



## Are students' beliefs about knowledge and learning associated with their reported use of learning strategies?

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**Background.** Although considerable research has examined beliefs and learning outcomes (e.g. Schommer, 1990, 1993a, 1993b; Schommer & Dunnell, 1997), little has looked at the relationship between beliefs and the actual learning process.

**Aims.** This research examines the relationship between beliefs about learning and knowledge, and reports of learning strategy-use relevant for successful text comprehension.

**Sample.** Participants were 81 Norwegian university students who had studied from 1 to 4 years in a range of disciplines.

**Method.** Students' beliefs about knowledge and learning were measured with the Schommer Epistemological Questionnaire (SEQ; Schommer, 1998b). Learning strategies particularly useful for text-based learning were measured with the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991). A correlational analysis between measures and full regression analyses of how beliefs influence strategy selection were performed.

**Results.** Beliefs about how thoroughly knowledge is integrated in networks (*simple*) and how fixed the ability to learn is from birth (*fixed*) contributed significantly to reported strategy use: *Simple* to rehearsal and organizational strategies, *fixed* to elaboration and critical thinking strategies, and a combination of *simple* and *fixed* to strategies relevant to the thoughtful monitoring of learning tasks. Beliefs about how certain knowledge is (*certain*) and how quickly learning can be expected to occur (*quick*) were not found to contribute to reported learning- strategy use in any significant way.

**Conclusion.** Some, but not all, beliefs about knowledge and learning offer insight into students' reported use of learning strategies relevant for reading course literature.

Is the way we think at the heart of the way we act? If so, then the manner in which students think about knowledge and learning deserves serious exploration in our quest to understand what drives students to learn the way they do.

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A healthy body of research related to epistemological beliefs has explored how students develop their attitudes towards knowledge and learning, as well as how those attitudes are associated with performance. Ryan (1984) took the first steps in establishing that epistemological beliefs, defined by Perry's scheme of dualists and relativists, do influence comprehension standards and criteria for monitoring those standards. He also found that these influences were significant predictors of grades, independent of academic aptitude or college experience. Although the findings were compelling, the study did not attempt to establish the relationship between students' standards and their actual learning practices. Indeed, performance has been the most frequently described outcome in research ever since. Therefore, more work is needed to understand how beliefs about knowledge and learning influence student engagement in the actual learning process prior to the achievement of those learning outcomes.

Do students' beliefs about knowledge and learning influence learning strategy choices while performing academic tasks? We began our investigation by clarifying the nature of beliefs, academic tasks, and learning strategies as they relate to the current study.

### **Beliefs about knowledge and learning**

Schommer (1998b) defines beliefs about knowledge and learning (frequently referred to as epistemological beliefs) as individually based systems of beliefs that are more or less independent of one another. Extending that definition, Jehng, Johnson, and Anderson (1993) define epistemological beliefs as 'socially shared intuitions' about the nature of knowledge and learning - intuitions based on what are regarded as 'the limits of knowing, the certainty of knowing, and the criterion of knowing' (p. 24). Accordingly, beliefs have been shown to vary from one individual to another as have the beliefs typical of discipline-specific learning cultures. For example, research has shown that younger learners tend to have more naïve beliefs than older learners (Schommer, 1998b), and this difference is amplified when the older learners have higher degrees of education (Jehng *et al.*, 1993; Schommer, 1998b). Likewise, students in 'soft' sciences tend to believe more than students in 'hard' sciences that knowledge is uncertain, acquired through independent reasoning, and not acquired in an orderly process (Jehng *et al.*, 1993).

In the last 10 years, at least three instruments have been created to measure epistemological beliefs as they are currently conceived (including beliefs about both knowledge and learning). Two of the measures are original (Schommer, 1998b; Spiro, 1989 cited in Jehng *et al.*, 1993) and one is a hybrid of the two (Jehng *et al.*, 1993). These instruments measure four (Schommer, 1998b) and five (Jehng *et al.*, 1993; Spiro, 1989 cited in Jehng *et al.*, 1993) dimensions of epistemological beliefs.

Schommer's measure is the best tested of the three, with a factor structure which she and her colleagues have replicated several times (e.g. Schommer, 1993a, 1998a, 1998b; Schommer, Crouse, & Rhodes, 1992) and normed for US high school students, college students, and adults (Schommer, personal communication, 1995). The Schommer Epistemological Questionnaire (SEQ) is structured around a set of 63 belief statements about which informants indicate on a 5-point Likert scale the degree to which they agree or disagree with each. High scores on the statements indicate what Schommer has termed a more naïve belief, and low scores indicate a more sophisticated belief. The beliefs measured with the SEQ are fixed ability (a belief spanning the naïve assumption that intellectual ability is fixed at birth to the sophisticated assumption one's

ability to learn can be improved over time), simple knowledge (a belief spanning the naïve assumption that knowledge is organized in isolated bits and pieces to the sophisticated assumption that knowledge is organized in networks of interrelated concepts), certain knowledge (a belief spanning the naïve assumption that knowledge is absolute to the sophisticated assumption that knowledge is tentative), and quick learning (a belief spanning the naïve assumption that learning happens quickly or not at all to the sophisticated assumption that learning happens gradually).

