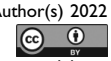
Article

PSYCHOLOGY LEARNING & TEACHING

Psychology Learning & Teaching
2023, Vol. 22(1) 20–38



DOI: 10.1177/14757257221113942
journals.sagepub.com/home/plj

Pre-service Teachers' Evidence-Informed Reasoning: Do Attitudes, Subjective Norms, and Self-Efficacy Facilitate the Use of Scientific Theories to Analyze Teaching Problems?

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Abstract

Using the theory of planned behavior, we investigated whether attitudes, subjective norms, and self-efficacy facilitate pre-service teachers' engagement in evidence-informed reasoning about classroom problems. $N = 157$ pre-service teachers were asked about these motivationally relevant antecedents to engaging in evidence-informed reasoning about classroom-related challenges and analyzed case scenarios of problematic teaching situations. Results revealed that self-reported evidence-informed reasoning was directly predicted by intention to engage in evidence-informed reasoning, self-efficacy, and attitude toward evidence-informed reasoning. However, the objectively coded quality of teachers' evidence-informed reasoning was seemingly negatively predicted by

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perceived costs and self-efficacy. Thus, the theory of planned behavior partly explained self-reported evidence-informed reasoning, but not objectively observed reasoning. Pre-service teachers might not be skilled enough to assess their own competency accurately and might be unaware of external conditions facilitating or hindering evidence-informed reasoning. Thus, interventions aiming to foster pre-service teachers' motivation to engage in evidence-informed reasoning might not be effective until such teachers gain the necessary skills.

Keywords
Evidence-based practice, reasoning skills, attitude, subjective norms, self-efficacy, pre-service teachers

Introduction

Problem Statement

In their future teaching careers, pre-service teachers will be confronted with various classroom problems. For example, at least occasionally, students will not be motivated to learn, not understand the instructions, be overwhelmed by the learning material, etc. Both educational science and policy-makers expect teachers to refer to scientific theories and evidence, especially from the learning sciences, to guide them in their classroom decision-making (Bauer et al., 2015; Bauer & Prenzel, 2012; Davies, 1999; Kultusministerkonferenz, 2004). However, research has shown that teachers rarely use scientific knowledge for teaching-related decisions (Dagenais et al., 2012; Demski, 2018; Hetmanek et al., 2015; Zeuch & Souvignier, 2016). The literature discusses various reasons for this problem (Center for the Use of Research and Evidence in Education, 2011; Dagenais et al., 2012). In this article, building on the theory of planned behavior (Ajzen, 1991), we focus on whether attitudes towards evidence-informed reasoning, corresponding subjective norms, and self-efficacy foster or inhibit pre-service teachers' evidence-informed reasoning. Therefore, our study may inform pre-service teacher education in finding ways to overcome possible motivational barriers to evidence-informed reasoning.

Conceptualizing Motivational Barriers of Evidence-Informed Reasoning by Aid of the Theory of Planned Behavior

Teachers increasingly face claims to base their classroom decisions not only on experience, but also on scientific evidence (Bauer et al., 2015; Bauer & Prenzel, 2012; Davies, 1999; Kultusministerkonferenz, 2004). In this article, we use the term *evidence-informed reasoning* to indicate that scientific evidence should not be regarded as a prescription (as the term evidence-*based* practice tends to imply), but rather as a resource that pre-service teachers can use to orient their actions in uncertain situations or situations that repeatedly prove difficult (Nelson & Campbell, 2017; Neuweg, 2007; Stark, 2017). The literature lists a variety of potential barriers to evidence-informed reasoning (e.g., Center for the Use of Research and Evidence in Education, 2011; Dagenais et al., 2012; Uhlenbrock, 2019). For example, Lysenko et al. (2014) distinguished between ability-related (e.g., expertise) and motivational barriers. In their empirical study, motivational barriers predicted a larger amount of variance of teaching professionals' readiness to use research-based information in practice than ability-related barriers.

In this study, we look more closely at motivational barriers. Our reference point is the theory of planned behavior (Ajzen, 1991), as the use of scientific evidence to deal with classroom problems can be considered planned (as opposed to intuitive) behavior. Evidence for this is provided by a study by König et al. (2014), in which teachers were asked to analyze video vignettes of classroom situations. The authors found the quality of these analyses to be strongly associated with available declarative and explicit pedagogical knowledge. In comparison, the more automatic and implicit process of only noticing critical classroom situations was not related to explicit knowledge. Hence, the authors argue that interpreting classroom situations is a deliberate, effortful process. We conclude that proper analysis of classroom situations requires the integration of explicit knowledge in a conscious, explicit reasoning process. As soon as pre-service teachers use knowledge explicitly, their intentions become relevant and the theory of planned behavior should apply. Also, the theory of planned behavior offers a comprehensive framework to conceptualize antecedents to engaging in evidence-informed reasoning and thus has already been used successfully in research on the implementation of (pedagogical) innovations (e.g., Cheon et al., 2012; De Leeuw et al., 2015; Knauder & Koschmieder, 2019; Schüle et al., 2016; Voet & De Wever, 2020; Yan & Sin, 2014; for a critique, see Sniehotta et al., 2014). It combines constructs such as beliefs, attitudes, norms, intentions, behavior, self-efficacy, and perceived control into a single theoretical model (see Figure 1) and therefore allows for comparing how strongly different predictors are related to the behavioral intention and behavior in question.

Intention and Perceived Behavioral Control Predict Behavior. According to this theory (Ajzen, 1991), a specific behavior is best predicted by one's intention and subjective estimation of the likelihood of being able to execute this behavior. Intention in turn depends on one's attitude toward the behavior, the subjective norm regarding the behavior, and perceived behavioral control.

