Conceptions of scientific knowledge influence learning of academic skills: epistemic beliefs and the efficacy of information literacy instruction

Tom Rosman[a], Johannes Peter[a], Anne-Kathrin Mayer[a], and Günter Krampen[ab]

[a] *Leibniz Institute for Psychology Information (ZPID), Universitaetsring 15, D-54296 Trier, Germany*

[b] *University of Trier, Universitaetsring 15, D-54296 Trier, Germany*

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Correspondence concerning this article should be addressed to Tom Rosman, Leibniz Institute for Psychology Information (ZPID), Universitaetsring 15, D-54296 Trier, Germany, Phone: 0049-651-201-2284, E-Mail: rosman@zpid.de

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Abstract

The present article investigates the effects of epistemic beliefs (i.e., beliefs about the nature of knowledge and knowing) on the effectiveness of information literacy instruction (i.e. instruction on how to search for scholarly information in academic settings). We expected psychology students with less sophisticated epistemic beliefs (especially multiplicistic students viewing psychological knowledge as inherently subjective) not to recognize the value of differentiated information searches and of the respective instructional courses. In a first intervention study with 67 psychology students, multiplicism was shown to reduce information-seeking skills students gain throughout the intervention. In a second intervention study with 64 psychology students, students with higher multiplicistic beliefs subjectively benefited less from the information searches carried out during instruction (in terms of reduced increases in subjective topic-specific knowledge). In conclusion, we recommend including elements from epistemic belief instruction into information literacy instruction.

Keywords: epistemic beliefs; absolutism; multiplicism; information literacy; instruction

1 Introduction

Epistemic beliefs and information-seeking share a lot of common ground. In fact, it is not surprising that individual conceptions about the origin and nature of knowledge (i. e., epistemic beliefs) determine how one approaches the tools and methods to acquire such knowledge. Students with unsophisticated beliefs – who view scientific knowledge as either an accumulation of absolute 'truths' or as purely subjective 'opinions' – will likely not see much sense in sophisticated information-seeking or in information literacy instruction. For example, Barbara Hofer (2004) argues that a student who perceives knowledge as absolute and certain will not be motivated to seek additional evidence or to integrate different pieces of information. Moreover, she suggests that epistemic beliefs not only have consequences for information-seeking behavior as such, but also for the amount of topic-specific knowledge students gain through searching on a specific subject (in other words, what they *learn* about the complexity and richness of their search topic by means of information-seeking).

In contrast, students viewing scientific knowledge as nuanced and contextual might have more elaborate criteria for what constitutes "good" learning. For example, they might expect learning to be complete 'when different pieces of information are related to one another and critically evaluated from multiple perspectives.' (Bromme, Pieschl, and Stahl 2010, 15). This entails, on a more tangible level, that they spend more time on planning their information search, try to access a multitude of information sources, or conduct more focused searches (Hofer 2004; Pieschl, Stahl, and Bromme 2013). It is therefore likely that such students will not only conduct more elaborate information searches, but also benefit more from information literacy instruction.

Even though some research on the relationship between epistemic beliefs and

information-seeking exists, no studies have yet been conducted on the association between epistemic beliefs and how students learn to search for scientific information. An abundance of research – mostly from the information sciences – underlines that information-seeking skills do not develop on their own, but require extensive instruction (e.g., Warwick et al. 2009). The present research therefore investigates epistemic beliefs as a moderator of information literacy instruction effectiveness in terms of both information literacy gains (e.g., increases in information-seeking skills) and the practical benefit students pull out of information literacy instruction (i.e., increases in topic-specific knowledge).

2 Background

2.1 Information literacy

The Association of College and Research Libraries (ACRL; 2000) defines information literacy as a set of individual skills and abilities necessary to recognize an information need and subsequently to locate, evaluate, and use the required information. Information-seeking behavior constitutes an important prerequisite for information literacy since it refers to actual behavior regarding the location and evaluation of information (Birke et al. 2014; Boon, Johnston, and Webber 2007; Rosman, Mayer, and Krampen 2015). Information literacy (and information-seeking) are important for self-regulated learning since they allow learners to actively construct their knowledge, for example by weighting of evidence for a certain theory or hypothesis (Joo, Bong, and Choi 2000; Johnston and Webber 2003; Brand-Gruwel, Wopereis, and Vermetten 2005). In line with this, the American Psychological Association (APA) views information literacy as one central learning goal psychology students are required to

achieve (American Psychological Association 2013).