The SEQ (Schommer, 1998b) has been used in a comprehensive research programme to demonstrate how students' beliefs about the nature of knowledge affects comprehension (Schommer, 1989, 1990; Schommer *et al.*, 1992), problem-solving and academic performance (Schommer & Dunnell, 1997), student attitudes about school (Schommer & Walker, 1997), academic achievement (Schommer, 1993a, 1993b) and attrition (Schommer, 1993b). Differences in epistemological beliefs have also been documented in gifted and non-gifted students (Schommer & Dunnell, 1994), across time for high school students (Schommer, Calvert, Gariglietti, & Bajaj, 1997), and across academic domains (Jehng *et al.*, 1993; Schommer, 1995).

In the comprehension studies, Schommer's work indicates that beliefs do indeed influence reading comprehension and confidence (Schommer, 1990; Schommer *et al.*, 1992). In these studies, it was found that the belief regarding the certainty of knowledge was found to predict when people make inappropriately absolute conclusions about complex material (Schommer, 1990). The belief regarding the organization of knowledge was also found to interact directly with comprehension overconfidence, and both directly and indirectly with comprehension-based performance outcomes (Schommer *et al.*, 1992).

Although Schommer's research programme has been thorough in describing the relationship between epistemological beliefs and knowledge-related outcomes, far less attention has been paid to the work that learners engage in preceding their learning outcomes. For example, in only one of Schommer's studies has she actually investigated how SEQ measured epistemological beliefs may affect the actual process of knowledge acquisition (Schommer *et al.*, 1992). In that study, beliefs were found to directly influence learning outcomes. They were also found to influence those same outcomes indirectly. This was indicated by the beliefs' influence on reported learning-strategy use as measured by 2 of 10 Learning and Study Strategies Inventory (LASSI) subscales: information processing and test preparation (Weinstein, Palmer, & Schulte, 1987). Even though scores on all 10 subscales were measured, Schommer *et al.*, chose to focus only on the effects of these particular LASSI subscales because they measure the integration of knowledge. Information processing measures elaboration and critical thinking skills, and test preparation measures the use of task-appropriate tactics. However, the LASSI also measures how learners identify main ideas and self-test. Both of these strategies are, arguably, important for knowledge acquisition, yet their relationship with the SEQ measures were not reported.

Although Schommer's measure of epistemological beliefs and the LASSI are both based on statements about learning in general, in order to understand the relationship between epistemological beliefs and actual knowledge acquisition process, it would be informative to study how students engage in learning process when learning something specific. Because understanding texts is an important and central means of acquiring knowledge in university-level courses, we chose to study the learning skills associated with the cognitive and meta-cognitive management of knowledge acquisition when reading and working with written course material. Course readings are especially

critical at Norwegian universities (where this research was conducted) since lectures are typically not compulsory and exams are commonly based entirely on the reading curriculum.

### **Academic learning tasks and reading comprehension strategies**

Reading for a course at university typically involves effective comprehension of single texts, as well as the ability to integrate multiple texts and discourse from lectures. There are two critical elements in single-text comprehension. The first is the ability to create coherent sense of a single text's content. This process is facilitated, firstly, by making fundamental text-specific inferences to support the building of a coherent understanding of the text as a whole and, thereby, developing an understanding of it. This involves processing and understanding the individual ideas in the text (van Dijk & Kintsch, 1983). Through retaining these ideas in working memory, the reader is then able to develop a coherent text representation at the conceptual level. The more coherent the text is to a reader, the higher the probability that s/he will be able to retrieve that information later. The second step involves elaborating and critically analysing a text to develop a fuller sense of how connects to the reader's prior knowledge, thereby incorporating the text into a situation model (e.g. Dahl, 1991; Graesser & Britton, 1996; Kintsch, 1988, 1994; van Dijk & Kintsch, 1983).

Van Dijk and Kintsch (1983) broadly define two types of inferences that facilitate the construction of a coherent text representation: bridging inferences (those that connect text information with a reader's relevant prior knowledge), and elaborative inferences (those that add detail beyond the text's explicit and implicit content). Bridging inferences are essentially the glue that connects the individual propositions in a text into a coherent whole (Bradshaw & Anderson, 1982). Elaborative inferences are essentially the glue that links information in the text with readers' prior knowledge in order to create situation models.

Elaborating on these principles for single text comprehension, Perfetti, Rouet, and Britt (1999) have proposed the Documents Model of competent multiple text comprehension. Their model suggests that 'intelligent use of texts entails mental representations of specific texts, situations described in texts, and relations among texts' (p.99). The main ingredients for this model, then, are the text base and the situation models that readers have constructed from individual texts, and the inferences that connect these models to each other across multiple texts.

In the Documents Model, readers construct, to varying degrees, one or both of two sub-models (intertextual and situations) with the help of explicit or implicit inferences and elaborations.

Readers' Intertextual Models link each single text to other texts read. They are created from a map of document nodes that each include, for each text read, the content of the text (e.g. the text base model created) plus other information that the reader may have encoded about the author, rhetorical goals, and text source.

