



Misconceptions die hard: prevalence and reduction of wrong beliefs in topics from educational psychology among preservice teachers

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Abstract

Endorsement of educational psychological misconceptions among preservice teachers can be a threat for reaching educational goals. Therefore, it is of societal interest whether preservice teachers hold educational psychological misconceptions and, if they do, whether these misconceptions can be reduced through confrontation with empirical evidence. Prevalence and refutability of misconceptions were analyzed among $N=937$ German preservice teachers who participated in an online survey. Results indicated a high prevalence of educational psychological misconceptions but also the possibility of a reduction through refutation-style texts. However, only few preservice teachers shifted their opinions from (rather) endorsing a misconception to (rather) not endorsing it after reading the text. We conclude that educational psychological misconceptions are common among German preservice teachers and that merely presenting empirical evidence is insufficient to effectively counteract misconceptions. Future research should deepen the understanding of why and wherefrom these misconceptions occur and develop efficient interventions to counteract misconceptions among preservice teachers.

Keywords Educational psychology · Evidence · Misconceptions · Preservice teachers · Refutation

“Maybe this particular study shows this effect but I myself experienced it differently. Therefore, it can’t be true and I don’t believe this!”. This is an exemplary statement typically

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made by preservice teachers who attend educational psychology lectures and who have just been confronted with the findings of empirical studies. This quotation indicates two disconcerting aspects: First, at least some preservice teachers seem to hold wrong beliefs about topics in educational psychology, mostly based on (personal) experiences. Second, their preexisting opinion does not seem to be changed through the presentation of empirical evidence. Educational psychological misconceptions among preservice teachers are both disadvantageous for students' own learning and precarious for their future students' development. This is the case because incorrect knowledge can impede further knowledge and teachers might distribute their (incorrect) knowledge as well as not use scientific evidence to design their own lessons. It has been shown in different countries that preservice teachers endorse misconceptions about topics in educational psychology (e.g., Dekker et al. 2012; Dündar and Gündüz 2016). Therefore, the aim of this study is to empirically analyze to what extent preservice teachers in Germany endorse misconceptions about topics in educational psychology as well as whether they change their misconceptions after being informed about the current state of research in a refutational fashion. Furthermore, previous studies indicate that preservice teachers seem to prefer anecdotal over empirical evidence (e.g., Bråten and Ferguson 2015; Williams and Coles 2007) but these types of evidence have never been tested against each other. With our study, we wanted to address the aforementioned three aspects based on a large data basis from Germany. If many preservice teachers endorsed educational psychological misconceptions and these would not be reduced sufficiently through refutations with empirical evidence, this would have practical implications on teacher education in university courses (e.g., focus on these misconceptions, adaptation of the way we present empirical evidence).

Definition and prevalence of psychological misconceptions

Psychological misconceptions can be defined as beliefs in wrong and popular assumptions that are contradictory to results from psychological research (Bensley and Lilienfeld 2015). Psychological misconceptions might arise from beliefs in psychological myths. For instance, believing in the myth that "It's better to express anger to others than to hold it in" (e.g., Lilienfeld et al. 2010) leads to a misconception about this specific topic of interpersonal behavior. Other common psychological misconceptions concern "People use only 10% of their brain" (e.g., Higbee and Clay 1998) or "Playing Mozart's music to infants boosts their intelligence" (e.g., Lilienfeld et al. 2010). Psychological misconceptions seem to be highly prevalent among both the general population and psychology students (e.g., Furnham and Hughes 2014; Hughes et al. 2015; Lilienfeld et al. 2010; McCutcheon 1991; McCutcheon et al. 1993; Taylor and Kowalski 2004; Vaughan 1977). Furnham and Hughes (2014) identified 37 myths in popular psychology believed by at least two-thirds of their sample of both, the general population and psychology students. Psychology students endorsed significantly less psychological misconceptions than the general population; however, the effects were small. Regarding psychology students in more detail, about 28% of the presented common beliefs in psychology were not recognized to be wrong by at least half of the students from different introductory psychology classes in one study (Vaughan 1977) and, in another study, a sample from an introductory psychology class endorsed, at average, misconceptions about more than 60% of the presented topics (Taylor and Kowalski 2004). This research indicates that during the last decades, psychological misconceptions have been identified as a widespread issue and that having a background in psychology does not prevent from endorsing psychological misconceptions.

The seriousness of psychological misconceptions is pronounced when comparing their prevalence to the prevalence of misconceptions about general science topics. Often investigated common beliefs that are in opposition to a scientific consensus address climate change, vaccinations, evolution, or HIV (e.g., Hamilton et al. 2015b; Lewandowsky and Oberauer 2016). Concerning climate change, about 47% of a large sample from the USA did not totally agree that climate change is anthropogenic (Hamilton et al. 2015a) and in a British representative sample, about 18% considered natural processes mainly or entirely as causes of climate change (Poortinga et al. 2011). Even though the claim that vaccinations cause autism has been proofed wrong many times (e.g., Taylor et al. 2002), about 25% of parents from a representative US sample still believed in this causal chain (Freed et al. 2010). Also, the purported connection between autism and vaccinations was named by 22% in Great Britain and 30% in Sweden to explain their concernedness against vaccinations (Stefanoff et al. 2010). Furthermore, between 7% (in Denmark) and about 45% (in Turkey) of an international sample believed that evolution is definitely false (Miller et al. 2006). Also, ignoring the fact that HIV is a serious virus can be life-threatening because in this case, indispensable medication will not be provided. Even though these claims have been proven wrong many times, they are still believed by a significant percentage of people. However, this number is rather low compared to the number of people holding psychological misconceptions.

Prevalence of educational psychological misconceptions among (preservice) teachers

While previous research has focused on the general population and psychology students as well as general psychological misconceptions (see above), the group of (preservice) teachers and myths about topics from educational psychology have not received as much specific attention yet. But (preservice) teachers' misconceptions about topics from educational psychology are of special interest: Teachers will act as distributors of knowledge in their professional lives and should therefore be prevented from holding misconceptions. At least one of the myths about topics from educational psychology—the learning styles myth—has been investigated among (preservice) teachers in different countries. In studies in the UK, about 82% (Howard-Jones et al. 2009) or even 93% (Dekker et al. 2012) of the participating teachers believed in it. In the Netherlands, the prevalence of this misconception among the interviewed teachers was 96% (Dekker et al. 2012). In Turkey, 97.6% of the preservice teacher sample agreed that individuals learn better when they receive information in their preferred learning style (Dündar and Gündüz 2016). In the French-speaking part of Switzerland, 87% of the (preservice) teacher sample believed that a pedagogical approach based on the distinction between visual and auditory learners would favor learning (Tardif et al. 2015). Thus, the learning styles myth is not only one of the most examined but probably also one of the most believed psychological myths in the educational context.