On the other hand, students often show insufficient information-seeking skills (Bawden and Robinson 2009), especially with regard to searching in bibliographic databases (Rosman, Mayer, and Krampen 2016). For example, many use inadequate search queries, refer to Google instead of academic search engines, and do not even possess basic knowledge on information evaluation (e.g., cannot distinguish between peer-reviewed journal papers and magazine articles). Moreover, research shows that information-seeking skills do not necessarily develop on their own (Warwick et al. 2009). Information literacy instruction is therefore crucially important not only for students' achievement, but also to help students become independent thinkers and active, self-regulated learners. In fact, we strongly agree with Bruce's (2004) position that 'the significance of information literacy education lies in its potential to encourage deep, rather than surface learning, and in its potential to transform dependent learners into independent, self-directed, lifelong learners' (4). Helping students find their way in a digitalized world is more important now than ever, especially since the tools and methods to do so are often highly complex and user-"unfriendly" (Rosman, Mayer, and Krampen 2016).

In his so-called Australian and New Zealand Information Literacy (ANZIIL) Framework, Alan Bundy (2004) distinguishes between four components of information literacy instruction. *Generic* instruction consists of extracurricular classes and/or self-paced packages. In contrast, the other three components (e.g., parallel, integrated, and embedded instruction) take into consideration that information literacy is discipline-specific. *Parallel* instruction also consists of these classes and packages, but in contrast to generic instruction, complements the respective curriculum. *Integrated* instruction consists of classes and packages that are part of the curriculum. The most sophisticated

form of information literacy instruction, called *embedded* instruction, is a curriculum design drawing on ongoing interaction and reflection with information (Bundy 2004). Unsurprisingly, embedded instruction is seen as the most effective form of instruction, since students not only learn how to search for information, but also become aware of their learning and are required to transfer their learning experiences to new contexts (Andretta 2005). In fact, combining "theoretical" instruction with authentic learning tasks (e.g., using the results from course-specific searches to write a seminar paper; Artman, Frisicaro-Pawlowski, and Monge 2010) will, according to contemporary instructional design models, facilitate knowledge transfer and learning efficacy (van Merriënboer and Kirschner 2013). Parallel, integrated, and embedded forms of instruction are always – at least to a certain extent – discipline-specific (because search tools differ from one discipline to another).

2.2 Epistemic beliefs

Despite numerous *best practice* examples on how to design good information literacy instruction, not all students benefit equally from such instruction. In fact, beliefs about the nature and changeability of knowledge, knowing, and abilities have long been shown to influence learning and information processing (e. g., Perry 1970; Dweck 2006), and might lead to students standing in their own way when developing their information-seeking skills. Hofer and Pintrich (1997) define epistemic beliefs as individual conceptions about knowledge or knowing in a certain domain or field. Based on Perry's scheme of the intellectual and ethical development (1970) and Piaget's Theory of Intellectual Development (1972), Kuhn (1991) describes the development of epistemic beliefs as a sequence of three consecutive steps which are characterized by different, sometimes even opposing, conceptions of knowledge and knowing. The stage

of *absolutism* is defined by a dualist, right-or-wrong, truth-or-untruth view of knowledge (Hofer and Pintrich 1997). Upon dismissal of this conception, individuals move into a stage called *multiplicism*. Knowledge is now viewed as inherently subjective: individuals see different opinions as equally valid and exchangeable, and therefore become fully arbitrary in their view on science (*radical subjectivity*; Hofer and Pintrich 1997). Finally, individuals who reach the stage of *evaluativism* realize that they themselves are part of the knowledge generation process. Moreover, they acknowledge that in science, argumentative positions differ in their quality and therefore require evaluations of truthfulness and weighting of evidence.

Individual conceptions about knowledge and knowing have been shown to influence knowledge acquisition and information processing (e.g., Rodriguez and Cano 2007; Pieschl, Stahl, and Bromme 2013). For example, a view of science as an accumulation of facts and truths (absolutism) relates to superficial learning and information processing (Schommer 1990). Individuals with absolute beliefs are likely not motivated to integrate information from various sources if they assume one source to be correct and all other sources to be wrong. Moreover, Bråten, Strømsø, and Samuelstuen (2008) as well as Bråten et al. (2013) found that a view of knowledge as inherently subjective (multiplicism) might also be maladaptive. They argue that multiplicism might lead to superficial information processing and therefore entail a lack of cohesion and integration in mental representations (Bråten et al. 2013).

Apart from these effects of epistemic beliefs on information processing, epistemic beliefs also influence higher-order processes that regulate information-seeking (e.g., Hofer 2004). ‘Metacognitive control’ describes an individual’s tendency towards ‘regulating or fine-tuning and adjusting activities, such as changing a course of action by implementing a new tactic or strategy or enacting a previous one’ and has

been shown to be influenced by epistemic beliefs (Muis and Franco 2010, 38). One might therefore suppose that students with sophisticated beliefs alter their information-seeking strategies to gain a more integral and differentiated overview over a specific subject. Moreover, a view of knowledge as context-dependent and personally constructed requires more personal initiative when searching for and evaluating information. Students with more sophisticated epistemic beliefs might, for example, spend more time on planning their search, consult multiple information sources, or conduct more focused searches (Hofer 2004; Bromme, Pieschl, and Stahl 2010; Pieschl, Stahl, and Bromme 2013).