Readers' Situations Models then link interrelated facts, situations, or events that appear within the multiple texts into a coherent, complete, and accurate representation of common situations and ideas represented by several texts. Although a reader's Intertextual Model may render the resultant Situations Model redundant, this need not be the case depending upon how well readers associate the ideas they have learned with the texts from which they have learned them.

When a reader's intertextual and Situations Models interconnect, a full Documents Model is created. The nature of the document models that readers develop is likely to be dependent upon the nature of the task one reads for (Perfetti *et al.*, 1999). If one is able to recount who wrote what and how, one is more likely to invest in the use of strategies that facilitate intertextual model building. However, if one is able to recount what the big picture among texts is, one is more likely to invest in the use of strategies that facilitate Situations Model building. We believe that Situations Models are created more easily and implicitly than Intertextual Models, especially when readers have a high degree of relevant prior knowledge. Furthermore, we believe that Situations Models are more likely to follow from the building of Intertextual Models than vice versa. Therefore, the use of strategies for building a complete Intertextual Model are likely to have a greater effect overall on the effective building of full document models than use of strategies for building a Situations Model.

Strategic reading of multiple texts involves knowing the purpose of the reading task and evaluating which strategy to use to successfully accomplish the task just as much as it involves using on-line cognitive learning strategies. Strategic reading also requires a certain degree of metacognitive self-regulation to assure that the comprehension process proceeds as the reader desires (e.g. Coté & Goldman, 1999; Garner, 1987; Perfetti *et al.*, 1999; Pintrich, 1989). When readers are aware of their reading goals and register a discrepancy between their goals and progress, they may make adjustments in their strategy use in order to increase their chances of meeting their desired goal (e.g. Dahl, 1991). Whether this happens at the propositional, text base, or situational level depends on the nature of the perceived deficit.

Integral to these single and multiple text comprehension processes, then, is readers' activation of relevant prior knowledge, metacognitive awareness of their cognitive progress, and their knowledge of cognitive strategies that they can employ to facilitate current needs.

### **Measurement of learning strategies**

The Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich *et al.*, 1991) was developed to measure students' motivational orientations and use of cognitive learning strategies for any specified academic course. Five MSLQ subscales for measuring cognitive and metacognitive learning strategies nicely capture the strategies relevant for this study's questions. They measure students' self-reported use of strategies that help them grasp ideas within texts, and to connect them into broader themes and with their prior knowledge. These subscales are: (1) rehearsal strategies, which are positively associated with attention and encoding, but negatively associated with the making of connections within texts or with prior knowledge; (2) elaboration strategies, which are positively associated with the making of connections within texts and with prior knowledge; (3) critical thinking strategies, which are positively associated with how well students apply prior knowledge to current information; (4) organization strategies, which are positively associated with the selection of appropriate information with which to make connections to other concepts or prior knowledge; and (5) meta-cognitive and self-regulation strategies, which are positively associated with the planning, monitoring, and regulating of knowledge acquisition (Pintrich, 1989; Pintrich *et al.*, 1991).

The rehearsal strategies measured by the MSLQ represent skills that are important when learners want or need to master propositions within a text. Although these

strategies are weak tools in the construction of actual text base models and Intertextual Models, their strength lies in their use in attending to, and encoding, the elements with which the text base models are built. Text base models and Intertextual Models use propositional elements to create coherent summaries of text contents binding ideas within or among them through inferential processes, such as those measured by the MSLQ subscale, elaboration. For the process of creating a situation model that links prior knowledge to one's understanding of a text base, critical thinking skills used within or across texts help a reader see how ideas interrelate, and organization strategies used within or across texts help a reader see how ideas are structured. These skills may play different roles in the construction of a full Documents Model, with critical thinking skills contributing more to the construction of a Situations Model, and organization strategies contributing more to the construction of an Intertextual Model. For the process of monitoring one's progress along the way, the metacognitive and self-regulation strategies are essential.

Because of the links between the theories of (multiple) text comprehension and the concepts measured by the five MSLQ subscales, we determined that readers' subscale scores should be able to provide some insight into which strategies students would be likely to select when reading and making sense of text-based course material.

### **Measurement of beliefs about knowledge and learning**

Using the criteria suggested by Duell and Schommer-Aikins (2001) to select an instrument for measuring beliefs, we also determined that the SEQ could be a viable tool for our research. It is theoretically compelling, its dimensions are relevant to the main questions pursued in our research, it is easy to administer, it lends itself to cross-cultural comparisons, and Schommer's programme of research provided a rich contextual base from which to interpret our findings.