Even though these findings indicate a widespread belief in the learning styles myth among (preservice) teachers from various countries, findings from different countries cannot easily be transferred to another country. For instance, British and American students differed significantly in their endorsement of psychological misconceptions with British students endorsing significantly less misconceptions than American students (McCutcheon et al. 1993). Additionally, less is clear about preservice teachers' beliefs in other educational psychological myths apart from the learning styles myth (for a list of popular educational myths, see de Bruyckere et al. 2015).

Consequences of psychological misconceptions among (preservice) teachers

Psychological misconceptions are not only prevalent but also harmful. In general, prior knowledge affects future learning (see Ambrose and Lovett 2014); it can either ease or impede the growth of knowledge. Enhancement can occur through correct prior knowledge, whereas impairment can occur through incorrect prior knowledge, like misconceptions (see Bransford et al. 1999; Thompson and Zamboanga 2004). Accordingly, Kuhle et al. (2009) report a negative association between the number of psychological misconceptions held on the first day of an introductory psychology course and grades at the end of the course. Misconceptions can harm in other ways, too. For instance, a person with the “opposites attract”-misconception may not find the right partner due to inapt searching strategies based on this misconception (see Gardner and Brown 2013). Holding misconceptions can therefore be an impairment on the individual level through hindering learning or through leading decisions in a wrong direction.

Educational psychological misconceptions cannot only impede a single person but can even have a negative impact on the society level. As already mentioned, a group with particular influence is the group of (preservice) teachers: If teachers hold psychological misconceptions about topics from the educational context, the reach of their negative influence can be tremendous because they will have an impact on many students throughout their careers. For example, if teachers believe that class size itself has a positive influence on students’ learning outcomes, they might not seize the possible opportunities given by a smaller class (e.g., individualized instruction, increased participation of each student). There are several studies that show that teachers do not adapt their instructional practice to a significant extent to the number of children in their classes (e.g., Betts and Shkolnik 1999; Shapson et al. 1980). However, research has shown that class size itself has no or if at all only a small effect on better learning outcomes, but teaching conditions like reciprocal teaching or providing feedback matter (Hattie 2009). Of course, if teachers believe that class size itself rather than the adaptation of their teaching methods matters, the risk of missing a chance to enhance students’ learning outcomes increases.

There are numerous more situations in which teachers’ misconceptions about topics from the educational context can lead to missed chances concerning learning facilitation or enhancement of learning outcomes. For example, if teachers deny the testing effect, believe in the learning styles myth or hold an opinion regarding multiple intelligences that is not in line with the current state of research, their teaching might differ from teachers who are knowledgeable about these topics. To sum up, teachers’ psychological misconceptions concerning the educational context are a threat for educational practice because they can hinder learning as well as misdirect financial investment and time input (see Pasquinelli 2012).

Reduction of psychological misconceptions

In order to prevent the detrimental effects of teachers’ misconceptions regarding educational psychological topics, not only the prevalence of these is of importance but also whether and how they can be reduced. Apparently, psychological misconceptions can be very persistent (e.g., Gutman 1979; Vaughan 1977). Already former studies report that students in psychology introductory courses endorse nearly the same amount of psychological misconceptions before entering and after ending their course (e.g., Gardner and Dalsing 1986; Vaughan 1977). Further studies indicate that standard lectures are not sufficient to correct false beliefs but that it is necessary to use specific techniques (see Taylor and Kowalski 2014). Kowalski and Taylor

(2009) used a specific technique in implementing refutational lectures in their psychology introductory course. These refutational lectures directly concentrated on common misconceptions as well as scientific evidence that contradicted the misconceptions. Standard lectures, on the other hand, addressed the scientific evidence but did not refer to the specific misconceptions. The procedure of the refutational lecture led to a greater change in disbelieving the popular but wrong claims compared to standard lectures or not covering the misconceptions' topics at all.

Refutations to counteract misconceptions can not only be applied in lectures but also in written texts. In a refutation-style text, the misconception is activated (e.g., through a statement or a question) and then directly refuted in combination with correct information and explanations (see Lassonde et al. 2017). In one study, undergraduates from psychology courses read different texts about multiple psychological misconceptions. One text, the refutation-style text, directly refuted the misconception and was combined with causal explanations that focused on scientific evidence. The other text, the non-refutation-style text, neither refuted the misconception directly nor was it combined with causal explanations. However, both versions of the texts offered the same correct outcome (i.e., disproving the misconception). As a result, students' beliefs in psychological misconceptions decreased more after reading a refutation-style text with causal explanations compared to beliefs in psychological misconceptions after reading a non-refutation-style text without causal explanations (Lassonde et al. 2016). To sum up, changing psychological misconceptions seems to be hard, but feasible through refutations implemented in lectures or written texts.

The role of anecdotal evidence for (preservice) teachers

Causal explanations (see above) can be based on various sources (e.g., findings from research or experience-based explanations). According to Hargreaves (2000), preservice teachers do not consider research as helpful for practical problems and teachers mainly trust in their own experiences. More precisely, there is growing evidence that (preservice) teachers do not primarily rely on findings from educational research for their decisions but rather concentrate on experience-based knowledge (e.g., Allen 2009; Bråten and Ferguson 2015; Gitlin et al. 1999; Hargreaves 2000; Ingram et al. 2004; Parr and Timperley 2008; Williams and Coles 2007). Relying on informal information instead of sound scientific information, however, might not only result in the negative consequences mentioned above but also conflicts with current calls for evidence-based practice (see Bauer and Prenzel 2012; Slavin 2002). For example, in one study, interviewed preservice teachers indicated that research was less important than experience and that they would use teachers as resources in order to make decisions (Gitlin et al. 1999). Additionally, preservice teachers of another study mentioned that (pedagogical) theory from teacher education was rather useless for classroom practice (Sjølie 2014). Also, interviewed teachers from the UK named discussions with teaching colleagues as their most used source when looking for research information (Williams and Coles 2007). Bråten and Ferguson (2015) reported that preservice teachers showed a higher preference for experiential and practically derived sources of knowledge compared to theory-based sources concerning instruction and student learning. Moreover, these preservice teachers showed a strong motivation to learn from practice. Additionally, at least German teachers do not seem to use scientific findings from educational science to plan their classes (Hetmanek et al. 2015). Taking together, literature indicates that anecdotal evidence plays a vital role in (preservice) teachers' professional lives whereas empirical evidence and research seem to be less important.