Conversely, since they conceive scientific knowledge as an accumulation of purely subjective 'opinions' (Hofer and Pintrich 1997), especially students with strong multiplicistic beliefs will likely not put much effort into evaluating and weighting different positions to issues. In their view of knowledge as entirely personally constructed, they might put more emphasis on figuring out issues on their own instead of consulting experts in the respective field (e.g., by searching for relevant literature). We therefore propose that multiplicistic beliefs hinder both information-seeking and learning processes aiming at acquiring information-seeking skills. This might be particularly relevant for domains exhibiting a structure that facilitates multiplicistic thinking (e.g., 'soft' sciences). For example, the enormous complexity of human behavior has resulted – over the years – in a significant amount of contradictory findings in psychology, which in turn facilitates the development of multiplicistic beliefs in psychology students (Muis, Bendixen, and Haerle 2006; Peter et al. 2015; see also Kaartinen-Koutaniemi and Lindblom-Ylänne 2008). On the other hand, absolute beliefs have been shown to be relatively low in psychology students (Green and Hood 2013).

3 The present article

Information-seeking skills do not necessarily develop on their own, which highlights the crucial role of information literacy instruction (Arp et al. 2006; Warwick et al. 2009). We suggest two beneficial outcomes of information literacy instruction. First, on the level of the search process, information literacy instruction enables students to search for and evaluate information more effectively (i.e., it fosters their information-seeking skills): students should, for example, develop knowledge on how to use bibliographic databases or formulate adequate search terms, and get to know different criteria they might employ to evaluate the quality of information (e.g., peer review, journal impact factor, etc.).

Second, on the level of search outcomes, information literacy instruction should enable students to develop broader and more comprehensive knowledge on the topics they inquire, thus allowing them to become critical and independent thinkers and to gain expertise in their field. For example, they should become more aware of the central concepts, authors, and methodological approaches in their subject and develop a better overview over the current state of research because they become able to do more elaborate information searches.

This relationship between epistemic beliefs and information-seeking has been found in several studies (e.g., Hofer 2004; Bromme, Pieschl, and Stahl 2010; Kammerer and Gerjets 2012). The present article seeks to add to this research by suggesting that epistemic beliefs not only influence information-seeking as such, but also play a crucial role in information literacy instruction, especially with regard to the two outcome levels

described above. In an effort to investigate this, we conducted two intervention studies, which are described below.

4 Study 1

The first study focused on the effects of epistemic beliefs on information literacy instruction effectiveness conceptualized as an increase in information-seeking skills (level of the search process). We presumed that students with unsophisticated epistemic beliefs would not recognize the value of information-seeking (Hofer 2004) and would therefore be less motivated to enhance their information-seeking skills. With regard to absolutism, Hofer (2004) argues that 'if knowledge is [viewed as] simple, there is little need to seek further evidence or to integrate information from multiple sources' (53). Regarding the second stage of Kuhn's model (1991), students with high multiplicistic beliefs will likely prefer to figure issues out all by themselves instead of relying on information searches solely returning 'opinions' of unreliable and untrustworthy 'experts'. On a most tangible level, highly absolute and/or multiplicistic beliefs would thus entail a reduced information-seeking proficiency gained through information literacy instruction.

Hypothesis 1: Epistemic beliefs moderate information literacy instruction effectiveness on the level of the search process. Higher levels of absolutism (H1a) and multiplicism (H1b) will be associated with lower increases in information-seeking skills as a consequence of information literacy instruction.

4.1 Method

4.1.1 Standardized information literacy instruction

With the intent of fostering psychology undergraduates' information-seeking skills, a discipline-specific blended learning course was developed. The course focused, in part, on the utilization of bibliographic databases, the generation of search terms, and on criteria suited to evaluate the quality of discovered information (e.g., peer review, journal impact factor, etc.). Instructional content was primarily conveyed via online learning modules (drawing on, for example, short expository texts and multimedia tutorials). Most online modules also included standardized exercises (i.e., information search tasks on predefined topics). The online modules were complemented by problem-based face-to-face instruction that employed constructivist teaching principles (e.g., discussion, question sessions, etc.) and aimed at strengthening and deepening students' understanding of the content. Thus, the instruction primarily uses elements from the *parallel* component of Bundy's ANZIIL framework (2004), but also makes recourse to some features of the *embedded* component (e.g., discussion of learning contents and reflection over students' learning processes).

To minimize the impact of potential nuisance factors in the measurement of instruction effectiveness, instruction was highly standardized: every participant performed exactly the same exercises and attended the same modules. The course took approximately 10 hours (about seven hours of online learning and three hours of face-to-face-learning).