Additionally, the SEQ is the most used of the epistemological beliefs measures. However, it has not gone uncriticized. For example, the fact that the SEQ analyses are based on factor scores rather than the original raw items has been contested (Hofer & Pintrich, 1997). However, by using Schommer's method of transforming the SEQ raw scores to *z* scores, and then analysing them with the mechanism of the normed factor scores derived from a comparable US group, cross-cultural comparisons are possible. This is a quality absent in all of the other measures. The measure's reliability and validity as an instrument for measuring epistemological beliefs has also been contested (Clarebout, Elen, Luyten, & Bamps, 2001). In terms of reliability, the inter-item correlations that have been reported are comparable to those of other similar measures (Duell & Schommer-Aikins, 2001). In terms of validity, the current study is about the relationship among beliefs and reported practice and not about the nature of epistemology *per se*. This reservation is, therefore, unproblematic since in another critical study, Cole, Goetz, and Willson (2000) found that the subscales derived from a hybrid of Schommer's (1990) and Jehng *et al.*'s (1993) scales collapsed into two factors – the nature of learning, and the nature of knowledge – the very nature of the beliefs we were interested in investigating.

### **The study – the relationship between beliefs and academic learning**

Research has shown that students' perceptions about the stability of traits may serve an important role in how students think and act in academic settings

(Dweck & Legget, 1988; Heyman & Dweck, 1998). Intelligence is one factor that has been studied and found to have trait-like qualities. Belief in its innateness can have a profound effect on their persistence in the face of academic challenges (Dweck & Legget, 1988), particularly as one grows older (Cain & Dweck, 1995). When learning with the belief that one's intelligence is a fixed entity, students have been shown to engage in quick and superficial learning more than thoughtful, deep learning (Stipek & Gralinski, 1996). When they fail to succeed, they are also more likely to give up than to persist (Dweck & Leggett, 1988). Therefore, we hypothesized that students with naïve beliefs about the nature of intelligence (*fixed*) and how quickly learning can be expected to occur (*quick*) should report using effective learning strategies less than their more sophisticated scoring peers.

In examining whether students read texts in ways commensurate with their SEQ beliefs, Schommer *et al.*, (1992) found that only the belief about how knowledge is organized (*simple*) significantly interacted with study strategy use.

Finally, in a recent study that used think-aloud protocols with college students reading complex texts, it was found that beliefs about how quickly learning should occur (as measured by a subset of Schommer's items that measured facets of the *quick* factor) negatively correlated with the total number of strategies used by readers, as well as the use of intra-sentential and inter-sentential ties established between sentences (Kardash & Howell, 2000). Intra-sentential ties were used to 'resolve ambiguity by examining individual words and sentences', and inter-sentential ties were used to 'actively make connections between paragraphs and sentences as well as draw inferences based on their reading' (p. 535). Although the modified *quick* factor did not correlate significantly with total sentence recall, it did correlate negatively with the total number of distortions produced, with readers with more naïve beliefs producing more distortions than their more sophisticated scoring peers. They also found that readers with sophisticated beliefs about how certain knowledge is (as measured by a subset of Schommer's items that measured facets of the *certain* factor) used more strategies than their more naïve scoring counterparts to establish inter-sentential ties.

Given these findings, we wanted to explore whether the manner in which university students report using learning strategies when reading for their courses is influenced by their beliefs about knowledge and learning. This was done using the SEQ and five scales from the MSLQ. The main hypotheses were that more naïve beliefs measured by each of the SEQ scales would be associated with greater tendencies to use more rehearsal strategies and fewer elaboration, critical thinking, and organization strategies. They would also be associated with less metacognitive self-regulation.

## Method

### Participants

Undergraduate students were recruited from a medium-sized university and a large college in Norway. The 81 participants were fairly evenly divided across a range of disciplines from phonetics (6), psychology (10), social anthropology (10), sociology (10), medicine (25), and early child-care education (20). A total of 21 men and 60 women participated, with a mean age of 22.6 ( $SD = 6.4$ ). They had studied from between one half to 4 years at the university level (mean = 1.9 years,  $SD = 1.0$  years). Participation was voluntary.

### Materials

*The SEQ.* The students' beliefs about knowledge and learning were measured with a Norwegian translation of the SEQ. The SEQ had been translated into Norwegian for use in earlier studies (e.g. Kras & Lyng, 1999). One of the three translators was a native speaker of English, and the other two were native speakers of Norwegian. All were proficient speakers of the other language. The measure was first translated into Norwegian by the native speakers of Norwegian and then back-translated into English by the native speaker of English. The goal was to translate the items as literally as possible, deviating only when the literal translations altered the conceptual meaning of the items. In those cases, translations that preserved the meaning of the original item were used instead. Discrepancies in translations were resolved by the group until consensus for the Norwegian translation of the original English text was reached.

