The Influence of Web-supported Independent Activities and Small Group Work on Students' Epistemological Beliefs

Denise Tolhurst

School of Information Systems, Technology and Management
University of New South Wales, Australia
Kensington NSW 2052

d.tolhurst@unsw.edu.au

Abstract

Epistemological beliefs are those concerning the nature of knowledge and learning: beliefs about how individuals come to know, and how knowledge is constructed. There is growing evidence in the literature that indicates epistemological beliefs influence students learning, but little research as to how learning environments impact on students' epistemological beliefs, and hence students' approaches to study. This paper reports on a research project that investigated the effects of a major course revision on students' epistemological beliefs. The course that underwent revision was a large undergraduate information systems course. The learning environment created aimed to engage students in independent web-based learning, and utilised small-group workshop activities based on students' previous independent study. The independent work required students to undertake web-supported independent activities (WSIA) before attending lecturer facilitated small group workshops. Formal lectures were minimised to just five 1-hour lectures in the session. Research into students' epistemological beliefs was undertaken at the time of the introduction of the new course structure, and encouragingly, some aspects of students' beliefs were changed in just one teaching session (even if not in the way anticipated). This paper briefly describes the new web-supported course structure and then reports on quantitative results of the accompanying epistemological beliefs research. Implications of this research for structuring learning environments in universities are discussed.

Keywords: Epistemological beliefs, learning environments, information systems

1 Introduction

Students' epistemological beliefs have been shown to influence students learning and study approaches (as detailed in the section that follows). This paper reports on a course revision that attempted to create a learning environment that would influence students' development of sophisticated epistemological beliefs, and a research study that accompanied it. The course revision and research was undertaken in an introductory undergraduate information systems course, and aimed to develop in students learning characteristics seen as desirable in university level students.

2 The Research on Epistemological Beliefs

Increasing interest and research activity is evident in the literature concerning how students' beliefs about knowledge and knowing mediate their learning processes. The number of annual publications on students' personal epistemology, or epistemological beliefs, is currently growing, indicating recognition of the importance of the area and increase in theoretical thinking and research activity.

In a review of research literature that investigates the implications for teaching and learning of students' personal epistemology Hofer (2001) concludes that 'a growing body of work provides evidence that personal epistemology is an important component of student learning'. Beliefs about knowledge have been shown to influence factors such as student's motivation, persistence and problem solving approach (Schraw, 2001;Kardash and Scholes,1996; Schommer, 1994; Jacobson and Spiro, 1995). Kardash and Scholes (1996) draw attention to 'A growing body of evidence (that) suggests individuals' epistemological beliefs play a critical role in strategic learning in general and higher-order thinking and problem solving in particular' (p261). Schommer (1994b) suggests that '... epistemological beliefs affect the degree to which individuals (a) actively engage in learning, (b) persist in difficult tasks, (c) comprehend written material, and (d) cope with ill-structured domains. In each of these areas, the evidence suggests that epistemological beliefs may either help or hinder learning' (p302). In summing up the same article Schommer concludes that '... there is enough evidence to suggest epistemological beliefs are critical to the learning process' (p315). Similarly Schraw (2001, p460) suggests '… results of studies that examine epistemological beliefs and their effects on learning are of considerable importance to educators … because …epistemological beliefs are related to a wide variety of complex cognitive outcomes. As (epistemological) beliefs change and

become more sophisticated, thinking and problem-solving skills improve as well'.

The concept of simple versus sophisticated epistemological beliefs is a concept developed from the work of Marlene Schommer (1994) in which she proposed five epistemological dimensions. The five dimensions are:

- Certainty of knowledge (absolute to tentative)
- Structure of knowledge (simple to complex)
- Source of knowledge (handed down by authority to derived by reason)
- Control of knowledge (ability to learn is fixed at birth to ability to learn can be changed)
- Speed of knowledge acquisition (knowledge is acquired quickly or not-at-all to knowledge is acquired gradually)