The current study

With our study, we wanted to address the prevalence and possible reduction of educational psychological misconceptions among preservice teachers in Germany. Previous research has focused on psychological misconceptions among the general public and psychology students in particular. However, the negative impact of teachers who endorse educational psychological misconceptions has been neglected and some studies have indicated some acceptance problems of empirical evidence among (preservice) teachers. If (preservice) teachers do not believe in empirical evidence, this might impede the requested concept of evidence-based education (e.g., Slavin 2002). To ensure quality of teaching and learning, it is important that teachers, if they hold misconceptions about topics from educational psychology, will shift their opinion based on empirical evidence. Corrective action should be applied at an early stage in education, hence, already with preservice teachers.

Psychology plays an important role in teacher education (see Anderson et al. 1995; for Germany see Spinath et al. 2018), especially educational psychological knowledge is of importance for (preservice) teachers (e.g. Patrick et al. 2011; for Germany see KMK 2004). However, to the best of our knowledge, whether preservice teachers in Germany endorse different educational psychological misconceptions has not been investigated yet. Due to the general high prevalence of psychological misconceptions and the high prevalence of at least one misconception from the educational psychological context (learning styles) among preservice teachers in different countries, we expect the prevalence of the investigated educational psychological misconceptions to be high among preservice teachers in Germany. The prevalence is expected to be both, high in absolute terms as well as higher than the prevalence of misconceptions about general science topics. Further, we wanted to know whether it is possible to change preservice teachers' wrong opinions about educational psychological topics through short refutation-style texts about the current state of research. According to literature, these refutation-style texts have been proven a suitable tool to change students' misconceptions about psychological topics (e.g., Lasonde et al. 2016) and should therefore also work for preservice teachers with misconceptions about educational psychological topics. Hence, we expect shifts of opinion (i.e., from (strongly) endorsing a misconception before reading the text to (rather) not endorsing a misconception after reading the text) for every topic from educational psychology. Additionally, literature suggests that (preservice) teachers believe experience-based information to be more important to them than evidence-based information (e.g., Bråten and Ferguson 2015). However, to the best of our knowledge, this is the first study to directly test whether anecdotal or empirical evidence is more believed in. According to the literature (e.g., Bråten and Ferguson 2015; Gitlin et al. 1999; Hargreaves 2000), we expect preservice teachers to shift their opinion more after reading the anecdotal version of the refutation-style text compared to the empirical version of the refutation-style text.

Thus, our study addresses the following three hypotheses:

1. Misconceptions about topics from educational psychology are highly prevalent among preservice teachers, both in absolute terms and compared to the prevalence of misconceptions about general science topics.
2. Preservice teachers with misconceptions about topics from educational psychology will shift their opinion after reading a refutation-style text about the current state of research.

3. Preservice teachers with misconceptions about topics from educational psychology will indicate a more pronounced shift of their opinion after reading an anecdotal version of the refutation-style text compared to an empirical version of the refutation-style text.

Method

Data collection

For this study, an online survey via the online questionnaire tool SoSci-Survey was conducted. The presented study was imbedded in an investigation that also assessed students' perception of scientific findings from different scientific (sub-)disciplines. Data collection was carried out between November 2017 and January 2018. Participants were recruited by asking them to take part in a study about the perception of scientific findings from different disciplines. We distributed the link to the online survey via social media platforms for preservice teachers in Germany, personal contact, mailing lists for preservice teachers, and lectures imbedded in preservice teachers' syllabus at different universities in Germany. Participation in this study was not associated with any specific university course and participants did not receive any course credit. Instead, we encouraged preservice teachers to support psychological research and offered them the chance to take part in a lottery of $20 \times 20\text{€}$. Participants were free to choose the location and time for doing the online survey by using their own technical devices. Enrollment for teacher education at a German institution was the only requirement of participating in this study. Due to the disengagement of the study from any further restrictions, a diverse sample of preservice teachers in Germany (e.g., regarding age, location, study program) was recruited (see below). Participation was voluntary and took approximately 15 min. Participants were informed about the anonymous data collection, provided informed consent and could abandon the survey at any time. Because of recruitment via snowball system, it is not possible to determine a return rate; however, completion rate of all started surveys was 77.8% and due to the settings of the survey, there were no missing data.

Participants

Three participants with their study location outside Germany were removed from the initial sample. Thus, the total sample of this study consisted of $N = 937$ preservice teachers (77.5% female). This gender distribution fairly well represents the typical gender distribution of preservice teachers in Germany (DESTATIS 2019). The mean age of the sample was $M = 22.08$ years ($SD = 3.35$) and 56% had attended one or more than one course of educational psychology during their study period. Participants were studying in 14 of 16 German federal states and at average, they were in their fourth semester ($M = 4.11$; $SD = 3.27$). The preservice teachers of this sample studied to become different kinds of teachers (i.e., 53% high school teacher, 17.1% elementary school teacher, 11.8% comprehensive school teacher, 9.1% special school teacher, 5.1% both a high school and a comprehensive school teacher, 3.7% vocational school teacher). In Germany, preservice teachers normally study at least two school subjects. Taking together the first, the second, and the third subjects, German was the most studied subject, with 389 preservice teachers studying it, followed by mathematics (293) and English (218).

Procedure

To address the first hypothesis regarding the prevalence of educational psychological misconceptions, we selected four specific topics from educational psychology. To our knowledge, there is no existing questionnaire covering specific *educational psychological* topics. While Dekker et al. (2012) investigated *neuromyths in education*, we were interested in a broader range of educational psychological topics. Thus, we chose topics that are common in preservice teacher education in Germany and that are of extreme relevance to (preservice) teachers, because correct knowledge about these topics could be directly transferred to evidence-based actions by (preservice) teachers themselves. Of our topics, three claims refer to the importance of learning styles, class sizes, and the testing effect for better learning outcomes. Thus, we included one topic (i.e., learning styles) that was also investigated by Dekker et al. (2012) as one of the most prevalent neuromyths in education. The first two claims have been contradicted by empirical evidence while the latter has been strongly supported by empirical evidence. As a fourth topic, we chose multiple intelligences, which have been classified as “a kind of philosophy rather than a proven theory [...] that has the potential to become a myth, if taken too seriously” (de Bruyckere et al. 2015; p. 68). De Bruyckere et al. (2015) also speculate on the origin of these educational psychological misconceptions: They might either contradict gut feelings (class size) or appear intuitively appealing (learning styles). Further, several educational psychological misconceptions might be based on the desire to believe that the statement is true. Further, we selected four general science topics that have been investigated in previous studies (i.e., climate change, evolution, vaccinations, HIV). Participants indicated their agreement to the general science topics first and to the educational psychology topics afterwards to prevent possible transfer effects of the educational psychological refutation-style texts on the general scientific topics.

