *Psychological Review, 125*, 689–713. https://doi.org/10.1037/rev0000097

Wirtz, D., Kruger, J., Scollon, C. N., & Diener, E. (2003). What to do on spring break? The role of predicted, on-line, and remembered experience in future choice. *Psychological Science, 14*, 520–524. https://doi.org/10.1111/1467-9280.03455

Yuan, K. H., & Bentler, P. M. (2000). Three likelihood-based methods for mean and covariance structure analysis with nonnormal missing data. *Sociological Methodology, 30*, 165–200. https://doi.org/10.1111/0081-1750.00078