Simple epistemological beliefs are associated with those which consider knowledge to be absolute, simple, handed down by authority, acquired quickly or not at all and that the ability to learn is fixed at birth. With simple beliefs students are likely to engage in study habits in which they rely on authority (perhaps the lecturer) to provide clear answers. When researching such students are likely to be satisfied with the first information they find that they believe provides a suitable answer, and not persist if they do not locate information quickly and easily. They are not likely to seek information from multiple sources, or integrate ideas. With more sophisticated epistemological beliefs students are more likely to consult multiple sources, integrate ideas, value different opinions and persist in the event of not being successful at first. Hofer and Pintrich (1997) link epistemological beliefs to academic tasks that, over time, shape epistemological beliefs. They suggest (p 128) 'students who are given multiple choice tests composed of low level items may come to view knowledge as a collection of facts and learn to study for tests by using memorization and rehearsal strategies. Moving to a class where higher-level processes are expected may require not only a change in strategy use, but a change in epistemological theories'.

Recognising that epistemological beliefs are an important influence on students' learning, of interest to effective teaching in our universities is the question as to how we can promote more sophisticated beliefs about knowledge in our students. Beliefs that lead students to view knowledge as complex, as requiring the integration of ideas and requiring task persistence. Can we structure our curriculum, courses and learning environments so as to encourage the development of more sophisticated epistemological beliefs in students that lead to greater personal involvement and acceptance of responsibility for learning?

A research study by Brownlee, Purdie and Boulton-Lewis (2001) provides some encouragement for the potential of influencing students' epistemological beliefs through learning environments. Brownlee et.al. conducted a study with Australian tertiary students at the University of Queensland that show it is possible to significantly influence students' epistemological beliefs and produce positive learning outcomes. Brownlee et.al. measured students beliefs before and after a course of study in which two groups of students experienced a year-long of study in which one group was required to reflect on their epistemological beliefs using personal diaries. They found that the group involved in reflective practice experienced a statistically significant shift to more complex epistemological beliefs that those students who did not. They conclude that student epistemological beliefs can be influenced, and that this has implications for how educators develop learning environments.

Another study (not related to epistemological beliefs) that supports the argument that learning environments can influence students' study and progress is that of van der Hulst and Jansen (2002). Using a multilevel analysis, these researchers from the Netherlands found evidence that the spread of study activities over the year, instruction characteristics and examination characteristics were found to have effects on progress. They suggest that 'institutes in higher education may improve their students' progress to some extent by means of efficient curriculum organisation'.

Based on the work of Brownlee et. al. that epistemological beliefs can be influenced, and that of van der Hulst and Jansen suggesting curriculum organisation influences student progress, a substantial course revision was undertaken in a first year undergraduate information systems course. The revision attempted to establish a learning environment that might encourage in students more complex epistemological beliefs, and hence encourage appropriate study approaches and independent learning in our students. Accompanying the course revision was a research study that examined the influence of course structure and the resulting learning environment on students' epistemological beliefs. This paper briefly reports on the course structure developed and then reports on its effect on students' epistemological beliefs.

3 Details and rationale of the course restructure

Before the course revision was undertaken, problems were recognised by lecturers of the introductory undergraduate information systems course at the focus of this study. The course typically attracted 400-500 students per session, twice a year (up to 1000 annually), and was organised in a format of two one-hour lectures per week, and a one-hour tutorial. By the middle of session attendance at lectures was poor and often behaviour in lectures was not ideal. Students in this course were also seen as taking a very surface approach to their work and to assignments, relying on one (or few) sources of information and wanting very detailed information about the assignment requirements and recommended sources of information from lecturing staff. Students did not appear to be accepting responsibility for their own learning, relying heavily on lecturers as their primary source of information.

Staff believed that some of the problems lay in the fact that the largely lecture format of the course placed

students in a passive 'reception' mode, failing to engage the students with the material or each other. It was felt that students were not being inspired or engaged by the course in its current form.

In response to the perceived problems the course structure was radically revised to a format that involved students in weekly web-supported independent activities (WSIA), regular small group workshops (max 24 students) and reducing lectures to only five one-hour lectures during the 14 week session. Students were expected to complete the WSIA before attending workshops and lecturer's took the role of 'facilitators' of learning. Lecturers guided group activities in the workshops, activities which relied on students' preparation in their independent work.