Attitude Toward the Behavior. One's overall attitude toward a behavior consists of various beliefs regarding this behavior which are salient to the individual at the moment of appraisal. Each belief links the behavior to a specific attribute, e.g., an expected outcome that is a direct consequence of the behavior. In the case of a pre-service teacher, this might mean that the behavior in

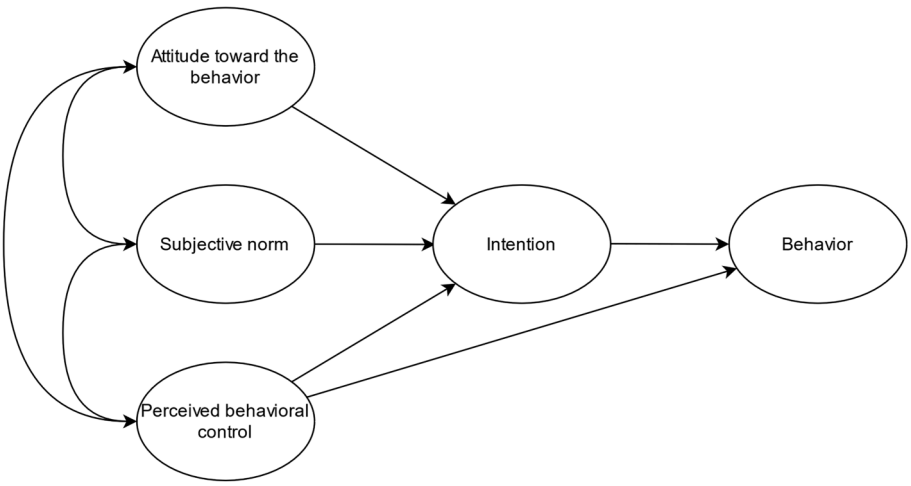

Figure 1. Theory of planned behavior (redrawn according to Ajzen, 1991).

question (applying scientific evidence to a practical teaching problem) is linked to a desirable outcome (high-quality teaching). Each attribute has a certain value to the individual, and has a certain likelihood of being realized if the behavior is executed. Our pre-service teacher might find this outcome desirable, but unlikely to happen. Consequently, one's attitude is the sum of all salient beliefs, which in turn represent expectancy*value interactions regarding attributes of that behavior.

Two approaches to measuring attitude are possible: First, a pretest might assess which beliefs are salient regarding a specific behavior. Then, questionnaire items can be formulated to capture the expectancy and value components of these beliefs. With respect to measuring pre-service teachers' attitudes towards engaging in evidence-informed reasoning, such items might ask them to rate to what extent they agree that evidence-informed reasoning is associated with high-quality teaching decisions, effort, or interesting reading material and so on. Second, a global attitude toward a behavior might be assessed directly, i.e., without specifying underlying beliefs. For example, pre-service teachers might simply be asked to indicate how useful they consider evidence-informed reasoning to be for teaching quality. Both approaches only correlate moderately with each other (Ajzen, 1991), which might be because they are accessed via different mental processes: A global attitude might depend more on implicit memory, whereas rating specific beliefs must be performed in a more rational-analytic way relying on declarative memory (Ajzen, 1991). Since the former approach is feasible without exact knowledge about which beliefs are salient in a specific situation, we applied the global measurement approach in the present study.

To conceptualize a global attitude toward a behavior, we use a distinction between four dimensions of value proposed by Eccles and Wigfield (2002): (a) utility value, (b) attainment value, (c) intrinsic value, and (d) costs. *Utility value* reflects the perception of the likelihood that a behavior will result in outcomes that are positively valued by the individual. For example, a given teacher behavior might lead to better learning results among their students, which the teacher might highly value. *Attainment value* represents how strongly an individual identifies with the behavior, i.e., perceives the behavior in question as part of their identity or self. A pre-service teacher might conceive of being able to apply evidence-informed reasoning to teaching problems as a key professional competence of a teacher. *Intrinsic value* describes the direct perceived effect of the behavior on the individual themselves while executing it. For example, a pre-service teacher might believe that evidence-informed reasoning might help achieve deep insight into what is going on with their students and find this genuinely interesting. *Costs* refer to the perceived time and energy needed to engage in the respective behavior: Pre-service teachers might find evidence-informed practice useful, important, and interesting, but believe it takes too much time and effort.

Subjective Norms. Fishbein and Ajzen (2010) distinguish between injunctive and descriptive variants of subjective norms. *Injunctive norms* reflect what relevant others think is supposed to be done in a specific situation, whereas *descriptive norms* represent the actual behavior of relevant others. Pre-service teachers might believe they ought to base their teaching on scientific evidence or that other teachers actually use evidence-informed reasoning in their classrooms. These two kinds of norms influence an individual's behavior in different ways: While injunctive norms might induce an expectation of receiving rewards or punishments as a result of enacting the behavior, descriptive norms might offer clues on what is sensible in a specific situation (Fishbein & Ajzen, 2010). The pre-service teachers above might believe that they will be admonished by their principal if they fail to use evidence-informed reasoning or might believe that using evidence-informed reasoning when solving problems in the classroom could be useful because other teachers seem to do so as well.

Perceived Behavioral Control/Self-Efficacy. Even if a certain behavior is attractive and there is social pressure to execute this behavior, individuals might still not carry it out. This happens when they believe that their abilities and/or the circumstances prevent them from successfully executing the behavior in question. Thus, perceived behavioral control is defined as the belief that one is "capable of performing a given behavior" (Fishbein & Ajzen, 2010), which is identical (Ajzen, 1991) to how Bandura (1997) defined self-efficacy beliefs. Therefore, we use "self-efficacy" hereafter in this article because this term is more widely used. To illustrate this concept, think of a pre-service teacher who believes that evidence-informed reasoning is valuable for solving a teaching problem and that others appreciate it as well, but only acts accordingly when they believe they are actually able to perform evidence-informed reasoning.