The SEQ consists of 63 items with statements about knowledge or learning. Of the 63 items, 28 are negatively worded. Students were instructed to respond to each of the statements on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). These items are transformed by factor scores from 12 subset scores into four measures of beliefs. The *simple* belief is composed of subscale scores based on items that capture how much students believe that one should avoid integrating material (e.g. 'Being a good student generally involves memorizing facts'), seek single answers (e.g. 'The best thing about science courses is that most problems have only one right answer'), avoid ambiguity (e.g. 'It's a waste of time to work on problems which have no possibility of coming out with a clear-cut and unambiguous answer'), and depend on authority (e.g. 'How much a person gets out of school mostly depends on the quality of the teacher'). The *fixed* belief is composed of subscale scores based on items that capture how much students believe that individuals can't learn how to learn (e.g. 'Self-help books are not much help'), the ability to learn is innate (e.g. 'The potential to learn is established at birth'), learning occurs with the first effort (e.g. 'Almost all the information you can learn from a textbook you will get during the first reading'), and success is unrelated to hard work (e.g. 'The really smart students don't have to work hard to do well in school'). The *quick* belief is composed of subscale scores based on items that capture how much students believe that the actual process of learning is quick (e.g. 'Successful students learn things quickly') and one should avoid criticizing authority (e.g. 'You can believe almost everything you read'). The *certain* belief is composed of subscale scores based on items that capture how much students believe that knowledge is certain (e.g. 'If scientists try hard enough, they can find the truth to almost anything').

Prior to the regression analyses, the SEQ subscale scores were transformed into the four epistemological factor scores of *simple*, *fixed*, *certain*, and *quick* using a procedure specified by Schommer (personal correspondence, 1995). The procedure entails creating *z* scores for 12 subscales, multiplying each *z* score by its respective factor coefficient provided by Schommer for the normed college student sample (see Table 1 for the mean factor scores).

The legitimacy for using this transformation procedure on Norwegian data was tested by comparing the Norwegian scores with the American norms. As indicated in Table 1, the mean SEQ scores of the Norwegian university student sample do not deviate significantly from the normed US university student sample (since their *z* score means are 0). However, the Norwegian sample shows less variation around the mean than the US sample (the standard deviation for the Norwegian sample being less than 1.0 on all four of the beliefs). Because the Norwegian normed means were not significantly different, and the Norwegian variances were not greater than those in the US sample

**Table 1.** Intercorrelations among the measures of epistemological beliefs and cognitive and meta-cognitive strategy use, and mean scores and standard deviations for each ( $N = 81$ )

Measure	1	2	3	4	5	6	7	8	9
1. Simple	–								
2. Fixed	.29**	–							
3. Quick	.18	.27*	–						
4. Certain	.06	.37**	.03	–					
5. Rehearsal	–.31**	–.16	.03	–.09	–				
6. Elaboration	–.27*	–.44**	–.16	–.13	.41**	–			
7. Critical Thinking	–.15	–.50**	–.13	–.17	.26*	.59**	–		
8. Organization	–.43**	–.32**	–.04	–.22*	.55**	.62**	.42**	–	
9. Metacognitive Self-Regulation	–.41**	–.35**	–.08	–.15	.56**	.62**	.53**	.66**	–
M	0.00	0.00	0.00	0.00	3.66	4.77	4.17	4.42	4.22
SD	0.75	0.88	0.73	0.58	1.03	0.95	1.17	1.23	0.91

Note. \* $p < .05$ , \*\* $p < .01$ . Mean scores for Variables 1–4 are reported in z scores. Variables 5–9 are based on a 7-point Likert scale. Higher scores indicate greater reported strategy use.

(perhaps because of the Norwegian sample's more restricted range by years of study), all analyses reported in this paper were conducted with the normed transformations on the Norwegian data.

*The MSLQ.* The students' self-reported use of learning strategies were measured with the Norwegian translation of 31 items from five subscales of the MSLQ (Pintrich *et al.*, 1991): rehearsal, elaboration, critical thinking, organization and metacognitive self-regulation.

The MSLQ had been translated into Norwegian for use in earlier studies (e.g. Dahl, 1993). One of the three translators was a native speaker of English, and the other two were native speakers of Norwegian. Again, all of the translators were proficient speakers of the other language. Similar to the SEQ translation procedure, the measure was first translated into Norwegian by the native speakers of Norwegian and then back-translated into English by the native speaker of English. Again, the goal was to translate the items as literally as possible, deviating only when the literal translations altered the conceptual meaning of the items. In those cases, translations that preserved the meaning of the original item were used instead. For instance, 'studying' is a term without a direct match in Norwegian, and the Norwegian term that best describes the act of studying was used (in this case, reading and/or completing assignments). Discrepancies were resolved by the group until consensus for the Norwegian translation of the original English text was reached.

Students were instructed to respond to each of the statements on a 7-point Likert scale (1 = *not at all true of me*, 7 = *very true of me*) in terms of their behaviour in the main course they were taking at the university at the time of the study (at the university the students came from, it was typical to take only one full-load course per semester). The rehearsal subscale (original English  $\alpha = .69$ , Norwegian translation  $\alpha = .48$ ) consisted of four items regarding how typical it was for students to memorize material when studying (e.g. 'When I study for this class, I practice saying the material to myself over and over'). The elaboration subscale (original English  $\alpha = .76$ , Norwegian translation  $\alpha = .74$ ) consisted of six items regarding how typical it was for students to

paraphrase, summarize, or make analogies when studying (e.g. 'When reading for this class, I try to relate the material to what I already know'). The critical thinking subscale (original English  $\alpha = .80$ , Norwegian translation  $\alpha = .81$ ) consisted of five items regarding how typical it was for students to apply their prior knowledge to new situations (e.g. 'When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence'). The organization subscale (original English  $\alpha = .64$ , Norwegian translation  $\alpha = .70$ ) consisted of four items regarding how typical it was for students to outline or select the main idea from their readings (e.g. 'When I study the readings for this course, I outline the material to help me organize my thoughts'). The metacognitive self-regulation subscale (original English  $\alpha = .79$ , Norwegian translation  $\alpha = .75$ ) consisted of 12 items regarding how typically they plan, monitor, and regulate their learning activities (e.g. 'I ask myself questions to make sure I understand the material I have been studying in this class').