The new course structure was seen as requiring students to accept greater responsibility for their own learning. Students felt the pressure of maintaining their credibility as each was required to actively engage with their peers and lecturers in group-discussions. Each was required to research, read and prepare before coming to class, and then engage with others on an intellectual level in workshops. Students were expected to support their discussion and opinions from credible sources, rather than from opinion and hearsay. Rather than taking a passive role in lectures in which the lecturer delivered course content, students took an active role before and during class.

Descriptions of the new course structure, including detail about the web-supported independent activities and workshops, can be found in the article by Tolhurst and Baker (2003).

4 Description of the study

A research study that explored the influence of this different course structure on students' epistemological beliefs was undertaken. Consistent with the approach of Brownlee, Purdie and Boulton-Lewis (2001), this study measured students' epistemological beliefs at the very beginning of the course, and then again twelve weeks later. It was expected that students' beliefs would be influenced by the new course structure, moving towards more sophisticated beliefs. Beliefs that indicate students view knowledge as more complex, more tentative, derived by reason, and are acquired gradually (Schommer 1994).

In order to measure students' epistemological beliefs two scales were adopted for this research. The first was Schommer's 'Epistemological Questionnaire' (1998), a 63 item questionnaire that measures the five epistemological dimensions described in the 1994 paper, with twelve subscales. See table 1 for the scales and thirteen subscales. This questionnaire measures 'general' epistemological beliefs. The questionnaire requires students to respond to statements and express their agreement or disagreement on a 5-point likert scale. Sample items that show the nature of the questionnaire are: 'If scientist try hard enough they can find the truth to almost anything' (certainty of knowledge); 'A good teacher's job is to keep his students from wandering from the right track (simple knowledge); 'Successful students understand things quickly' (quick learning); 'Sometimes you have to accept answers from a teacher even if you don't understand them' (depend on authority); 'Students who are "average" in school will remain "average" for the rest of their lives' (innate ability). Item values were combined to form values for the five dimensions of epistemological beliefs, with twelve subscales.

The second scale used was Hofer's Discipline Focused Epistemological Beliefs Questionnaire (2000). Quain and Alvermann (1995) and Hofer (2000) identified that Schommer's Epistemological Questionnaire failed to distinguish domain specific beliefs and developed alternative scales. Hofer's (2000) 18 item scale was selected to measure domain specific epistemological beliefs and addition to Schommer's Epistemological Questionnaire that measures general beliefs. There is growing evidence that epistemological beliefs can be both general and domain specific (Schraw, 2001; Hofer, 2000; Hofer and Pintrich, 1997; Quain and Alvermann, 1995). Both scales were adopted to capture data on general and domain specific beliefs.

Hofer's scale measures four dimensions, as shown in table 2. Samples of the items that show the nature of Hofer's scale are: 'Truth is unchanging in this subject' (certainty of knowledge); 'First hand experience is the best way of knowing something in this field' (justification of knowledge: personal); 'If my personal experience conflicts with ideas in the textbook, the textbook is probably right' (Source of information: authority); 'Experts in this field can ultimately get to the truth' (Attainment of truth). Like Schommer's scale, this scale requires students to express their agreement or disagreement on a 5-point likert scale.

Both scales were administered in week 1 of the course at the beginning of the very first lecture. The only activities that occurred before students completed the questionnaires was that the course name was announced and the staff were introduced. The questionnaires were again completed by students in week 12 of the course during a workshop session.

5 Results of the Study

Table 1 shows the results of Schommer's Epistemological Questionnaire, and Table 2 shows the results of Hofer's Domain Focused Epistemological Beliefs Questionnaire. Means, standard deviations for each subscale in the two questionnaires for weeks 1 and 12. Also provided are the p-values for repeated measures analyses. Pair wise deletion was used for missing data, meaning that if a student failed to complete an item a subscale, then their data were excluded for the whole subscale. Some students completed all items in the pre-test, but missed some in the post-test. If this was the case there is a difference between the pre- and post-test Ns in the tables.