Empirical Findings Regarding Motivationally Relevant Antecedents of Pre-Service Teachers' Evidence-Informed Reasoning

Several studies suggest that attitudes toward evidence-informed reasoning predict the respective intention and behavior. Uhlenbrock (2019) showed that the more useful pre-service teachers perceived evidence-informed reasoning, the more strategic knowledge of how to prevent typical errors in evidence-informed reasoning they developed when analyzing case vignettes of problematic classroom situations. They also developed more procedural knowledge on how to identify errors, and more positive attitudes toward, more subjective knowledge of, and more interest in educational science theories. In another study with pre-service teachers, Kiemer and Kollar (2018) found a small but significant relation between general attitudes towards research on learning and instruction and actual engagement in cognitive processes of scientific reasoning, indicating that the more positive students' attitudes towards research on learning and instruction were, the more frequently they engaged in scientific reasoning processes. Similar results have also been found for in-service teachers (e.g., Haney et al., 1996; Lysenko et al., 2014; Rochnia & Trempler, 2019). Thus, overall, there are clear indications that attitudes towards evidence-informed reasoning are a substantial predictor of the respective intention and behavior.

There is also evidence that teachers' subjective norms regarding evidence-informed reasoning may predict intention and behavior. In one study, Demski (2018) asked 1527 teachers and principals how intensively they use different knowledge resources based on scientific evidence in their school practice. A subsample of 35 persons was interviewed regarding their reasons for or against using research-based knowledge resources. The only interview participants who reported using evidence to inform their pedagogical behavior were employed at schools where average evidence usage was highest. This finding can be interpreted tentatively as an effect of a school climate favoring evidence-informed practice: When colleagues use evidence in their practice (= descriptive norm), teachers are more likely to engage in evidence-informed practice themselves. A study by Veal et al. (2016) provides evidence that an injunctive norm is also associated with actual teaching behavior. They found innovative teaching practices to be related to the corresponding injunctive norm about what ought to be done in science teaching. For example, teachers who thought that science is primarily about facts and the most important part of instruction is curricular content used fewer innovative teaching practices than teachers who disagreed with these statements. These results might analogously apply to evidence-informed reasoning. Thus, overall, the literature suggests both kinds of subjective norms to be relevant for engagement in evidence-informed reasoning.

Finally, the relevance of teachers' self-efficacy for evidence-informed reasoning has also already been subject to investigation, albeit with mixed findings: In one study, Anderson et al. (1988) found

evidence for a relation between teaching self-efficacy and teachers' reasoning skills, at least when comparing extreme groups (teachers scoring highest vs. lowest in self-efficacy). In contrast, teachers' personal self-efficacy was significantly related to student achievement, while teaching efficacy and teachers' reasoning skills were not significantly related. In another study, Çevik and Andre (2013) had their participants analyze cases that referred to classroom management problems and decide upon solutions. The quality of these decisions was associated neither with self-efficacy nor with participants' confidence in the correctness of their decisions. According to the authors, this might be due to the general, only domain- but not task-specific nature of self-efficacy measures. However, these studies examined theoretical constructs slightly different from evidence-informed reasoning as investigated here. In the study by Lysenko et al. (2014), participants' scores on items referring to self-efficacy were positively related to the extent to which teachers used research-based information. In conclusion, findings regarding the association between self-efficacy and evidence-informed reasoning about classroom-related problems appear to be mixed. Based on the results by Anderson et al. (1988) and Lysenko et al. (2014), though, we assume that acting in an evidence-informed way while reasoning about classroom situations should be related to self-efficacy if the latter is measured in a context-specific way.

Hypotheses

Previous research seems to indicate the power of the theory of planned behavior to explain (pre-service) teachers' engagement in evidence-informed reasoning. However, the studies reported above either investigated the predictors in isolation from each other or grouped them into theoretically heterogeneous constructs (Lysenko et al., 2014). Thus, the relative importance of attitudes, subjective norms, and self-efficacy still needs to be determined. In addition, only a few studies have investigated pre-service teachers, although a lack of evidence-informed reasoning is a practically relevant problem that teacher education should address as early as possible. Thus, our goal was to determine to what extent attitudes, subjective norms, and self-efficacy predict pre-service teachers' engagement in evidence-informed reasoning when confronted with classroom-related challenges.

We formulated the following hypotheses:

1. Pre-service teachers' engagement in evidence-informed reasoning is predicted by their intention to engage in evidence-informed reasoning and their self-efficacy to perform this behavior.
2. The intention to engage in evidence-informed reasoning depends on various dimensions of (a) attitudes toward evidence-informed reasoning, (b) subjective norms regarding evidence-informed reasoning, and (c) self-efficacy to perform evidence-informed reasoning.

Method

Sample

Participants were $N = 157$ pre-service teachers ($M_{Age} = 22.76$, $SD = 3.54$, 70.1% female) enrolled in two different educational psychology classes at two German universities. On average, students were in their fifth semester of studies ($M_{Sem} = 4.87$, $SD = 2.05$). At this point, students should already have acquired a rich body of knowledge regarding psychological theories and evidence to draw from when engaging in evidence-informed reasoning. In contrast, they typically have not gained substantial practical experience at this point. We report how we determined our sample size, all data exclusions, data from all experimental conditions, and all study measures relevant to the current research question. Regarding sample size, we collected data from all students enrolled in

the courses without intermediate data inspection or a second wave of data collection. The final sample size was determined by the class size, since analyzing the cases in the study was a mandatory part of the class. Participation in the other aspects of data collection was voluntary, but no one opted out. After data collection, we excluded eight students from the analysis at t3 who scored below 3 on a scale from 0 to 10 asking how conscientiously they worked on the assignment. The study complies with European rules regarding privacy protection and the ethical guidelines of the German Psychology Association. The dataset is available here: https://doi.org/10.23668/psycharchives.5660