### Procedure

Early in the semester, the students were given information about the study in class. The SEQ and MSLQ questionnaires were handed out to the students who agreed to participate in the study during a class break. The forms were collected from the students at the end of class.

### Results

Pearson  $r$  correlation coefficients were calculated to identify any noteworthy patterns in the data. Results indicate several clear findings (see Table 1). Beginning with the SEQ beliefs (Variables 1-4), the correlations indicate that the beliefs are not orthogonal. The single most differentiated variable is *certain*, virtually uncorrelated with *simple*, and *quick*, but moderately correlated with *fixed*. Looking at the MSLQ scores (Variables 5-9), the high intercorrelation among the MSLQ scores indicate that the reported use of the different cognitive and metacognitive strategies overlaps significantly.

Distinct patterns of how individuals' beliefs correlate with their reported use of learning strategies also emerged. The more sophisticated individuals' beliefs are about how thoroughly integrated knowledge is in networks (*simple*) and how fixed the ability to learn is from birth (*fixed*; both indicated by negative correlations), the more likely it is that they will report using each of the learning strategies measured. Individuals' beliefs about how quickly they believe learning should happen (*quick*) and how certain they believe knowledge is (*certain*) shows virtually no correlation with their reported use of cognitive and metacognitive learning strategies.

Full regression model analyses were performed, testing the predictive value of the four beliefs on students' reported use of each of the five cognitive and metacognitive strategies. Commensurate with the cursory correlation analyses, results from regression analyses on each dependent MSLQ score (rehearsal, elaboration, critical thinking, organization and metacognitive self-regulation) indicate that the *simple* and *fixed* beliefs, to some extent, predict the learning strategies that students use when studying, whereas the *quick* and *certain* beliefs predict little.

*Rehearsal and organization strategies.* The regression analyses indicate that beliefs about how thoroughly integrated knowledge is in networks (*simple*) contributes significantly to the prediction of students' reported use of rehearsal

strategies (see Table 2) and organization strategies (see Table 3). The less students believe knowledge is organized in complex networks (the naïve epistemological perspective), the more they tend to report using rehearsal strategies, and the less they tend to report using organization strategies (selecting appropriate information with which to construct connections).

**Table 2.** Summary of full model regression analysis for epistemological variables predicting rehearsal strategies ( $N = 81$ )

Variable	B	SE B	$\beta$	t	$R^2$	Adj $R^2$	F(4, 76)
Simple	-0.41	0.16	-0.30	-2.60**	.11	.06	2.33
Fixed	-0.09	0.15	-0.08	-0.64			
Quick	0.14	0.16	0.10	0.89			
Certain	-0.07	0.21	-0.04	-0.36			

Note. \*\* $p < .01$ .

**Table 3.** Summary of full model regression analysis for epistemological variables predicting organization strategies ( $N = 81$ )

Variable	B	SE B	$\beta$	t	$R^2$	Adj $R^2$	F(4, 76)
Simple	-0.63	0.17	-0.38	-3.64**	.25	.21	6.16***
Fixed	-0.23	0.16	-0.18	-1.52			
Quick	0.14	0.18	0.08	0.79			
Certain	-0.29	0.23	-0.14	-1.25			

Note. \*\*\* $p < .001$ .

*Elaboration and critical thinking strategies.* Student's beliefs about how fixed the ability to learn is from birth (*fixed*) contributed significantly to the prediction of the use of elaboration strategies (see Table 4) and critical thinking strategies (see Table 5). The more they believe that knowledge is fixed (the naïve epistemological perspective), the less likely they are to report using elaboration and critical thinking strategies.

**Table 4.** Summary of full model regression analysis for epistemological variables predicting elaboration strategies ( $N = 81$ )

Variable	B	SE B	$\beta$	t	$R^2$	Adj $R^2$	F(4, 76)
Simple	-0.19	0.14	-0.15	-1.43	.22	.18	5.24***
Fixed	-0.43	0.13	-0.39	-3.37***			
Quick	-0.04	0.14	-0.03	-0.27			
Certain	0.05	0.18	0.03	0.28			

Note. \*\*\* $p < .001$ .

*Metacognitive and self-regulation strategies.* The *simple* and *fixed* beliefs contributed significantly to the prediction of the reported use of strategies relevant to metacognitive self-regulation strategies (planning, monitoring, and regulating their learning; see Table 6). The more students believe that knowledge is simple and fixed

**Table 5.** Summary of full model regression analysis for epistemological variables predicting critical thinking strategies ( $N = 81$ )

Variable	$B$	SE $B$	$\beta$	$t$	$R^2$	Adj $R^2$	$F(4, 76)$
Simple	-0.01	0.16	0.00	-0.00	.25	.21	6.22***
Fixed	-0.67	0.15	-0.50	-4.37***			
Quick	0.01	0.17	0.00	0.04			
Certain	0.03	0.22	0.02	0.16			

Note. \*\*\* $p < .001$ .