As can be seen from Table 1, significant differences were found on five of the thirteen subscales of Schommer's Epistemological Questionnaire of general beliefs. A significant change in a desirable direction was found in students belief in simple knowledge, in particular students belief in seeking single answers was significantly reduced

(mean=3.11 to 3.05, p=.0036). Encouragingly students also had significantly increased beliefs that it is possible to learn how to learn (mean 2.26 to 2.37, p=.0005). Less encouragingly, students belief that learning occurs in the first instance (i.e. quickly) was also significantly increased (mean=2.56 to 2.52, p=.0182). Students' belief in omniscient authority was significantly increased on both subscales, depend on authority (mean=3.02 to 3.08, p=.0396) and don't criticise authority (mean=2.30 to 2.38, p=.0009). The source of authority that students perceive may be of interest, however. If students' view of authority is the lecturer, then this could be seen as undesirable outcome. If, however, their view the source of authority as 'related specifically to expert knowledge, texts and other external authority as the source of knowledge … as opposed to knowing as justified by individual opinion and first-hand experience' (Hofer 2000), then this would be more desirable. The results on Hofer's domain specific beliefs questionnaire in Table 2 show a significant and positive result for the source of knowledge as being authority as described by Hofer above (related to expert knowledge, texts and other external authority) (mean=2.96 to 3.04, p=.0001). Also a positive and significant finding on Hofer's domain specific questionnaire was that students view knowledge as less certain and simple (mean=2.47 to 2.40, p=.0064).

Schommer's General Epistemological Beliefs Questionnaire (1994) Scales, Subscales	Student responses		P-Value for Repeated Measures
	Pretest (M, SD, N)	Posttest (M, SD, N)	(N)
Quick Learning			
Learning is quick	2.79, 0.52 (n=397)	2.55, 0.58 (n=328)	0.1370 (n=240)
Learn first time **	**2.46**, 0.63 (n=399)	**2.52**, 0.65 (n=333)	**0.0182** (n=249)
Concentrated effort is a waste of time	2.60, 0,71 (n=399)	2.69, 0.73 (n=334)	0.0869 (n=248)
Certain Knowledge			
Avoid ambiguity	3.09, 0.62 (n=390)	3.15, 0.63 (n=332)	0.3052 (n=243)
Knowledge is certain	2.88, 0.46 (n=394)	2.73, 0.50 (n=330)	0.6284 (n=239)
Avoid integration	2.44, 0.35 (n=390)	2.89, 0.37 (n=329)	0.8614 (n=237)
Innate Ability			
Can learn how to learn ***	**2.26**, 0,52 (n=391)	**2.37**, 0.55 (n=330)	**0.0005** (n=240)
Success unrelated to hard work	2.88, 0.46 (n=394)	2.34, 0.61 (n=325)	0.2423 (n=233)
Ability to learn is innate	2.66, 0.72 (n=389)	2.73, 0.67 (n=326)	0.5832 (n=233)
Omniscient Authority			
Depend on authority *	**3.02**, 0.56 (n=396)	**3.08**, 0.56 (n=333)	**0.0396** (n=245)
Don't criticise authority ***	**2.30**, 0.48 (n=394)	**2.38**, 0.49 (n=331)	**0.0009** (n=241)
Simple Knowledge			
Seek single answers **	**3.11**, 0.33 (n=383)	**3.05**, 0.31(n=327)	**0.0036** (n=228)
Avoid integration	2.44, 0.35 (n=390)	2.89, 0.37 (n=329)	0.8614 (n=237)

Subscale range is 1 to 5, 5 represents strong agreement.
* significant at .05, ** significant at .01, *** - significant at .001
Reliability of 63 item scale: pretest standardised item alpha = 0.7638,
post-test standardised item alpha = 0.8017

Table 1: Results of Schommer's General Epistemological Beliefs Questionnaire (1994)

Hofer (2000) Domain Focused Epistemological Beliefs Questionnaire	Student responses		P-Value for Repeated Measures
	Pretest (M, SD, N)	Posttest (M, SD, N)	(N)
Certainty and simplicity of knowledge **	**2.47**, 0.52 (n=370)	**2.40**, 0.51 (n=323)	**0.0064** (n=222)
Justification of knowing: personal ~	3.14, 0.60 (n=382)	3.34, 0.59 (n=318)	0.2140 (n=224)
Source of knowledge: authority ^ ***	**2.96**, 0.64 (n=400)	**3.04**, 0.62 (n=336)	**0.0001** (n=247)
Perceived attainability of truth	3.11, 0.78 (n=401)	3.06, 0.83 (n=341)	0.0777 (n=251)