To address the second and the third hypotheses regarding the reduction of educational psychological misconceptions after reading (different) refutation-style texts, participants were randomly assigned to either an empirical or an anecdotal version of the texts. In order to prevent participants from an excessive demand, only misconceptions about the aforementioned four educational psychological topics were investigated. After indicating their opinion concerning the first topic, participants read a short refutation-style text with causal explanations about the current state of research concerning this topic. This text was either presented in the form of a summary of empirical studies (i.e., empirical version) or in the form of a personal report by companioned teachers (i.e., anecdotal version). Both versions refuted the popular misconception directly and were followed by short causal explanations, either backed up with empirical studies or personal experiences. Afterwards, the aforementioned statement was repeated and participants were asked how much they agreed with it *now*. The same procedure followed for the other three topics.

Materials

Topics from educational psychology To measure the prevalence of educational psychological misconceptions among preservice teachers, their opinion concerning four specific topics from educational psychology (i.e., learning styles, multiple intelligences, testing effect, and class size) was assessed using one item for each topic (e.g., “How much do you agree with the thesis that there are different learning styles (e.g. auditory, visual or kinesthetic) that enable more effective learning?”; see [Appendix 1](#) for all items). Participants indicated their agreement

to the statements on a five-point Likert-Scale (1 = “I do not agree at all”; 5 = “I agree very much”) for each item.

General science topics To measure the prevalence of general science misconceptions among preservice teachers, their opinion concerning four specific topics from general science (i.e., climate change, evolution, vaccinations, and HIV) was assessed using one item for each topic (e.g., “Climate change is also caused by humans.”; see [Appendix 2](#) for all items). Participants indicated their agreement to the statements on a five-point Likert-Scale (1 = “I do not agree at all”; 5 = “I agree very much”) for each item.

Empirical version One version of the refutation-style texts presented the current state of research in an evidence-based format (i.e., a summary of empirical studies). For learning styles, multiple intelligences and class size, the text started with “The current state of research in educational psychology indicates that [the statement is not true]” and for the testing effect, the text started with “The current state of research in educational psychology indicates that [the statement is indeed true]”. After this first sentence, each text referred to several studies that reported evidence on the (in)correctness of the claims. Further, the text included explanations on why the specific misconceptions might have arisen.

Anecdotal version The other version of the refutation-style texts presented the current state of research in an experience-based format (i.e., a personal report by companioned teachers). For learning styles, multiple intelligences and class size, the text started with “Companioned teachers tell you that they have experienced that [the statement is not true]” and for the testing effect, the text started with “Companioned teachers tell you that they have experienced that [the statement is indeed true]”. Further, the texts included examples from these teachers’ many years of experience that explain why the statement cannot be true (i.e., for learning styles, multiple intelligences, and class size) or must be true (i.e., for the testing effect).

Statistical analyses

The program IBM SPSS Statistics (version 24) was used for all statistical analyses. A dependent *t* test for paired samples was used to examine whether preservice teachers’ misconceptions about topics from educational psychology and their misconceptions about general science topics differed. Analyses of variance (ANOVAs) with repeated measures for each topic of educational psychology were used to investigate whether participants changed their opinion after reading a short text about the current state of research and whether the change of their opinion differed between the two groups (empirical version vs. anecdotal version).

Results

Below, the prevalence of educational psychological misconceptions is presented—first in absolute terms and then compared to misconceptions about general science topics. The frequencies of each response category (i.e., level of agreement) of every misconception (educational psychological misconceptions and general science misconceptions) are depicted

in detail in Table 1. Afterwards, results about preservice teachers' change of their wrong knowledge about topics from educational psychology—in general and depending on the version—are displayed. Table 2 depicts descriptive statistics of the ANOVAs.

Prevalence of misconceptions about topics from educational psychology

Descriptive statistics concerning the four different topics from educational psychology were analyzed to investigate whether and to what extent misconceptions about these topics are prevalent among preservice teachers in Germany. In this study, holding a misconception was defined as (*rather* or *very much*) agreeing (i.e., agreement ≥ 4) to a claim that is not in accordance with the current state of research. For learning styles, 95% of the participants indicated an opinion contrary to the current state of research, for multiple intelligences it was 88.2%. Asked about the testing effect, 7.9% indicated an opinion contrary to the current state of research, for class size it was 85.6%. These numbers of prevalence indicate that misconceptions about most of the investigated topics from educational psychology are endorsed by the vast majority of preservice teachers in Germany.

To investigate whether preservice teachers' opinion concerning topics from educational psychology and their opinion concerning general science topics differ, a dependent *t* test for paired samples was conducted. All items were recoded so that low values indicate an opinion in accordance with the current scientific level of knowledge. There was a significant difference between the topics from educational psychology ($M = 3.83$; $SD = 0.47$) and general science topics ($M = 1.81$; $SD = 0.54$); $t(936) = 85.171$, $p < .001$, $d = 4.00$. This result suggests that preservice teachers' opinions concerning topics from educational psychology are less in accordance with the current scientific level of knowledge than their opinion concerning general science topics.

Reduction of misconceptions about topics from educational psychology—general and depending on the kind of evidence

To analyze whether preservice teachers' misconceptions about topics from educational psychology can generally be changed as well as whether the change depends on how they are confronted with the current state of research, a 2 (empirical version vs. anecdotal version) \times 2 (before reading the refutation-style text vs. after reading the refutation-style text) ANOVA with

Table 1 Frequencies (plus percentage) and descriptive statistics of misconception endorsement

	Not at all	Rather not	Neither/nor	Rather	Very much	<i>N</i>	<i>M</i>	<i>SD</i>
Educational psychological topics								
Learning styles	5 (0.5)	17 (1.8)	24 (2.6)	193 (20.6)	697 (74.4)	936	4.67	0.67
Multiple intelligences	7 (0.7)	37 (3.9)	66 (7.0)	319 (34.0)	508 (54.2)	937	4.37	0.84
Testing effect	352 (37.6)	345 (36.8)	166 (17.7)	59 (6.3)	15 (1.6)	937	1.98	0.97
Class size	16 (1.7)	58 (6.2)	60 (6.4)	294 (31.4)	508 (54.2)	936	4.30	0.96
General science topics								
Climate change	678 (72.4)	238 (25.4)	9 (1.0)	9 (1.0)	2 (0.2)	936	1.31	0.56
Evolution	624 (66.6)	174 (18.6)	42 (4.5)	39 (4.2)	57 (6.1)	936	1.64	1.14
Vaccinations	443 (47.3)	263 (28.1)	146 (15.6)	68 (7.3)	15 (1.6)	935	1.88	1.03
HIV	277 (29.6)	312 (33.3)	149 (15.9)	84 (9.0)	115 (12.3)	937	2.41	1.32