4.1.2 Participants and procedure

A field experimental study using a three-wave design (i.e., with three measurement points) and a waiting list control group was carried out. Epistemic beliefs and baseline information-seeking skills were assessed at the first measurement point (t1). Participants

were then randomly split up into two groups with only one group (EG1) undergoing the intervention. After four weeks, information-seeking skills were measured a second time (t2). Thereafter, the other group (EG2), who had served as untreated control group from t1 to t2, underwent the intervention. After another four weeks, information-seeking skills were measured a third time (t3) in both groups. All data collections took place in groups of 13 to 20 students in a computer lab at a large German university.

In sum, $N = 67$ psychology undergraduates ($n = 34$ second semester and $n = 33$ fourth semester bachelor students) participated in the study. Participants were 78 % females and 22 % males, and $M = 21.67$ ($SD = 2.38$) years old. Participants were recruited by means of flyers and a mailing list inviting them to take part in a study on an information literacy intervention. All participants were paid for their participation in the data collections (that were mandatory for study participation). The first group (EG1) consisted of $n = 37$ students, the second group (EG2) of $n = 30$ students.

4.1.3 Measures

Information-seeking skills were measured by the ILT-P information literacy test (Leichner et al. 2013). The multiple-choice test contains 35 items which focus on both information-seeking (e.g., knowledge about bibliographic databases, the library catalogue, interlibrary loan, etc.) and information evaluation (e.g., knowledge about peer review, journal impact factor, etc.). Most items have three response options, of which none, one, two, or all three can be correct. For example, students are asked which publication types are indexed in bibliographic databases, and can choose between (a) journal articles (correct), (b) books (correct), and (c) relevant web resources (wrong). Test scores are obtained through a standardized scoring key.

Epistemic beliefs were measured by the German EBI-AM questionnaire (Peter 2015; Peter et al. 2015), which is based on established epistemic belief measures (e.g., Schommer 1990; Hofer 2000; Elder 2002). It contains 23 epistemic statements that are to be rated on 5-point Likert scales. Its central advantage is that it measures absolutism (12 items) and multiplicism (11 items) on separate scales, thus allowing the separate consideration of absolute and multiplicistic beliefs. Moreover, the questionnaire may be used to assess epistemic sophistication beyond the developmental stage of multiplicism. Peter et al. (2015) refer to this as 'evaluativism'. Following a view of epistemic sophistication as a more cautious and reluctant endorsement of both absolutism and multiplicism, they assume evaluativism to be reflected by low levels of agreement with both types of statements (see also Elby and Hammer 2001 and Bråten, Strømsø, and Samuelstuen 2008).

4.2 Results

Table 1 shows means, standard deviations, intercorrelations, and reliabilities of all study variables. In line with other studies on psychology-specific epistemic beliefs, absolute beliefs were fairly low, whereas multiplicistic beliefs were rather pronounced (e.g., Muis, Bendixen, and Haerle 2006; Green and Hood 2013). To investigate changes in information-seeking skills over the study, ILT-P scores from the first (t1) and third (t3) measurement point were used. Scores from the second measurement point (t2) were discarded because only one group (EG1) had undergone the intervention by then. Both groups (EG1 and EG2) did not differ significantly at the first measurement point (t1) with regard to absolutism ($t[65] = 1.27$; $p = ns$), multiplicism ($t[65] = 0.43$; $p = ns$), and

ILT-P scores (t[65] = 0.78; p = *ns*). Additional calculations[1] revealed a highly significant increase in information-seeking skills throughout the intervention (t[66] = 17.29; $p < .001$).

Table 1. Means, standard deviations, intercorrelations, and reliabilities of Study 1 variables

	M	***SD***	**1**	**2**	**3**	**4**
1 ILT-P (t1)	21.17	2.32	**(.63)**			
2 ILT-P (t3)	26.42	1.95	.33**	**(.55)**		
3 Absolute beliefs	2.12	0.52	.14	-.11	**(.72)**	
4 Multiplicistic beliefs	3.46	0.44	.00	-.24*	.12	**(.56)**

Note: ILT-P = information-seeking knowledge; t1 = first measurement point; t3 = third measurement point; *M* = arithmetic mean; *SD* = standard deviation; Values in bold on the diagonal = Cronbach's Alpha.

* $p < .05$.

** $p < .01$.

To test Hypothesis 1, two separate multiple regressions (one for absolutism and one for multiplicism) were calculated. ILT-P scores of the third measurement point (dependent variable) were regressed on ILP-P scores of the first measurement point and on epistemic beliefs. A positive beta weight of epistemic beliefs (absolutism or multiplicism) indicates that epistemic beliefs indeed influence the change in ILT-P scores (Cronbach and Furby 1970). Since both intervention groups (EG1 and EG2) had undergone treatment at different time points and data from the second measurement

[1] Further information on this can be found in Leichner et al. (2014).

point (t2) was discarded from our analysis, we statistically controlled – in a second step – for study condition (EG1 vs. EG2). Moreover, we controlled for study progress (in semesters), as study progress has been shown to correlate both with information-seeking skills (Rosman, Mayer, and Krampen 2015) and with epistemic beliefs (Peter et al. 2015), which might cause artificial correlations.