Subscale range is 1 to 5, 5 represents strong agreement. ** significant at .01, *** - significant at .001
~ represents the view that knowing is justified by individual opinion or firsthand experience
^ relates specifically to expert knowledge, texts and other external authority as the source of knowledge
Reliability of 18 item scale: pretest standardised item alpha 0.5801,
post-test standardised item alpha = 0.5985

Table 2: Results of Hofer's Domain Focused Epistemological Beliefs Questionnaire (2000)

6 Discussion, Conclusions and Implications

As discussed in the above section 'Description of the study', it was expected that students' beliefs would be influenced by the new course structure, moving them towards more sophisticated beliefs. It was expected that students' beliefs about knowledge would become more complex, more tentative, perceive knowledge as derived by reason, and acquired gradually. It was expected this would occur as a result of being involved in a course in which they were more actively involved in their own learning. A course where they were required to research, read and prepare for each class, and then engage with others on an intellectual level in workshops. A course in which students were required to support any discussion points and opinions from credible sources, rather than relying on opinion and hearsay.

As can been seen from the results students' epistemological beliefs were influenced by their experiences in this course, in the relatively short period of just twelve weeks. Not all of the subscales on the measures were influenced, but there were some significant influences on important aspects of students' beliefs. After experiencing the course students' beliefs were more sophisticated in that they believe less in the certainty and simplicity of knowledge as measured by Hofer's domain specific epistemological beliefs scale. Similar changes in beliefs are not apparent on the general epistemological beliefs scale, but this is consistent with the growing evidence in the research literature that beliefs can differ between domains, as can general beliefs from domain specific (Buehl and Alexander, 2001; Hofer, 2000; Paulsen and Well, 1998; Jehng, Johnson and Anderson, 1993).

Further evidence of the development of more sophisticated beliefs is that students had a reduced level of belief in the seeking of single answers, and had a stronger belief that it is possible to learn how to learn.

In conflict with the trend in these more positive results towards the development of more sophisticated beliefs, students displayed a stronger belief on Schommer's general beliefs scale that learning occurs the first time. This result was not an outcome that was expected, and is difficult to explain in the context of the different course structure. The three items that contribute to the subscale of quick learning relate to the reading of textbooks and the relative value of rereading chapters. Perhaps this reflects on students' perceptions of the value of learning from textbooks, and perhaps more diverse items regarding 'learning the first time' should be included in the measure. It could also be that students' experiences in the course meant that they did not feel the need for revisiting the course materials in their studies.

Results regarding the students' beliefs about authority require some further exploration. Hofer's domain specific scale indicates that students have an increased belief that the source of knowledge is expert knowledge, texts and other external authority, as opposed to knowing as justified by individual opinion or firsthand experience. These beliefs are characteristic of the more sophisticated beliefs associated with desirable learning approaches. Results of Schommer's general epistemological beliefs questionnaire however, show that students believe that they should depend on authority, and not criticise authority. If 'authority' is seen by students as the expert knowledge presented in journal readings, authentic websites and real-world case studies utilised in the course, then this outcome can be seen as also contributing to students development of more sophisticated epistemological beliefs. If however, 'authority' is seen as the lecturer, then these results cannot be seen as being so positive. The items in Schommer's questionnaire tend towards the latter (for example: Item 5 'How much a person gets out of university depends on the quality of their lecturer', and Item 40 'Sometimes you just have to accept answers from the lecturer even though you don't understand them'). It could be claimed that the apparently different outcomes on the two different scales could be attributed to students' general beliefs as compared to domain specific beliefs, but this is difficult because of the lack of parity between the two scales. A potential area for further research would be the development of domain specific and general epistemological beliefs scales that permit more direct comparisons to be made between the two sets of beliefs.