Procedure

The data were collected in the context of a larger study (a comprehensive overview of the design and materials is available here: https://osf.io/u78xa/). In this larger study, after a pre-test (t1), two training sessions (t2 and t3) asked participants to use psychological theories and evidence to analyze written case vignettes of about 460 words describing problematic classroom situations. There was no variation in vignettes between participants, i.e., each case vignette was presented to every participant. One vignette had to be analyzed in the pre-test and two in each training session. For example, in the pre-test vignette, a language teacher is handing back a marked dictation exercise to his class. During this process, two students exchange their thoughts about their assumed performance. Finally, the teacher reaches them and comments on their performance while giving them back their dictations. Both the students' and the teacher's utterances contained statements that can be considered problematic from an attribution theory (Weiner, 1985) or achievement goal theory (Elliot & McGregor, 2001) perspective. For instance, the teacher said: "Lea, you've had another stroke of luck. One point less and it would have been a D + ." This statement attributes Lea's success[1] to an external and variable cause (luck) rather than an internal and variable cause, such as Lea's effort. The vignettes differed in the problems that had to be analyzed: In the first case, problems related to achievement goals and attribution, while in other cases, the problems concerned the cognitive theory of multimedia learning (Mayer, 2014), social cognitive theory (Bandura, 1986), and so on. This variation in topics was necessary to provide the students with varying learning opportunities and avoid simple reproduction from previous cases.

The analysis of each vignette was structured as follows: First, participants read evidence texts that presented summaries of two theories from educational psychology (i.e., two out of achievement goal theory, attribution theory, the cognitive theory of multimedia learning, social cognitive theory, self-regulated learning, multi-store model of memory). Second, they were instructed to identify problematic aspects of teachers' and pupils' behavior in the vignette with the help of the evidence texts. Third, participants were asked to analyze these problematic aspects one by one. To do so, students were provided with the general prompt at t1: "Now please analyze the identified problem using the theory summaries." At t3, students were guided through the analysis of each problem step-by-step (description, explanation, goal setting, and action planning; a sample analysis is provided in Table 2 in the appendix).

During training (t2 and t3), participants were offered support in applying evidence-informed reasoning to their analyses (varied in an experimental 2×2 design: theory summaries with vs. without examples as well as prompts with different levels of detail to support student engagement in the different steps of evidence-informed reasoning while analyzing the case vignettes, see https://osf.io/u78xa/ for details). A post-test (t4) and a follow-up (t5) measured the acquired skills and knowledge and their stability.

For this article, data from t1 (pre-test) and t3 (second training session, irrespective of experimental condition) were used. In t1, participants first completed several general trait measures and then

analyzed a first case vignette (without guidance). After that, they completed a questionnaire measuring the predictor variables of the current study, i.e., attitudes, subjective norms, and self-efficacy regarding evidence-informed reasoning. To measure the dependent variables, i.e., intention and behavior, we used data from the second training session to implement a time lag of two weeks so that the direction of causality of potential effects between predictors and criterion variables can be interpreted in light of the longitudinal design. By that time, students were expected to have gained experience with the specific format of the analyses during the training. Hence, their perceptions of their intentions should already be rather precise by then. Intentions to engage in evidence-informed reasoning were measured before students analyzed the two vignettes in that session (t3).

Objective behavior was assessed by coding the first of these two case analyses (see below). In this case vignette, a math teacher shows his class how to draw points in a coordinate system. However, he has difficulties explaining the concept so that students can easily grasp it. For example, he shows a video that alternates between drawings and written explanations, which violates teaching principles derived from the cognitive theory of multimedia learning (Mayer, 2014). Accordingly, this case vignette had to be analyzed using summaries of the cognitive theory of multimedia learning (Mayer, 2014) and social cognitive theory (Bandura, 1986). Subjective behavior was measured afterwards.

Instruments. **Attitudes Toward Application of Educational Science Knowledge.** Using a scale from Stark et al. (2018), participants indicated on twelve items from 1 (*not at all true)* to 5 (*absolutely true)* how much value they attribute to the structured application of educational science knowledge to teaching problems. All items were phrased using the same sentence stem: "The structured application of educational science knowledge to teaching problems…". Following the model by Eccles and Wigfield (2002), the scale consisted of the facets (1) utility value (sample item: "… is useful for me to learn"), (2) attainment value (sample item "… is important for me personally to learn"), (3) intrinsic value (sample item: "… is very interesting"), and (4) cost (sample item: "… is a waste of time"). A confirmatory factor analysis yielded a good model fit ($X^2(48) = 71.62$, $p = .015$, CFI = .98, TLI = .97, RMSEA = .06, SRMR = .04, all robust estimates) for the theoretical four-factor structure, which also was clearly superior to a one-dimensional solution, which might have been reasonable given the rather high factor covariations. Cronbach's alpha was satisfactory ($\alpha = .78/.81/.85/.84$).

Subjective Norms Regarding Application of Educational Science Knowledge. Participants indicated on six items from 1 (*not at all true*) to 5 (*absolutely true*) their subjective norms regarding the structured application of educational science knowledge to teaching problems. The items were newly constructed for this study. The scale consisted of the two facets (1) injunctive and (2) descriptive norms. Three injunctive norm items were phrased using the sentence stem: "People who influence my later teaching behavior (e.g., other teachers, persons in teacher education) think that I should use educational science knowledge to…" (sample item: "… identify teaching problems"). Three descriptive norm items were phrased using the sentence stem: "I believe that professional teachers use educational science knowledge …" (sample item: "… to identify teaching problems"). A confirmatory factor analysis yielded a very good model fit ($X^2(7) = 9.55$, $p = .215$, CFI = .99, TLI = .99, RMSEA = .06, SRMR = .05, all robust estimates) after including a residual covariance between the first items of each subscale, which is probably due to very similar item phrasing. The two-factor solution was clearly superior to a one-factor solution. Cronbach's alpha was good ($\alpha = .88/.86$).