As shown in Table 2, the beta weight of absolutism is negative (β = -.16). Even though the coefficient is only marginally significant ($p < .10$), this indicates that students with high absolute beliefs might benefit less from information literacy instruction. We therefore see Hypothesis 1a as partially supported. With regard to multiplicism (see Table 3), the respective beta weight was negative and significant (β = -.24; $p < .05$). This indicates that the increase in ILT-P scores as a consequence of the training is indeed lower for students with high multiplicistic beliefs. Beta weights stay significant when including the control variables. Hypothesis 1b is thus fully supported.

Table 2. Multiple regression predicting information-seeking knowledge (t3) from information-seeking knowledge (t1), absolute beliefs, and control variables

	ILT-P (t3)		
	β	R^2	ΔR^2
Block 1		.14**	
ILT-P (t1)	.36**		
Absolute beliefs	-.16+		
Block 2		.16*	.02
ILT-P (t1)	.36**		

Absolute beliefs	-.18^{+}
Study progress	.08
Group (experimental Group 1 vs experimental Group 2)	-.12

Note. ILT-P = information-seeking knowledge; t1 = first measurement point; t3 = third measurement point; β = standardized regression weight; *R2* = total variance explained; $\Delta R2$ = change in *R2*.

+ $p < .10$.

* $p < .05$.

** $p < .01$.

Table 3. Multiple regression predicting information-seeking knowledge (t3) from information-seeking knowledge (t1), multiplicistic beliefs, and control variables

	ILT-P (t3)		
	β	R^2	ΔR^2
Block 1		.17**	
ILT-P (t1)	.33**		
Multiplicistic beliefs	-.24*		
Block 2		.19**	.02
ILT-P (t1)	.33**		
Multiplicistic beliefs	-.25*		
Study progress	.10		
Group (experimental group 1 vs. experimental group	-.10		

2)

Note. ILT-P = information-seeking knowledge; t1 = first measurement point; t3 = third measurement point; β = standardized regression weight; *R2* = total variance explained; $\Delta R2$ = change in *R2*.

* $p < .05$.

** $p < .01$.

4.3 Discussion

The first study aimed to investigate the effects of epistemic beliefs on the effectiveness of information literacy instruction with regard to increases in information-seeking skills. We hypothesized that students with more unsophisticated epistemic beliefs (high absolutism and/or multiplicism) would acquire less proficient information-seeking skills upon their participation in information literacy instruction than students with more sophisticated beliefs.

With regard to absolutism, results were in the expected direction but only marginally significant ($p < .10$). We suggest the rather low absolute beliefs in psychology students to be responsible for this slightly disappointing finding. In fact, Green and Hood (2013) suggest that studying psychology fosters epistemic sophistication, because 'psychology focuses on critical thinking, through emphasis on research methods and integrating knowledge from multiple theoretical perspectives' (171). We therefore suppose that the shift from absolutism to multiplicism that often occurs at the beginning of college (King and Kitchener 2002) had already happened in most of our participants by the time of study. In that sense, only very few strong absolute thinkers might have remained in our sample. Even though there were slight individual differences in absolute beliefs, these variations might have happened on rather differentiated levels (i.e., all our subjects would have acknowledged that one

cannot find absolute truths in psychology, even though their certitude on this slightly varied). Statistically speaking, a floor effect might thus be responsible for the rather low effects of absolutism on information literacy instruction effectiveness.

With regard to multiplicism, our hypothesis was fully supported. High levels of multiplicism indeed impede information literacy instruction efficacy. This again supports our previous assumptions that (1) excessive multiplicism might be a grave danger for psychology students (Peter et al. 2015), and that (2) epistemic belief interventions should focus on buffering excessive multiplicism rather than on reducing absolutism by conveying undifferentiated views of psychology as tentative and evolving (Rosman et al. 2015).

5 Study 2

Along with the numerous advantages of our highly standardized design in Study 1 comes a downside. On the level of search outcomes, it is not suited to investigate how students eventually use the taught skills for their own research and study. ‘Objective’ improvements in information-seeking skills do not necessarily imply that students use the newly acquired skills for searches on their own topics. On this account, a second study investigated whether the findings from Study 1 would be transferable to more naturalistic settings.