As identified in the earlier discussion of the literature, students' epistemological beliefs *do* influence their learning. Evidence suggest they have an effect on critical and higher-order thinking, problem solving, task persistence and motivation (Schraw, 2001;Kardash and Scholes,1996; Schommer, 1994; Jacobson and Spiro, 1995) It is also evident that 'as (epistemological) beliefs change and become more sophisticated, thinking and problem- solving skills improve as well (Schraw, 2001). This research has shown that students' epistemological beliefs can be changed, although it is not easy to predict how they will be changed. This research has also shown that course structure *can* influence students' epistemological beliefs.

The question that does arise from this research is, if we can influence students' epistemological beliefs through course structure and the learning environments we create, what is the best structure to encourage the most desirable outcomes regarding students' beliefs, and hence desirable learning approaches and outcomes? The course structure at the focus of this research was designed to create a learning environment that engaged students in active and independent learning. It clearly achieved desirable outcomes on some subscales, not so desirable outcomes on some subscales, and no change on others.

Although this study did not achieve all the changes in students' epistemological beliefs it set out to, it did show that students epistemological beliefs can be influenced in as shorter time-period as twelve weeks. This means that all our courses contribute to students' perceptions of knowledge and its nature in some way or another. All

educators need to consider the implicit message that they convey to students through the structure of the courses they teach and the learning environments they create. These structures and environments implicitly reflect the beliefs that lecturers have regarding knowledge in their discipline, be they carefully considered or subconscious.

It is apparent from this research on students' epistemological beliefs that further research is needed to determine what is the best course structure and how to structure learning environments to support students' development of sophisticated epistemological beliefs that are associated with desirable learning approaches and outcomes. It is also apparent that we need to consider the messages we convey to our students implicitly through the course structures we utilise, and the effects they might have on students' learning.

7 References

BROWNLEE, J., PURDIE, N. and BOULTON-LEWIS, G. (2001) Changing epistemological beliefs in pre-service teacher education students. *Teaching in Higher Education.* **6**(2): 247-268.

BUEHL, M. M. and ALEXANDER, P. A. (2001) Beliefs about academic knowledge. *Educational Psychology Review*. 13(4): 385-418.

HOFER, B (2001) Personal epistemology research: implications for teaching and learning. *Journal of Educational Psychology Review*, **13**(4): 353-383.

HOFER, B. (2000) Dimensionality and differences in personal epistemology. *Contemporary Educational Psychology*. **25**: 378-405.

HOFER, B. and PINTRICH, P. (1997) The development of epistemological theories: beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, **67**(1): 88-140.

JACOBSON, M. J., & SPIRO, R. J. (1995). Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: an empirical investigation. *Journal of Educational Computing Research,* **12**(5): 301-333.

JEHNG, J. J., JOHNSON, S. D., and ANDERSON, R. C. (1993). Schooling and students' epistemological beliefs about learning. *Contemporary Educational Psychology* **18**: 23–35.

KARDASH, C. M., & SCHOLES, R. J. (1996). Effects of preexisting beliefs, epistemological beliefs, and need for cognition on interpretation of controversial issues. *Journal of Educational Psychology,* **88**(2): 260-271.

PAULSEN, M. B., and WELL, C. T. (1998). Domain differences in the epistemological beliefs of college students. *Research in Higher Education* **39**: 365–384.

QUAIN, G. and ALVERMANN, D. (1995) Role of epistemological beliefs and learned helplessness in secondary school students' learning science concepts from text. *Journal of Educational Psychology*, **87**(2), 282–292.

SCHOMMER, M. (1998) The influence of age and education on epistemological beliefs. *British Journal of Educational Psychology*. **68**: 551-562.

SCHOMMER, M., (1994): Synthesising epistemological beliefs research: tentative understandings and provocative confusions. *Educational Psychology Review* **6**(4): 293-319.

SCHRAW. G. (2001) Current themes and future directions on epistemological research: a commentary. *Educational Psychology Review*, **13**(4): 451-464.

TOLHURST, D. AND BAKER, R. C. (2003) A new approach to a first year undergraduate information systems course. *Proceedings of the Australasian Computer Education Conference*. Adelaide February 4-7, 2003. **25**(5) 169-177

VAN DER HULST, M. and JANSEN, E (2002) Effects of curriculum organization on study progress in engineering studies *Higher Education* **43** (4): 489-506.