For each topic, high values for “rather” and “very much” indicate a misconception

Table 2 Descriptive statistics of the ANOVAs with repeated measures for the topics from educational psychology

	Empirical version		Anecdotal version	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Learning styles pre	4.77	0.42	4.79	0.41
Learning styles post	3.67	1.28	4.41	1.12
Multiple intelligences pre	4.54	0.50	4.68	0.47
Multiple intelligences post	3.71	1.19	4.42	0.74
Testing effect pre	3.46	0.67	3.25	0.46
Testing effect post	2.27	0.89	2.73	0.87
Class size pre	4.47	0.47	4.60	0.49
Class size post	3.93	1.09	4.18	0.83

$N_{\text{learning styles}} = 890$, $N_{\text{multiple intelligences}} = 825$, $N_{\text{testing effect}} = 240$, $N_{\text{class size}} = 802$

repeated measures was conducted for each of the four topics. For every topic except the testing effect, only participants indicating a misconception (i.e., agreement ≥ 4) were included in this analysis. Because the prevalence of the misconception concerning the testing effect was low, all participants indicating an agreement ≥ 3 (i.e., indicating an opinion not in accordance with the current state of research) were included for this topic. In total, 890 participants were included in the analysis concerning learning styles and 825 participants were included in the analysis concerning multiple intelligences. To analyze the testing effect, 240 participants were included and to analyze class size, 802 participants were included.

For learning styles, the 2×2 ANOVA with repeated measures showed a statistically significant main effect of version ($F(1,888) = 82.626$, $p < .001$, $d = 0.61$) and of time ($F(1,888) = 469.534$, $p < .001$, $d = 1.45$). Additionally, a statistically significant interaction effect was found ($F(1,888) = 110.556$, $p < .001$, $d = 0.71$), indicating a more pronounced change of opinion after reading the empirical version of the text. The analogous ANOVA for multiple intelligences revealed a statistically significant main effect of version ($F(1,823) = 89.709$, $p < .001$, $d = 0.66$) and of time ($F(1,823) = 333.619$, $p < .001$, $d = 1.27$). Additionally, a statistically significant interaction effect was found ($F(1,823) = 89.600$, $p < .001$, $d = 0.66$), indicating a more pronounced change of opinion after reading the empirical version of the text. For the testing effect, results showed a statistically significant main effect of time ($F(1,238) = 226.237$, $p < .001$, $d = 1.95$) and a statistically significant interaction effect ($F(1,238) = 36.177$, $p < .001$, $d = 0.78$), indicating that participants reading the empirical version changed their opinion to a more pronounced extent even though they started with stronger misconceptions. For class size, we found a statistically significant main effect of version ($F(1,800) = 4.382$, $p < .05$, $d = 0.14$) and of time ($F(1,800) = 347.921$, $p < .001$, $d = 1.32$). Additionally, a statistically significant interaction effect was found ($F(1,800) = 26.555$, $p < .001$, $d = 0.36$), indicating that participants reading the empirical version changed their opinion more even though they started with stronger misconceptions.

In sum, these results suggest that preservice teachers changed their wrong opinions about educational psychological topics more when confronted with the current state of research presented in an empirical version compared to an anecdotal version of a refutation-style text. A rigorous shift of opinion was only assumed when participants indicated an agreement of ≥ 4 (i.e., *rather* or *very much*) before reading the text and an agreement of ≤ 2 (i.e., *rather not* or

not at all) after reading each text about the current state of research. The percentage of participants who rigorously shifted their opinion was rather small in absolute terms, see Table 3.

Discussion

One aim of this study was to gain a first insight into the prevalence of misconceptions about different topics from educational psychology among preservice teachers in Germany. In line with our first hypothesis, the prevalence of educational psychological misconceptions among preservice teachers was very high: For each topic (except the testing effect), more than 80% of the participants indicated an opinion contrary to the current state of research. The prevalence of the learning styles myth was particularly high, namely 95%, which is in accordance with previous literature that reports the prevalence of this myth in different countries to range from 82 to 97.6% (e.g., Dekker et al. 2012; Dündar and Gündüz 2016; Howard-Jones et al. 2009; Tardif et al. 2015). Additionally, the severity of educational psychological misconceptions' dissemination was emphasized through a comparison to the dissemination of general science misconceptions. In detail, preservice teachers' knowledge about general science topics was in strong accordance with the recent state of knowledge, whereas their knowledge about central educational psychological topics was not. The findings of this study expand previous literature in transferring the results from the learning styles myth to other educational psychological topics and to another country.

Another aim of this study was to investigate whether refutation-style texts about the current state of research lead to a change of wrong beliefs in educational topics among preservice teachers. In line with our second hypothesis, reading refutation-style texts resulted in a reduction of misconceptions about each topic. This finding extends the previous literature on psychology students (e.g., Kowalski and Taylor 2009; Lasonde et al. 2016) to preservice teachers. Even though the refutation-style texts worked overall, only a minority of participants rigorously shifted their opinion. This finding indicates that confronting preservice teachers with refutational information—which lectures at university often do—may be insufficient to really change students' opinions.

Contrary to our third hypothesis, participants reading the empirical version of the refutation-style text indicated a more pronounced change of their opinion compared to participants reading the anecdotal version of the text. In addition, more people in the empirical version group compared to the anecdotal version group showed a rigorous shift of opinion. We had expected the anecdotal version to be more powerful because previous research has

Table 3 Percentage of participants indicating a rigorous shift of opinion after reading a refutation-style text about the current state of research

	Empirical version	Anecdotal version	Overall
Learning styles	21.6	3.0	12.0
Multiple intelligences	17.3	2.5	9.5
Testing effect	69.7	36.7	56.3
Class size	14.8	5.4	10.0

A rigorous shift of opinion is defined as agreement to the statement ≥ 4 (for the testing effect ≥ 3) *before* and agreement to the statement ≤ 2 *after* reading a text about the current state of research

indicated that (preservice) teachers do not primarily rely on findings from educational research but rather name experience (e.g., Bråten and Ferguson 2015; Gitlin et al. 1999) and other teachers (e.g., Gitlin et al. 1999; Williams and Coles 2007) as important sources for their decisions. However, the assumption that (preservice) teachers concentrate on experience-based knowledge or intuition instead of evidence-based research was often based on research which either did not use any data (e.g., Hargreaves 2000; Labaree 2003) or only small samples (e.g., Allen 2009). In our data-based study with a large and heterogeneous sample, preservice teachers changed their opinion more in the empirical version group than students in the anecdotal version group. Thus, the preservice teachers showed higher trust in empirical than anecdotal explanations for the formation of their opinion. This result indicates that preservice teachers do not devalue empirical findings but use them in a positive way to a certain extent. Nevertheless, the majority of participants reading the empirical refutation-style text did not rigorously shift their opinion which indicates that these preservice teachers could not be convinced by empirical evidence. The findings of this study are therefore in line with previous literature but allow a more differentiated view on the power of empirical evidence to reduce misconceptions among preservice teachers.