Self-Efficacy Regarding Application of Educational Science Knowledge. Participants indicated on three items from 1 (*not at all true*) to 5 (*absolutely true*) their self-efficacy regarding the structured application of educational science knowledge to teaching problems. The items

were adapted from the Allgemeine Selbstwirksamkeit Kurzskala (ASKU; Beierlein et al., 2014). All items were phrased using the sentence stem: "In the structured application of educational science knowledge to teaching problems, …" (sample item: "… I can rely on my abilities in difficult situations"). Cronbach's alpha was $\alpha = .77$.

Intention to Apply Educational Science Knowledge. Participants indicated their intention to apply educational science knowledge to teaching problems in a structured way on five items from 1 *(not at all true*) to 5 *(absolutely true*). The items were newly constructed for this study and were based on the dimensions of the problem analysis students were asked to conduct, i.e., identification, description, and explanation of problematic aspects of the classroom situation, goal setting, and action planning (see above). All items used the same sentence stem: "In the following case analyses, I want to use educational science knowledge in a structured way to …" (sample item: "… explain teaching problems"). Cronbach's alpha was $\alpha = .80$.

Behavior Regarding Application of Educational Science Knowledge. Behavior was measured both subjectively and objectively: At the subjective level, participants rated their actual behavior while analyzing the case study on five items from 1 (*not at all true*) to 5 (*absolutely true*). The same items as for the measure of *Intention* were used with the sentence stem: "In the previous case analyses, I actually used educational science knowledge in a structured way to …". Cronbach's alpha was $\alpha = .78$. At the objective level, each written problem analysis was coded with respect to the presence or absence of the six formal steps of analysis derived from the literature (e.g., description: "Does the analysis include paraphrases of the presented problems in the participant's own words?"; explanation: "Does the analysis include a cause-and-effect model?"; e.g., Van Es & Sherin, 2008), and with respect to the content-related quality with which these steps were executed (e.g., "Does the description reflect the problem in the case vignette without altering its meaning?", "Is the explanation of the problem correct?"). All codes were dichotomous (0 = no, 1 = yes). The analyses in the pre-test were objectively coded with a global rating regarding the presence or absence as well as the correctness of each step of the analysis on a Likert scale from 0 to 4. Participants' analyses were coded manually by two independent raters (average rater agreement for all variables and cases: Gwet's AC1 = .82, determined by independently coding 10% of the material).

The objective measure of behavior for the statistical analyses was calculated by standardizing and then averaging (a) the number of reasoning aspects formally present in each problem analysis (possible values from 0 to 6), and (b) the proportion of correct or meaningful reasoning aspects (possible values from 0 to 1). For the pre-test scores, the ratings for the number of formally present aspects and their correctness were also standardized and then averaged.

Analyses. Factor scores were determined by calculating confirmatory measurement models for each predictor group separately and saving the factor scores generated by the regression method. We then calculated a confirmatory model with the second-order factors (attitude toward evidence-informed reasoning and subjective norms) and self-efficacy using the manifest factor scores calculated before. This was followed by a series of exploratory models that will be explained below. The pre-test scores were integrated into all models to control for a priori inter-individual differences in scientific knowledge and reasoning skills. All confirmatory factor analyses (CFA) and structural equation modeling (SEM) were performed in R [version 4.0.0] (R Core Team, 2020) with the R-package lavaan [version 0.6-6] (Rosseel, 2012), using maximum likelihood as the estimator since the data was approximately normally distributed, and with full-information maximum likelihood to handle missing values. The analysis script and output are available here: https://osf.io/u78xa/

Results

Descriptive results are shown in Table 1. The mean attitudes toward the behavior were highly positive, while the means of subjective norms and self-efficacy were more in the middle of the scale. Average intentions and subjective behavior were rather in favor of applying educational science knowledge to teaching problems. Intention was associated with all predictors except for injunctive norms and self-efficacy. The pattern of associations for subjective behavior was similar to that of intention; however, injunctive norms together with self-efficacy instead of descriptive norms were significantly associated with subjective behavior. Objective behavior in the pre-test was significantly associated with utility and intrinsic value, injunctive norms, intention, and subjective and objective behavior. Beyond that, objective behavior at t3 was also significantly associated with perceived behavioral costs, but not with the other predictors.

To test our hypotheses, we calculated a confirmatory path model, which yielded an insufficient model fit ($X^2(6) = 17.56$, $p = .007$, CFI = .89, TLI = .63, RMSEA = .11, SRMR = .06). Therefore, we exploratorily added paths regressing behavior directly on attitude based on modification indices (see Figure 2) to achieve a sufficient fit ($X^2(2) = 1.40$, $p = .50$, CFI = 1, TLI = 1, RMSEA = 0, SRMR = .01). In this model, subjective behavior was directly predicted by not only intention and self-efficacy, but attitude as well. Objective behavior was only predicted by pre-test behavior, but not by the other predictors. Interestingly, subjective and objective behavior were not related. Intention to engage in evidence-informed reasoning was only predicted by attitude. Consequently, the indirect path from attitude via intention to subjective behavior was also significant, $\beta = .11$, $p = .004$.