**Table 6.** Summary of full model regression analysis for epistemological variables predicting meta-cognitive self-regulation strategies ( $N = 81$ )

Variable	$B$	SE $B$	$\beta$	$t$	$R^2$	Adj $R^2$	$F(4, 76)$
Simple	-0.41	0.13	-0.34	-3.21**	.23	.19	5.65***
Fixed	-0.26	0.12	-0.25	-2.16*			
Quick	.05	0.13	0.05	0.46			
Certain	-0.06	0.17	-0.04	-0.33			

Note. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

(the naïve epistemological perspective), the less likely they are to report using meta-cognitive and self-regulation strategies

## Discussion

The results indicate that there are clear patterns of how beliefs contribute to the reported process of knowledge acquisition, though not as globally as predicted. Beliefs about how knowledge is organized (*simple*), and how fixed learning is as an individual trait or skill (*fixed*), have the greatest relationship with the reported selection of cognitive and metacognitive learning strategies. For the reported selection of rehearsal and organization strategies, *simple* beliefs matter, for the reported selection of elaboration and critical thinking strategies, *fixed* beliefs matter, and for the reported use of strategies for metacognitive monitoring and self-regulation, both *simple* and *fixed* beliefs matter.

### Simple and fixed beliefs

Both *simple* and *fixed* beliefs are each uniquely relevant to students' reported use of behaviours that facilitate constructing text base and situation models. The reported monitoring and regulating of those behaviours are associated with both. Since these findings are based on reports of how students master their written course material, further study on what students actually do while reading, and how they actually comprehend the texts they read, would need to be tested jointly to validate these reports.

As compelling as the patterns of beliefs and learning strategy interactions may be, none of the beliefs accounted for a high degree of variance in reported learning strategy

selection. The full beliefs model accounted for the least variance in the use of rehearsal strategies (6%). The degree of variance it accounted for with more sophisticated strategies was greater, though modest, with 18% on elaboration, 21% on critical thinking, 21% for organization, and 19% for metacognition and self-regulation. Nonetheless, the more complex the strategy needed to carry out the learning task, the more beliefs seemed to be associated with their reported use.

Although we predicted that students' beliefs about how knowledge is organized (*simple*) would negatively correlate with how they would report attending to, and encoding, new information into their knowledge base (e.g. through the reported choice of rehearsal strategies), this proved not to be the case. Even though *simple* was the only belief that predicted the reporting of rehearsal strategy use at all, the model's predictive value was low. This could, in part, be related to the relatively low reliability of the rehearsal items, although it is just as likely that there are other factors beyond the beliefs measured in this study that figure in to students' use of rehearsal strategies.

On the other hand, the *simple* belief did correlate negatively with organization as predicted. This supported the hypothesis that people who believe that knowledge is organized in isolated bits and pieces do, indeed, spend less time organizing what they are learning than those who do not.

The belief that seemed to have the strongest association with the kinds of strategies that link individual ideas within texts (elaboration) and to bigger ideas (critical thinking) was the belief that learning ability is *fixed*. As hypothesized, the more students believe that learning ability is fixed, the fewer the strategies they report using to connect their prior knowledge with new knowledge that is to be learned, or to think critically about the information that they are processing. This finding also supports findings from earlier research (Dweck & Leggett, 1988; Stipek & Gralinski, 1996).

Finally, how students plan, monitor, and regulate their learning appears to be associated with two beliefs: how students believe information is organized (*simple*), and how much they believe that learning ability is fixed (*fixed*). This supported our prediction and corroborated Schommer *et al.*'s (1992) finding that *simple* interacted with the task-appropriate selection of strategies for test preparation. However, our findings diverged from Schommer *et al.*'s finding about students' beliefs about the ability to learn being *fixed* since Schommer *et al.*, only found a significant interaction with the *simple* belief. This is probably due to the fact that Schommer *et al.*, initially used a forward entry regression analysis in their study to test all their predictors, entering the epistemological belief factor scores after prior knowledge, gender, passage, and instructions. They then entered the beliefs in the following predesignated order: *simple*, *certain*, *fixed*, *quick*. Why this particular order was chosen was not specified. Nevertheless, when they found only *simple* to have a significant effect on the variance, they used only *simple* in their subsequent analyses to test interactions between beliefs and learning strategies. On the other hand, we used a full regression model with only the SEQ beliefs entered, all simultaneously, with the express purpose of testing their combined and individual effects on specific learning-strategy use. Since the intercorrelations among all the beliefs and the learning strategy scores that Schommer *et al.*, measured were not reported, it is not possible to check if their findings might have been different had they used another means of regression. Thus, whether our different findings about the effect of the *fixed* belief are based on conceptual or methodological differences, is not clear.