Limitations

In this study, the prevalence of educational psychological misconceptions was measured for only four topics. These topics were chosen because of their high importance for (preservice) teachers and their professional lives and can be viewed as a first indicator of prevalence. Also, only very few participants, namely 7.9%, denied the testing effect. This is a pleasant finding because it indicates that preservice teachers do not only hold misconceptions about topics from educational psychology. However, there have been no claims that testing was not useful for learning. That is, something like the opposite of the testing effect has not been classified as an educational psychological misconception. Hence, the testing effect might not have been an optimal topic for the purpose of our study. As a first investigation, our study only sheds light on the status quo of prevalence and does not offer an insight into causes and sources of these misconceptions. Another limitation of this study is the lack of a follow-up investigation. Based on our study, we cannot say whether and how long the changes of opinions last. Further, because we only collected self-reports and no behavioral data, we do not know whether the successful refutation of a misconception leads to behavioral implementations in the classroom that are in accordance with the current state of research. Additionally, preservice teachers' voluntary participation in our study could be a sign for their high interest in the topic. It would deepen our knowledge to repeat our study with preservice teachers who show low interest in the topic. This might result in even more alarming findings.

Practical implications and future research

The investigated educational psychological misconceptions about learning styles, the existence of multiple intelligences, and the influence of class size on students' learning appear very hardened among German preservice teachers. As already mentioned, only few preservice teachers rigorously shifted their opinion after reading a refutation-style text. As confronting students with empirical evidence is an approach often implemented in university lectures, we can assume that preservice teachers fail to evolve their full potential in exams when they endorse misconceptions about covered topics. In addition, this could mean that preservice

teachers leave their lectures still endorsing misconceptions. Even more alarming, they might also enter their professional lives with these misconceptions, which can have severe implications, for example, hinder their students' learning and result in a waste of time and money (see Pasquinelli 2012). As a first step, it is important for university instructors to be alert about specific and possibly hardened misconceptions among their students in order to target them. Further, future research needs to concentrate on diverse interventions to target preservice teachers' misconceptions in other and more efficient ways. Hence, it is worthwhile to conduct a longitudinal study to investigate whether interventions only have short-term or also long-term effects, lasting for students' duration of study and even their practical work. In this regard, investigating behavioral outcomes affected by educational psychological misconception endorsement would add new knowledge about consequences of these misconceptions among teachers. Future work should also extend investigations to other topics from educational psychology to draw an accurate and representative picture of the prevalence of different educational psychological misconceptions among preservice teachers. It is also of high interest where these misconceptions come from. Taylor and Kowalski (2004) report that psychology students in their study mostly did not remember the sources of their misconceptions. In order to counteract misconceptions efficiently, it is important to know whether preservice teachers derive their misconceptions about educational psychology from personal experiences, the media, or maybe even previous classes. Different origins of misconceptions might ask for different kinds of rebuttal: If people believe their knowledge is based on scientific evidence—but in fact this evidence is outdated or not scientific at all—it might be helpful to present them with the latest rigorous scientific evidence. On the other hand, if people base their knowledge on personal experiences, it might be helpful to make them aware of possible cognitive biases that we all fall victim to.

Conclusion

This study illustrates that preservice teachers from Germany hold misconceptions about topics from educational psychology. University instructors need to be informed about these misconceptions and should target them in an efficient way during their lectures. It is important to prevent teachers from entering their professional lives with misconceptions about topics from educational psychology because this could otherwise lead to serious consequences for society. Our findings are in line with previous literature concerning the persistence of psychological misconceptions. Although some preservice teachers rigorously shifted their opinion after reading a refutation-style text with empirical evidence, the vast majority did not. Future research in this area should investigate further educational psychological misconceptions, identify different reasons and sources for the endorsement of misconceptions, and concentrate on efficient ways to counteract misconceptions among preservice teachers.

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Appendix 1: English translation of the items about educational psychological topics

- Learning styles: “How much do you agree with the thesis that there are different learning styles (e.g., auditory, visual or kinesthetic) that enable more effective learning?” (false).
- Multiple intelligences: “How much do you agree with the thesis that multiple intelligences (e.g., verbal-linguistic, logical-mathematical, visual-spatial intelligences) exist?” (false).
- Testing effect: “How much do you agree with the thesis that repeated (self-)testing (e.g., with the aid of flashcards or quizzes) leads to better long-term learning than repeated reading of the material?” (true).
- Class size: “How much do you agree with the thesis that the number of pupils in a class (i.e., class size) influences pupils learning?” (false).

Appendix 2: English translation of the items about general science topics

- “How much do you agree with the following statements?”
- Climate change: “Climate change is also caused by humans.” (true).
- Evolution: “Humans and apes do not share common ancestors.” (false).
- Vaccinations: “Autism is a developmental disorder that can be caused through vaccinations.” (false).
- HIV: “HIV leads to AIDS if it is not treated.” (true).

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References

- Allen, J. M. (2009). Valuing practice over theory: How beginning teachers re-orient their practice in the transition from the university to the workplace. *Teaching and Teacher Education*, 25, 647–654. <https://doi.org/10.1016/j.tate.2008.11.011>.
- Ambrose, S. A., & Lovett, M. C. (2014). Prior knowledge is more than content: Skills and beliefs also impact learning. In V. A. Benassi, C. E. Overson, & C. M. Hakala (Eds.), *Applying science of learning in education: Infusing psychological science into the curriculum* (pp. 7–20). Washington, DC: American Psychological Association (division 2).
- Anderson, L. M., Blumenfeld, P., Pintrich, P. R., Clark, C. M., Marx, R. W., & Peterson, P. (1995). Educational psychology for teachers: reforming our courses, rethinking our roles. *Educational Psychologist*, 30, 143–157. https://doi.org/10.1207/s15326985ep3003_5.
- Bauer, J., & Prenzel, M. (2012). Science education. European teacher training reforms. *Science*, 336(6089), 1642–1643. <https://doi.org/10.1126/science.1218387>.
- Bensley, D. A., & Lilienfeld, S. O. (2015). What is a psychological misconception? Moving toward an empirical answer. *Teaching of Psychology*, 42, 282–292. <https://doi.org/10.1177/0098628315603059>.
- Betts, J. R., & Shkolnik, J. L. (1999). The behavioral effects of variations in class size: the case of math teachers. *Educational Evaluation and Policy Analysis*, 21(2), 193–213. <https://doi.org/10.3102/01623737021002193>.

- Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: brain, mind, experience, and school*. Washington, DC: National Academy Press.
- Bråten, I., & Ferguson, L. E. (2015). Beliefs about sources of knowledge predict motivation for learning in teacher education. *Teaching and Teacher Education, 50*, 13–23. <https://doi.org/10.1016/j.tate.2015.04.003>.
- de Bruyckere, P., Kirschner, P. A., & Hulshof, C. D. (2015). *Urban myths about learning and education*. London: Elsevier.
- Dekker, S., Lee, N. C., Howard-Jones, P., & Jolles, J. (2012). Neuromyths in education: Prevalence and predictors of misconceptions among teachers. *Frontiers in Psychology, 3*(429), 1–8. <https://doi.org/10.3389/fpsyg.2012.00429>.
- DESTATIS (2019). *Bildung und Kultur: Studierende an Hochschulen (Vorbericht) [Education and culture: Students in higher education (preliminary report)]*. Retrieved from <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Hochschulen/Publicationen/Downloads-Hochschulen/studierende-hochschulen-vorb-2110410198004.html>. Accessed 16 Mar 2020.
- Dündar, S., & Gündüz, N. (2016). Misconceptions regarding the brain: the neuromyths of preservice teachers. *Mind, Brain, and Education, 10*, 212–232. <https://doi.org/10.1111/mbe.12119>.
- Freed, G. L., Clark, S. J., Butchart, A. T., Singer, D. C., & Davis, M. M. (2010). Parental vaccine safety concerns in 2009. *Pediatrics, 125*(4), 654–659. <https://doi.org/10.1542/peds.2009-1962>.
- Furnham, A., & Hughes, D. J. (2014). Myths and misconceptions in popular psychology: comparing psychology students and the general public. *Teaching of Psychology, 41*, 256–261. <https://doi.org/10.1177/0098628314537984>.
- Gardner, R. M., & Brown, D. L. (2013). A test of contemporary misconceptions in psychology. *Learning and Individual Differences, 24*, 211–215. <https://doi.org/10.1016/j.lindif.2012.12.008>.
- Gardner, R. M., & Dalsing, S. (1986). Misconceptions about psychology among college students. *Teaching of Psychology, 13*, 32–34. https://doi.org/10.1207/s15328023top1301_9.
- Gitlin, A., Barlow, L., Burbank, M. D., Kauchak, D., & Stevens, T. (1999). Pre-service teachers' thinking on research: implications for inquiry oriented teacher education. *Teaching and Teacher Education, 15*, 753–769. [https://doi.org/10.1016/S0742-051X\(99\)00015-3](https://doi.org/10.1016/S0742-051X(99)00015-3).
- Gutman, A. (1979). Misconceptions of psychology and performance in the introductory course. *Teaching of Psychology, 6*, 159–161. https://doi.org/10.1207/s15328023top0603_9.
- Hamilton, L. C., Hartter, J., Lemcke-Stampone, M., Moore, D. W., & Safford, T. G. (2015a). Tracking public beliefs about anthropogenic climate change. *PLoS One, 10*(9), e0138208. <https://doi.org/10.1371/journal.pone.0138208>.
- Hamilton, L. C., Hartter, J., & Saito, K. (2015b). Trust in scientists on climate change and vaccines. *SAGE Open, 5*(3), 1–13. <https://doi.org/10.1177/2158244015602752>.
- Hargreaves, D. H. (2000). Teaching as a research-based profession: possibilities and prospects. In B. Moon, J. Butcher, & E. Bird (Eds.), *Leading professional development in education* (pp. 200–210). London: RoutledgeFalmer.
- Hattie, J. A. C. (2009). *Visible learning: a synthesis of over 800 meta-analyses on achievement*. London: Routledge.
- Hetmanek, A., Wecker, C., Kiesewetter, J., Trempler, K., Fischer, M. R., Gräsel, C., & Fischer, F. (2015). Wozu nutzen Lehrkräfte welche Ressourcen? Eine Interviewstudie zur Schnittstelle zwischen bildungswissenschaftlicher Forschung und professionellem Handeln im Bildungsbereich [For what do teachers use which kind of resources? An interview study on the interface between research and professional practice in education]. *Unterrichtswissenschaft, 43*, 193–208.
- Higbee, K. L., & Clay, S. L. (1998). College students' beliefs in the ten-percent myth. *Journal of Psychology: Interdisciplinary and Applied, 132*, 469–476.
- Howard-Jones, P., Franey, L., Mashmoushi, R., & Liao, Y.-C. (2009). The neuroscience literacy of trainee teachers. Paper presented at British Educational Research Association Annual Conference, Manchester.
- Hughes, S., Lyddy, F., Kaplan, R., Nichols, A. L., Miller, H., Saad, C. G., et al. (2015). Highly prevalent but not always persistent: undergraduate and graduate student's misconceptions about psychology. *Teaching of Psychology, 42*, 34–42. <https://doi.org/10.1177/0098628314562677>.
- Ingram, D., Seashore Louis, K., & Schroeder, R. G. (2004). Accountability policies and teacher decision making: barriers to the use of data to improve practice. *Teachers College Record, 106*, 1258–1287.
- KMK [Kultusministerkonferenz] (2004). Standards für die Lehrerbildung: Bildungswissenschaften. Beschluss der Kultusministerkonferenz. [Standards for teacher education. Decision of the Conference of the Ministers of Education and Cultural Affairs]. Bonn: KMK.
- Kowalski, P., & Taylor, A. (2009). The effect of refuting misconceptions in the introductory psychology class. *Teaching of Psychology, 36*, 153–159. <https://doi.org/10.1080/00986280902959986>.
- Kuhle, B. X., Barber, J. M., & Bristol, A. S. (2009). Predicting students' performance in introductory psychology from their psychology misconceptions. *Journal of Instructional Psychology, 36*, 119–124.