To obtain a more differentiated understanding of the antecedents of evidence-informed reasoning, a second exploratory model used the first-order factors as predictors. To find the best predictor set, we used a stepwise reduction method. Therefore, all first-order factors (e.g., utility value, injunctive norm, self-efficacy etc.) entered a saturated, perfectly fitting model with BIC = 1528.058. Then, using single Wald tests, we determined which path led to the least decrease in overall model fit when fixed to zero. Afterwards, we fixed this path to zero and calculated the model again. We proceeded with this procedure until further trimming would have resulted in a

Table 1. Means, Standard Deviations, and Correlations.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. utility	4.20	0.59										
2. attainment	4.07	0.63	.76*									
3. intrinsic	3.73	0.74	.64*	.74*								
4. costs	1.64	0.64	−.58*	−.64*	−.63*							
5. injunctive	3.95	0.74	.36*	.34*	.27*	−.29*						
6. descriptive	3.10	0.90	.28*	.25*	.21*	−.22*	.38*					
7. self-efficacy	3.62	0.60	.13	.17*	.20*	−.03	.20*	.21*				
8. intention	4.01	0.50	.36*	.40*	.31*	−.25*	.15	.21*	.14			
9. behavior	3.83	0.54	.38*	.37*	.32*	−.18*	.21*	.14	.23*	.50*		
10. objective behavior (t1)	0.00	0.70	.18*	.11	.19*	−.10	.18*	−.04	.07	.22*	.25*	
11. objective behavior (t3)	0.00	0.39	.05	.03	.14	−.21*	.04	.06	−.13	−.02	−.08	.18*

*$p < .05$.

significant ($p < .05$) decrease in overall model fit. The final trimmed model (see Figure 3) yielded an improved BIC = 1152.649, with a still excellent model fit ($X^2(16) = 17.69$, $p = .34$, CFI = 1, TLI = 1, RMSEA = .03, SRMR = .05). As in the second-order factor model, subjective behavior was predicted by intention and self-efficacy. In addition, a direct path from utility value to subjective behavior remained, mirroring the association with attitude in the exploratory second-order factor model. Intention, in turn, was predicted by attitude, specifically attainment value, descriptive norms, and objective behavior at pre-test, but not by self-efficacy. Objective behavior was negatively predicted by costs and self-efficacy, but not by intention.

Discussion

In this study, we assumed that pre-service teachers' evidence-informed reasoning might be explained by a model derived from the theory of planned behavior (Ajzen, 1991). However, this model yielded an inacceptable fit to our empirical data. This might mean that the structural assumptions of this theory are not appropriate for the field of evidence-informed reasoning, at least in our study context. Therefore, we conducted two exploratory analyses to better understand the empirical relations. Both models suggest that the intention to engage in evidence-informed reasoning is less central for predicting behavior than the theory of planned behavior proposes. In addition, the second model seems to suggest that differentiating between specific attitudes toward evidence-informed reasoning yields a differentiated pattern of attitude effects. However, the results from this first-order model need to be interpreted with caution, as the included attitude predictors covary strongly. To summarize, the theory of planned behavior could only be confirmed partly for subjective behavior, and not at all for objective behavior. For this reason, we will first discuss the results for subjective behavior and intention, and then turn to the results regarding objective behavior.

The first exploratory model is a simple adaptation of the hypothesized model with additional direct paths. In line with H1, it indicates that pre-service teachers who intend to engage in evidence-informed reasoning seem to be more likely to report doing so when analyzing classroom situations. This positive link between teachers' intention and behavior was also found in other studies (e.g., Knauder & Koschmieder, 2019; Schüle et al., 2016; Yan & Sin, 2014). Moreover,

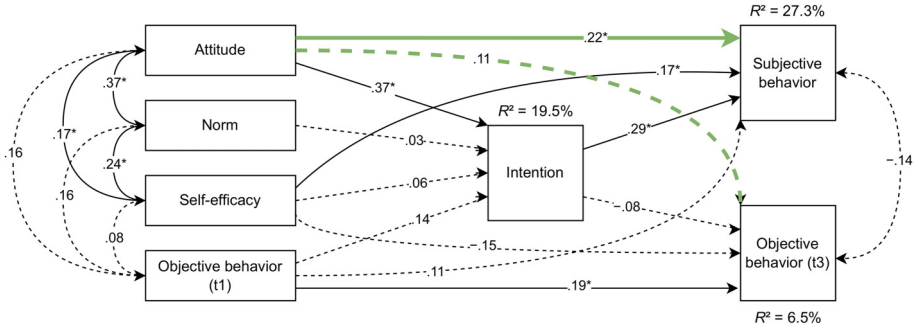

Figure 2. Second-Order Factor Path Model Predicting Evidence-Informed Reasoning.
Note. Attitude, subjective norms, and self-efficacy predict intention to engage in evidence-informed reasoning and subjective and objective engagement in evidence-informed reasoning, while controlling for prior skill in evidence-informed reasoning. Coefficents presented are standardized linear regression coefficients. Bold green paths were added exploratorily based on modification indices.
*p < .05, two-tiled. Dashed lines indicate non-significant effects with p > .05.

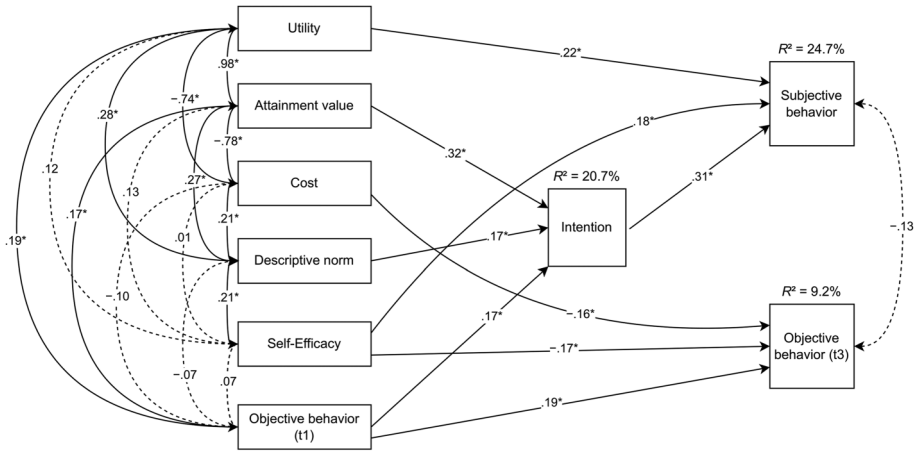

Figure 3. First-Order Factor Path Model Predicting Evidence-Informed Reasoning.
Note. Utility value, attainment value, perceived costs, descriptive norms, and self-efficacy predict intention to engage in evidence-informed reasoning and subjective and objective engagement in evidence-informed reasoning, while controlling fo prior skill in evidence-informed reasoning, Coefficients presented are standardized linear regression coefficients.
*$p < .05$, two-tailed.