The basic conclusion from our findings about students' reported strategy use when reading course materials is, therefore, that some, but not all, epistemological beliefs may

offer some insight into future studies of students' actual use of learning strategies. Though our results support earlier research in part by showing how *simple* and *fixed* beliefs seem to be associated with engagement in the learning process, the beliefs *certain* and *quick* are conspicuously absent from these findings.

### **Certain and quick beliefs**

Beliefs about how certain knowledge is has been shown in earlier research to only affect the number of strategies used by readers, not the quality of strategies used (Kardash & Howell, 2000). Our finding about *certain* beliefs, therefore, diverges from our hypothesis, though not from indications from previous research. Table 1 shows that the *certain* scores were the most restricted in range in this sample. It could be that this particular sample is too homogeneous on this factor to reveal any significant differences, or it could be that Norwegians really do think differently about the certainty of knowledge than the Americans for whom the factors were normed.

Beliefs about how quickly learning should occur have been shown to affect both the number and quality of strategies used by readers (Kardash & Howell, 2000; Stipek & Gralinski, 1996), thereby diverging from both our hypotheses and previous research. Do beliefs about how innate our ability to learn is (*fixed*) and how knowledge is organized (*simple*) supersede the effects of how quickly we believe learning should occur (*quick*)? Looking at Table 1, we can see that the range of scores for *quick* is similar to that for *fixed* and *simple*, so the range is not likely to be the issue in this case. Furthermore, *quick* is virtually uncorrelated with *simple* and *certain*. However, beliefs about how *fixed* students believed their ability to learn is seems to be correlated significantly with all three of the remaining factors, and may perhaps overshadow the effect of those variables in our analyses.

To test this, we reran the full model regression analyses on all the MSLQ learning strategy subscales, entering *simple*, *quick* and *certain* all simultaneously, leaving out *fixed*. In no cases did *quick* significantly contribute to the variance in the model. In this sample at least, it seems that *quick* is genuinely less powerful than the other beliefs measured by the SEQ in predicting the learning strategies students will report using.

### **The nature of beliefs and behaviour**

Some would criticize the inclusion of beliefs about the nature of intelligence in epistemological research and recommend studying such beliefs independently of beliefs about knowledge or the nature of knowing (e.g. Hofer & Pintrich, 1997; Rozendaal, De Brabander, & Minnaert, 2001). Hofer and Pintrich (1997) asserted that two of the four factors measured by the SEQ are core to epistemological theories, namely those directly measuring the nature of *knowledge* (*certain* and *simple*). On the other hand, they criticized the content of the SEQ for including measures of beliefs peripheral to epistemological theories (*fixed* and *quick*) and failing to include measures of the nature of knowing. Instead of measuring epistemological beliefs, Hofer and Pintrich asserted that the factor *fixed* measures the nature of intelligence, and the factor *quick* measures the nature of learning and instruction.

Accordingly, an analysis of epistemological beliefs and learning-strategy use based on Hofer and Pintrich's (1997) definition of epistemological beliefs would have excluded the variables *fixed* and *quick* and added other measures of knowing. This would have potentially led to different results than those reported in this study.

Although Hofer and Pintrich raise a definitional issue that would prompt the modification of the terms of the epistemological variables if this study was replicated, their definitional issues are beyond the scope of this paper. The definitions upon which the SEQ is based have been clear since the instrument was created, and remains actively used in current epistemological research. Our hypotheses were generated on that basis and evaluated accordingly.

Furthermore, the strong correlations among *fixed* and the other beliefs measured by the SEQ suggest that beliefs about intelligence should not be ignored in research devoted to understanding the relationship between beliefs and actions.

Of course, beliefs may interact with more than just text when students study. Previous research has shown that goals (e.g. McWhaw & Abrami, 2001; Schunk & Ertmer, 1999; Somuncuoglu & Yildirim, 1999) and motivation (e.g. Pintrich & De Groot, 1990; Wolters, 1999) also affect the choice of strategies. What is unclear in these independent findings is the combined effect of goals, motivation, and beliefs (Hofer & Pintrich, 1997).

Future research should address these possible interactions to refine the picture our findings have portrayed. Additionally, the relationship between reported strategy use, and actual strategy use when reading multiple texts, should be examined along with the direct effect of strategy use on comprehension and learning.

Initially, Schommer was intrigued by readers' feelings of satisfaction with their reading comprehension of single texts after which measures of what they understood showed their comprehension to actually be quite poor (Schommer, 1998a). Schommer's contention was that this might well be an outcome reflective of readers' beliefs - factors that set standards for learning behaviours (Ryan, 1984). Our study focused on the relationship between beliefs and reported strategy use, and it lends support to Schommer's contentions. However, it also points out that some beliefs may be more influential than others when selecting effective reading strategies. The exact constellation of those beliefs is not yet resolved, nor is the issue of how much their relationship with strategy selection may be mediated by other factors, especially when reading multiple texts. Nevertheless, the evidence is mounting in support of beliefs about knowledge and learning not only as achievement mediators, but also, perhaps, as mediators of decisions made during the learning process.

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