- Labaree, D. F. (2003). The peculiar problems of preparing educational researchers. *Educational Researcher*, 32, 13–22. <https://doi.org/10.3102/0013189X032004013>.
- Lassonde, K. A., Kendeou, P., & O'Brien, E. J. (2016). Refutation texts: Overcoming psychology misconceptions that are resistant to change. *Scholarship of Teaching and Learning in Psychology*, 2, 62–74. <https://doi.org/10.1037/stl0000054>.
- Lassonde, K. A., Kolquist, M., & Vergin, M. (2017). Revising psychology misconceptions by integrating a refutation-style text framework into poster presentations. *Teaching of Psychology*, 44, 255–262. <https://doi.org/10.1177/0098628317712754>.
- Lewandowsky, S., & Oberauer, K. (2016). Motivated rejection of science. *Current Directions in Psychological Science*, 25, 217–222. <https://doi.org/10.1177/0963721416654436>.
- Lilienfeld, S., Lynn, S., Ruscio, J., & Beyerstein, B. (2010). *50 great myths of popular psychology*. Oxford: Wiley-Blackwell.
- McCutcheon, L. E. (1991). A new test of misconceptions about psychology. *Psychological Reports*, 68, 647–653.
- McCutcheon, L. E., Furnham, A., & Davis, G. (1993). A cross-national comparison of students' misconceptions about psychology. *Psychological Reports*, 72(1), 243–247.
- Miller, J. D., Scott, E. C., & Okamoto, S. (2006). Public acceptance of evolution. *Science*, 313(5788), 765–766. <https://doi.org/10.1126/science.1126746>.
- Parr, J. M., & Timperley, H. S. (2008). Teachers, schools and using evidence: considerations of preparedness. *Assessment in Education: Principles, Policy & Practice*, 15, 57–71. <https://doi.org/10.1080/09695940701876151>.
- Pasquinelli, E. (2012). Neuromyths: why do they exist and persist? *Mind, Brain, and Education*, 6, 89–96. <https://doi.org/10.1111/j.1751-228X.2012.01141.x>.
- Patrick, H., Anderman, L. H., Bruening, P. S., & Duffin, L. C. (2011). The role of educational psychology in teacher education: three challenges for educational psychologists. *Educational Psychologist*, 46(2), 71–83. <https://doi.org/10.1080/00461520.2011.538648>.
- Poortinga, W., Spence, A., Whitmarsh, L., Capstick, S., & Pidgeon, N. F. (2011). Uncertain climate: an investigation into public scepticism about anthropogenic climate change. *Global Environmental Change*, 21, 1015–1024. <https://doi.org/10.1016/j.gloenvcha.2011.03.001>.
- Shapson, S. M., Wright, E. N., Eason, G., & Fitzgerald, J. (1980). An experimental study of the effects of class size. *American Educational Research Journal*, 17(2), 141–152. <https://doi.org/10.3102/00028312017002141>.
- Sjølie, E. (2014). The role of theory in teacher education: Reconsidered from a student teacher perspective. *Journal of Curriculum Studies*, 46, 729–750. <https://doi.org/10.1080/00220272.2013.871754>.
- Slavin, R. E. (2002). Evidence-based education policies: Transforming educational practice and research. *Educational Researcher*, 31(7), 15–21. <https://doi.org/10.3102/0013189X031007015>.
- Spinath, B., Antoni, C., Bühner, M., Elsner, B., Erdfelder, E., Fydrich, T. et al. (2018). Empfehlungen zur Qualitätssicherung in Studium und Lehre [Recommendations for quality management in higher education]. *Psychologische Rundschau*, 69, 171–192.
- Stefanoff, P., Mamelund, S.-E., Robinson, M., Netterlid, E., Tuells, J., Bergsaker, M. A. R., et al. (2010). Tracking parental attitudes on vaccination across European countries: The vaccine safety, attitudes, training and communication project (VACSATC). *Vaccine*, 28(35), 5731–5737. <https://doi.org/10.1016/j.vaccine.2010.06.009>.
- Tardif, E., Doudin, P.-A., & Meylan, N. (2015). Neuromyths among teachers and teacher students. *Mind, Brain, and Education*, 9, 50–59. <https://doi.org/10.1111/mbe.12070>.
- Taylor, A. K., & Kowalski, P. (2004). Naive psychological science: the prevalence, strength, and sources of misconceptions. *Psychological Record*, 54(1), 15–25.
- Taylor, A. K., & Kowalski, P. (2014). Student misconceptions: where do they come from and what can we do? In V. A. Benassi, C. E. Overson, & C. M. Hakala (Eds.), *Applying science of learning in education: Infusing psychological science into the curriculum* (pp. 259–273). Washington, DC: American Psychological Association (division 2).
- Taylor, B., Miller, E., Lingam, R., Andrews, N., Simmons, A., & Stowe, J. (2002). Measles, mumps, and rubella vaccination and bowel problems or developmental regression in children with autism: Population study. *British Medical Journal*, 324(7334), 393–396. <https://doi.org/10.1136/bmj.324.7334.393>.
- Thompson, R. A., & Zamboanga, B. L. (2004). Academic aptitude and prior knowledge as predictors of student achievement in introduction to psychology. *Journal of Educational Psychology*, 96, 778–784. <https://doi.org/10.1037/0022-0663.96.4.778>.
- Vaughan, E. D. (1977). Misconceptions about psychology among introductory psychology students. *Teaching of Psychology*, 4, 138–141. https://doi.org/10.1207/s15328023top0403_9.
- Williams, D., & Coles, L. (2007). Evidence-based practice in teaching: an information perspective. *Journal of Documentation*, 63, 812–835. <https://doi.org/10.1108/00220410710836376>.

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Evidence-based thinking, misconceptions, teacher education

Most relevant publications in the field of Psychology of Education:

No previous publications.

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Learning and teaching in schools and higher education, motivational prerequisites of learning and achievement, psychology learning and teaching, teacher education.

Most relevant publications in the field of Psychology of Education:

Weidinger, A.F., Steinmayr, R. & Spinath, B. (2019). Ability self-concept formation in elementary school: No dimensional comparison effects across time. *Developmental Psychology*, 55, 1005–1018.

Kriegbaum, K., Becker, N. & Spinath, B. (2018). The relative importance of intelligence and motivation as predictors of school achievement: a meta-analysis. *Educational Research Review*, 25, 120–148.

Spinath, B. & Steinmayr, R. (2012). The roles of competence beliefs and goal orientations for change in intrinsic motivation. *Journal of Educational Psychology*, 104, 1135–1148.

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Evidence-based thinking, scholarship of teaching and learning, teacher education.

Most relevant publications in the field of Psychology of Education:

Seifried, E., & Spinath, B. (in press). Using formative (self-)assessment to improve teaching and learning in educational psychology courses. In E. Landrum, C. Hakala, & S. Nolan (Eds.), *Assessment: Individual, Institutional, and International Approaches*. APA Books.

Seifried, E., Eckert, C., & Spinath, B. (2018). Optional learning opportunities: Who seizes them and what are the learning outcomes? *Teaching of Psychology*, 45, 246–250.

Seifried, E., Lenhard, W., & Spinath, B. (2016). Automatic essay assessment: Effects on students' acceptance and on learning-related characteristics. *Psithologija*, 49, 469–482.