the more confident pre-service teachers feel in advance about being able to engage in evidence-informed reasoning, the more they report actually engaging in evidence-informed reasoning afterwards. This association between self-efficacy and subjective reasoning behavior corresponds with the theory of planned behavior as well as the findings of Lysenko et al. (2014). In addition to the hypothesized paths, the exploratorily added direct paths from attitude to behavior indicated that subjective behavior was predicted by attitude. The first-order factor model suggests that utility value might be the driving attitude component responsible for this relation. Therefore, perceiving evidence-informed reasoning as useful might foster subsequent subjective appraisal of behavior, without mediation by intention. This might be interpreted as evidence that self-reported subjective behavior might represent wishful thinking more than precise observation of one's own behavior, especially given that university students might be not skilled enough to correctly evaluate their own behavior (Dunning, 2011).

H2 assumed that intention should be predicted by attitudes toward evidence-informed reasoning, subjective norms regarding evidence-informed reasoning, and self-efficacy. This hypothesis was only partially supported: Pre-service teachers seem more likely to form an intention to engage in evidence-informed reasoning when they hold a positive attitude towards this behavior. The first-order factor model tentatively indicates that this might especially be the case when they find doing so personally important. This is in line with findings of positive associations between attitudes toward evidence-informed reasoning and teaching practice (Kiemer & Kollar, 2018; Lysenko et al., 2014; Uhlenbrock, 2019).

Contrary to our assumptions, subjective norms did not predict intentions significantly. This would mean that pre-service teachers' intention to engage in evidence-informed reasoning is independent of how strongly they think that in-service teachers do so or relevant others think they should do so. This finding would contrast findings by Demski (2018) and Lysenko et al. (2014), who found associations between use of research-based information and factors referring

to the social environment. However, the first-order factor model pointed towards that the aggregation to create a global norm factor might have obscured a more specific effect: Descriptive norms were significantly related to intention to engage in evidence-informed reasoning, while injunctive norms were not. This might imply that the more pre-service teachers believe that in-service teachers engage in evidence-informed reasoning, the stronger their intention to do so as well. Considering the potential effects of attainment value and descriptive norms together, in-service teachers may be interpreted as professional role models for pre-service teachers, which is why it might be attractive for pre-service teachers to act like them, especially when they identify with this kind of behavior (Beauchamp & Thomas, 2009; Hammerness et al., 2005), as captured by high attainment value. In contrast, injunctive norms refer to social pressure, which might not be actively felt by pre-service teachers still enrolled in university. Therefore, such norms might not yet affect their behavior, resulting in non-significant associations with current intentions. Possibly, though, injunctive norms might become more important once these teachers actually enter schools after completing their studies.

Finally, self-efficacy was not significantly associated with intention. Thus, it does not seem to matter for their intention to engage in evidence-informed reasoning how efficacious pre-service teachers expect themselves to be. From a theoretical perspective, these results might be interpreted in light of the fact that students still enrolled in university might find behavioral aspects that apply right now more motivating compared to those that will only take effect later on, once they are actually standing in front of students. This explanation is supported by Eren (2012), who discovered that pre-service teachers who are more strongly future-oriented in general are more likely to hold high standards for their future teaching practice (academic emphasis), to feel confident in their ability to form trusting social relationships (with parents and students), and to feel self-efficacious regarding their future teaching (teacher efficacy).

From a methodological perspective, the lack of further unique effects on intention apart from attainment value might be due to the high covariations and large proportions of shared variance between attitude predictors. This interpretation is corroborated by the positive bivariate correlations between all attitudes and intention. This might also explain why Uhlenbrock (2019), who investigated utility value only, found effects on evidence-informed reasoning behavior that mirror the direct effect on subjective behavior in the present study. Injunctive norms, however, were not associated with intention in either bivariate correlations or the multivariate path model. Since Lysenko et al. (2014) only report a positive relation between use of research-based information and the organizational factor as a whole, for which only four out of eight items are thematically related to the injunctive norm, it is impossible to determine which of the items included in this factor were responsible for the association. Similarly, Veal et al. (2016) measured what participants thought "ought to be done". This does indeed reflect a form of injunctive norm, but is slightly different from how the theory of planned behavior and the present study operationalize injunctive norms: In our study, it is the norms other people are thought to hold which are measured. In Veal et al. (2016), it is the norm the subject themselves applies. Thus, subjects might identify more with these norms in comparison to norms other people hold.

The results discussed so far only apply to subjective behavior. A different pattern of results was found for objectively coded evidence-informed reasoning behavior. First, intention to engage in evidence-informed reasoning was not related to objective behavior. On the one hand, this might mean that good intentions are not sufficient to implement new behavior, especially given that the intended behavior is complex and not habituated yet (Sheeran & Webb, 2016). On the other hand, aspects of evidence-informed reasoning may not be considered as planned behavior, rendering intentions irrelevant (Reder & Schunn, 2014).

In addition, self-efficacy was not related to objective behavior in the second-order factor model, and was actually negatively related in the first-order factor model. Possibly, unskilled participants might have not been aware of their lack of competence (= Dunning-Kruger effect, Dunning, 2011), which might have counteracted the usually positive effects of self-efficacy (e.g., Lysenko et al., 2014).