As for the level of search outcomes, we assume students with more sophisticated epistemic beliefs to be more open-minded regarding variability in concepts, theories, and methods related to their search topics; in addition, they should be ready to acquire comprehensive knowledge about the most important authors and information sources in their field. In that sense, such students would reflect more intensively on searches

conducted during and after information literacy instruction and therefore pull out more topic-specific knowledge. Moreover, highly multiplicistic students will likely refuse – despite having acquired the respective information-seeking skills – to evaluate information according to the criteria suggested in the instruction (e.g., author or journal reputation). Instead, they might again just strive to figure issues out on their own. According to Psychological Reactance Theory (Brehm 1966), this will especially be the case when someone feels pressured to use certain techniques (e.g., to evaluate information by relying on specific evaluation criteria). In sum, we assume information literacy instruction to be of less practical value for students with unsophisticated beliefs because they will likely be less inclined to employ the taught information-seeking skills for real-world searches, which in turn impairs topic-specific knowledge gains. We suggest the following hypothesis:

Hypothesis 2: Epistemic beliefs moderate information literacy instruction effectiveness on the level of search outcomes. Higher levels of absolutism (H2a) and multiplicism (H2b) will be associated with lower increases in topic-specific knowledge as a consequence of information literacy instruction.

5.1 Method

5.1.1 Individualized information literacy instruction

The instruction employed in Study 2 was a variation of the first instruction that again employed a blended learning concept. Nevertheless, several differences regarding the degree of standardization exist between the two instructions. First, students were encouraged to search on their own topics when doing the exercises in the online modules (i.e., search for literature they would need for their bachelor/master thesis).

Moreover, the 90-minute face-to-face session now explicitly focused on specific problems students encountered when searching for information on their *own* topics (for example, they were encouraged to ask questions, etc.). Finally, as it targeted more advanced students (advanced undergraduates and graduate students), not all online modules were mandatory: students completed an information literacy test (a modified version of the ILT-P; Leichner et al. 2013) prior to their participation in the study and subsequently – depending on their prior knowledge – were given recommendations which online modules they would likely benefit from. This was in line with our goal of providing individualized instruction and allowing students sufficient time to focus on their own searches and issues.

In sum, the course primarily focused on specific skills that individual students would require to conduct their own study-related and topic-specific searches, and put less emphasis on conveying general information-seeking skills. In contrast to the teaching concept employed in Study 1 (i.e., *parallel* instruction complemented by *embedded* instruction), the instruction uses more embedded components, especially since students were required to apply their new skills to their own topic-specific searches (transfer of learning). The intervention (online modules and a 90-minute face-to-face module) took, depending on participants' prior knowledge, three to seven hours. All modules were to be completed within one week.

5.1.2 Participants and procedure

Study 2 employed a simple pre-post design. Epistemic beliefs and topic-specific knowledge were measured at pre-test stage (t1); topic-specific knowledge was measured again at post-test stage (t2) one week later. All data collections took place in groups of 8 to 18 students in a computer lab at a large German university.

N = 64 psychology students participated in the study (*n* = 31 bachelor students in their sixth semester or higher; *n* = 33 graduate students seeking a master's degree). Participants were 88 % females and 12 % males; mean age was *M* = 24.97 (*SD* = 3.63). Participants were again recruited by means of flyers and a mailing list and paid for their participation in the data collections.

5.1.3 Measures

Topic-specific knowledge was measured by the topic-specific subjective knowledge scale (TSSK), which was specifically designed for our study. A self-report format was used because of the unstandardized format of the instruction, as allowing students to search on their own topics makes it impossible to use a standardized topic-specific knowledge test. All items relate to potentially positive outcomes of a topic-specific information search on topic-specific knowledge. For example, we assumed that successful searchers would become more acquainted with topic-specific terminology, learn about influential journals and authors in their field, and get a comprehensive overview over different methodological approaches to their topic. Seven items of this kind were developed. Items were answered on a 5-point Likert scale and can be found in the Appendix.

Epistemic beliefs were again measured by the EBI-AM (Peter 2015; see Study 1).

5.2 Results

Table 4 shows means, standard deviations, intercorrelations, and reliabilities of all study variables. Again, students reported rather low absolute and moderate to high multiplicistic beliefs. Moreover, a highly significant increase in TSSK scores

throughout the intervention was found ($t[63] = 8.26$; $p < .001$). To test Hypothesis 2, two separate multiple regressions (one for absolutism and one for multiplicism) were calculated, and TSSK scores of the second measurement point were regressed on TSSK scores of the first measurement point and on epistemic beliefs. A positive beta weight of epistemic beliefs indicates that these indeed influence changes in TSSK scores throughout the instruction (Cronbach and Furby 1970). As in Study 1, we controlled for study progress because it has been shown to correlate with both information-seeking and epistemic beliefs which might cause artificial correlations.

Table 4. Means, standard deviations, intercorrelations, and reliabilities of Study 2 variables

	M	***SD***	**1**	**2**	**3**	**4**
1 TSSK (t1)	2.35	0.73	**(.82)**			
2 TSSK (t2)	3.02	0.80	.64**	**(.87)**		
3 Absolute beliefs	1.97	0.40	.12	.12	**(.65)**	
4 Multiplicistic beliefs	3.20	0.51	-.06	-.22+	-.44**	**(.67)**

Note: TSSK = topic-specific subjective knowledge; t1 = first measurement point; t2 = second measurement point; *M* = arithmetic mean; *SD* = standard deviation; Values in bold on the diagonal = Cronbach's Alpha.