The combination of the interpretations discussed above might also account for the lacking relation between subjective and objective behavior: Objective behavior might be a difficult, new behavior, which is not completely controlled by intentional processes, with which the participants are so unexperienced that they cannot accurately assess it yet. This may result in the measurement of subjective behavior to rather reflect participants' wish to exhibit useful behavior than actual behavior.

Yet, in line with the theory of planned behavior, the first-order model seemed to suggest that objective behavior might be predicted by perceived costs of this behavior: Pre-service teachers who belief that it is not worth the effort seemed to tend to engage less intensively in evidence-informed reasoning.

Limitations and Conclusions

Of course, this study is not without limitations. First, some of the associations might have been affected by common method bias, memory effects, or social desirability. Even though we cannot rule out these possibilities, the longitudinal design could have reduced these effects to some extent, as our participants might have forgotten their answers to the pre-questionnaire by the case analysis two weeks later. For example, the socially desirable goal to act in coherence with one's previously stated attitudes would usually bias subjective ratings of one's own behavior. However, the large time interval between measurements should make this effect less likely due to reduced recall of previous answers. Second, the associations with injunctive norms might be distorted because they were measured without specifying a reference point (e.g., teacher educators at university or teachers in schools). Different groups might hold different injunctive norms; thus, averaging across these groups might have lowered potential effect sizes. Third, we measured pre-service teachers' attitudes, subjective norms, and self-efficacy to engage in evidence-informed reasoning specific to the study context and the kind of analysis to be conducted. However, we did not specify the kind of teaching problem or the psychological theories to analyze it prior to measurement. Thus, future studies should provide students with information on the kinds of problems they will analyze prior to assessing their motivationally relevant appraisals. Finally, the current study might provide students with relatively optimal conditions to execute evidence-informed reasoning (e.g., all necessary theory texts were provided along with the problems to analyze, no time constraints, analyses were structured by prompts). This might have increased the mean levels of the variables, but also affected the relations between variables.

Despite these limitations, our findings have implications for both future research and practice. For research, the results of the present study emphasize that pre-service teachers' attitudes, subjective norms, and self-efficacy to engage in evidence-informed reasoning need to be assessed in a fine-grained manner, since specific aspects of attitudes, norms, and intention seem to have specific effects on subjective and objective behavior. Furthermore, pre-service teachers seem to have difficulty accurately assessing their own reasoning, which renders assessment of actual behavioral data necessary. The fact that intention was not related to objective behavior suggests that the theory of planned behavior might not fully account for all aspects of behavior in evidence-informed reasoning, even though the behavior is consciously executed.

For practice, our results point to different potential approaches to foster evidence-informed reasoning. When seeking to motivate pre-service teachers to engage in evidence-informed practice, one might at first glance seek to emphasize that they should do so (= strengthening injunctive

norms) and that doing so is useful (=increasing utility value; e.g., Uhlenbrock, 2019). Instead, it might be more important to make sure that intentions affect actual behavior. Therefore, pre-service teachers should receive sufficient training on the necessary skills, so that they can act on their intentions. Incorporating feedback into this process might also help to decrease potentially detrimental effects of overconfidence. In order to support such training, potential interventions should focus on helping pre-service teachers see evidence-informed reasoning as cost-efficient, i.e., that they achieve more with less effort when they rely on evidence to solve classroom problems.

Once reasoning skills are acquired, focus might shift to their actual deployment by raising pre-service teachers' intention to engage in evidence-informed reasoning behavior by increasing perceived descriptive norms and attainment value instead of utility value. For example, when designing pre-service teacher curricula, professional teachers could be involved in motivating pre-service teachers: If actual teachers model evidence-informed reasoning in authentic situations (Hammerness et al., 2005), it might raise pre-service teachers' perceptions of other teachers' behavior (=descriptive norms) and identification with this behavior (=attainment value).

In sum, our results provide evidence that augmenting pre-service teacher education with role models for engaging in evidence-informed reasoning might be a promising way to help pre-service teachers appreciate evidence-informed reasoning, which should go hand in hand with interventions aimed at developing their evidence-informed reasoning skills.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Deutsche Forschungsgemeinschaft, (grant number KO-3462/3-1, STA 596/8-1).

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Note

1. In the German grade system, a C – would still be considered "satisfactory".

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Appendix

Table 2. Example Case Analysis.

Excerpt from the case vignette to which the case analysis refers:
[…] Mr. Staudacher has drawn a coordinate system on the board before the lesson. Right next to it, he has written down the coordinates of four points. He decides to first show the students how to enter the points into the coordinate system without explaining what to focus on in detail. Then, he asks the students to copy the coordinate system including the points into their notebooks. […]
Participant's case analysis
You identified the following problem in the step before:
"He decides to first show the students how to enter the points into the coordinate system without explaining what to focus on in detail."
Please describe the selected problem in your own words.
"The teacher is doing something without explaining it, even though it's a new topic. The children don't know what to look for in the demonstration."
Please explain the problem based on the two evidence summaries.
"According to the cognitive theory of multimedia learning, it is wrong that the teacher demonstrates transferring the points to the class completely without providing explanations. The theory states that more learning occurs when the content to be learned is presented textually and pictorially rather than exclusively textually. In this math lesson, the content is presented only visually, which violates the two-channel hypothesis. This states that two channels of information (visual and auditory/textual) should be addressed in order to maximize learning. Accordingly, Mr. Staudacher needs to look at working memory capacity as well."
Based on the two evidence summaries, please derive what goal the teacher should strive for in the classroom to improve the current problem situation. Do not develop concrete options for teacher actions yet. First, define a goal; actions necessary to reach this goal will be selected later.
"From the point of view of the two-channel hypothesis, the teacher would also have to give an oral explanation during a visual presentation (i.e., blackboard picture) in order to achieve success."
Please develop as many concrete, immediately actionable, and observable options as possible for how the teacher could have achieved this goal in the current classroom situation.
"The teacher should explain the topic step by step while drawing the coordinate system and the points on it."