+ $p < .10$.

** $p < .01$.

Table 5. Multiple regression predicting topic-specific subjective knowledge (t2) from topic-specific subjective knowledge (t1), absolute beliefs, and control variables

	TSSK (t2)		
	β	R^2	ΔR^2
Block 1		.41***	
TSSK (t1)	.63***		
Absolute beliefs	.04		
Block 2		.41***	.00
TSSK (t1)	.63***		
Absolute beliefs	.04		
Study progress	.03		

Note. TSSK = topic-specific subjective knowledge; t1 = first measurement point; t2 = second measurement point; β = standardized regression weight; *R2* = total variance explained; $\Delta R2$ = change in *R2*.

*** $p < .001$.

Table 6. Multiple regression predicting topic-specific subjective knowledge (t2) from topic-specific subjective knowledge (t1), multiplicistic beliefs, and control variables

	TSSK (t2)		
	β	R^2	ΔR^2
Block 1		.44***	
TSSK (t1)	.63***		
Multiplicistic beliefs	-.19*		
Block 2		.44***	.00
TSSK (t1)	.63***		
Multiplicistic beliefs	-.19*		
Study progress	.01		

Note. TSSK = topic-specific subjective knowledge; t1 = first measurement point; t2 = second measurement point; β = standardized regression weight; *R2* = total variance explained; ΔR2 = change in *R2*.

* $p < .05$.

*** $p < .001$.

No significant effects of absolutism on TSSK changes were found ($\beta = .04$; p = *ns*; see Table 5). With regard to multiplicism, however, the respective beta weight was negative and significant ($\beta = -.19$; $p < .05$; see Table 6). This indicates that the increase in topic-specific subjective knowledge is indeed higher for students with lower multiplicistic beliefs. Including the control variables only causes very minor changes in beta weights. Hypothesis 2 is partially supported.

5.3 Discussion

The purpose of the second study was to investigate the effects of epistemic beliefs on the practical value students pull out of information literacy instruction. We hypothesized students with unsophisticated beliefs to be less inclined to employ the taught information-seeking skills for real-world searches, which in turn would impair topic-specific knowledge gains.

Our hypothesis was not confirmed for the absolutism scale. This is not particularly surprising because students again had relatively low absolute beliefs. One may therefore conclude that most students already had passed the shift from absolutism to multiplicism and that a floor effect of absolutism would be responsible for the nonsignificant results (see above). The fact that all participants were in their sixth semester or higher makes this explanation even more likely. With regard to multiplicism, our hypothesis was nevertheless confirmed: students with high multiplicistic beliefs indeed reported less topic-specific knowledge gains from the information searches conducted during instruction. In contrast, students with lower multiplicistic beliefs reported that they had become more acquainted with topic-specific terminology, learned about influential journals and authors in their field, and had gotten a comprehensive overview over different methodological approaches to their topic. This finding is particularly important as it shows that high multiplicism not only impairs the development of information-seeking skills in a standardized setting (Study 1), but also reduces the amount of topic-specific knowledge students pull out of unstandardized information searches.

Despite these encouraging findings, we acknowledge that our self-report measure for topic-specific knowledge might be less robust due to its subjective nature. To rule out potential effects of general self-efficacy, we formulated rather specific and

concrete items related to aspects of knowledge about the topic (see Appendix). Moreover, even if students with multiplicistic beliefs had only underestimated their objective knowledge gains (in the sense that there would be no actual relationship between epistemic beliefs and objective knowledge gains), this would nevertheless be an interesting finding. Multiplicism would then have inclined students to *think* that they did not learn much from their inquiries, which is intriguing because it might undermine their intentions to search for information in the future (Schunk 1991). We wish to point out that both explanations do not rule out each other, and advocate for future research on this point.

6 General Discussion

The present article investigates the influence of epistemic beliefs on information literacy instruction effectiveness. We assumed students with unsophisticated epistemic beliefs to be less motivated to acquire information-seeking skills, and to be less inclined to employ the taught information-seeking skills for real-world searches. The former would likely impair the development of information-seeking skills, whereas the latter would impair topic-specific knowledge gains.

Two studies were conducted to investigate our hypotheses. Study 1 employed a highly standardized design and found multiplicism (i.e., a view of scientific knowledge as inherently subjective) to significantly impair gains in information-seeking skills through information literacy instruction. Study 2, by drawing on a more naturalistic and less standardized design, found multiplicism to impair topic-specific knowledge gains that students pull out of information searches. Whether or not one may see this as a replication across measurement tools is beyond the scope of this article. Nevertheless,

we find it very interesting that with regard to multiplicism, our hypotheses were confirmed both in a highly standardized and in an unstandardized setting.

With regard to absolutism, findings were only marginally significant in Study 1, and not significant in Study 2. We were not particularly surprised about this. In fact, our previous research suggests that absolutism only plays a minor role in research on the personal epistemology of psychology students (e.g., Peter 2015; Peter et al. 2015; Rosman et al. 2015). That one cannot find absolute truths in psychology is – at least in our opinion – fairly evident and we assume that even first-year undergraduates incorporate this pretty quickly. Previous research supports this assumption (e.g., Paulsen and Wells 1998; Green and Hood 2013). The suggested shift from absolutism to multiplicism at the beginning of college might thus happen even earlier in psychology students, and we assume a floor effect of absolutism to be responsible for finding no corresponding effects.

Considering our somewhat specific sample, we nevertheless cannot rule out sample bias and domain specificity of results. Therefore, researchers should strive to replicate our results with regard to students more likely to have high absolute beliefs (e.g., law students; Karseth and Solbrekke 2006). Moreover, one might argue that both studies are prone to selectivity bias. In fact, one might suppose that students with unsophisticated beliefs would not be motivated to participate in studies on information literacy instruction because they do not recognize their value. Therefore, our samples might exhibit reduced variance in epistemic beliefs, thus narrowing the magnitude of potential negative effects of unsophisticated beliefs. This nevertheless also implies that the effects might be even higher in the general population of psychology students. Another potential limitation is that we were, due to sample size restrictions, not able to test the factorial validity of our epistemic belief inventory. We therefore have to rely on

the analyses by Peter (2015). Finally, the questionnaire's reliabilities as well as the relationships between the variables were rather low. This is a common problem in epistemic belief research, though (e.g., Schommer, Crouse, and Rhodes 1992; DeBacker et al. 2008), which might be accounted for by the rather abstract nature of the concept.

Our research has important implications both for curriculum design and for higher education policy. We first suggest gauging information literacy instruction quality not only by its effects on information-seeking skills, but also by its impact on topic-specific knowledge. In fact, higher scores in an information literacy test do not necessarily imply that students employ the newly acquired skills for their own searches. Study 2 nevertheless shows that encouraging students to search on their own topics during information literacy instruction entails increases in topic-specific subjective knowledge. We therefore suggest the TSST to be a suitable instrument to evaluate the effectiveness of corresponding instructional courses.

Regarding epistemic beliefs, both studies show that overly multiplicistic beliefs are a grave danger for information literacy instruction efficacy in psychology students. In contrast, evaluativistic beliefs (i.e., a view of scientific knowledge as interrelated, dynamic, and context-dependent) might well be helpful with regard to information literacy instruction. We therefore suggest including elements from epistemic belief instruction into course-integrated information literacy instruction. Consistent with a perception of (1) epistemic doubt (i.e., students questioning their existing beliefs), (2) epistemic volition (i.e., students' intention to devote sustained effort to changing their beliefs), and (3) specific resolution strategies (e.g., reflection and social interaction) as catalysts for epistemic belief change (Bendixen 2002), one may use constructivist teaching practices to foster epistemic sophistication (e.g., Muis and Duffy 2013; Rosman et al. 2015). For example, instructors could invite students to discuss pros and

cons of different bibliographic databases and article quality indicators. To take this further, they might even encourage students to seek for inconsistencies in their search results (e.g., contradictory studies) and subsequently resolve the controversies by adequately evaluating the quality of the discovered articles. This approach might be particularly suited to reduce multiplicism since it suggests that many scientific controversies *can* indeed be resolved, thus inducing epistemic doubt with regard to multiplicism. Group discussions and reflexive processes on study and/or article quality subsequently allow students to resolve their epistemic doubt through incorporating more sophisticated positions. In sum, we advocate for more *embedded* instruction, allowing students not only to learn information-seeking skills, but also to reflect on their newly made experiences and to apply these experiences to novel contexts (Andretta 2005). This appears particularly promising in an effort not only to connect, but to *integrate* epistemic belief and information literacy instruction, so that students can attain excellence in both these crucial areas of science education.

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8 Appendix

Topic-specific subjective knowledge scale (TSSK)

		not true at all				**very true**
TSSK_1	I can easily explain my topic to a layperson.	☐	☐	☐	☐	☐
TSSK_2	I know all central concepts of my topic and I can explain them adequately.	☐	☐	☐	☐	☐
TSSK_3	I have a comprehensive overview over different methodological approaches (e. g., measurement instruments) to my topic.	☐	☐	☐	☐	☐
TSSK_4	I have a comprehensive overview over the scientific literature on my topic (e. g., books, book chapters, journal articles).	☐	☐	☐	☐	☐
TSSK_5	If a fellow student asked me, I could spontaneously report on the current state of research on my topic.	☐	☐	☐	☐	☐
TSSK_6	I could spontaneously name important authors in my subject area.	☐	☐	☐	☐	☐
TSSK_7	I could spontaneously name several academic journals that regularly publish articles on my topic.	☐	☐	☐	☐	☐

Note: All items were administered in German language. The original items can be obtained from the authors.