Title	Effects of knowledge-building on teacher-education students' epistemological belief change
Authors	Huang-Yao HONG, Ching Sing CHAI and Shu-Ping LIN
Source	*17th International Conference on Computers in Education (ICCE 2009), Hong Kong, 30 November to 4 December 2009*
Published by	Asia-Pacific Society for Computers in Education

Citation: H-Y. Hong, C.S. Chai & S-P. Lin. (2009). Effects of knowledge-building on teacher-education students' epistemological belief change. In S. C. Kong, H. Ogata, H. C. Arnseth, C. K. K. Chan, T. Hirashima, F. Klett, J. H. M. Lee, C. C. Liu, C. K. Looi, M. Milrad, A. Mitrovic, K. Nakabayashi, S. L. Wong & S. J. H. Yang (Eds.), *Proceedings of the 17th International Conference on Computers in Education* (pp. 229-236). Hong Kong: Asia-Pacific Society for Computers in Education.

Kong, S.C., Ogata, H., Arnseth, H.C., Chan, C.K.K., Hirashima, T., Klett, F., Lee, J.H.M., Liu, C.C., Looi, C.K., Milrad, M., Mitrovic, A., Nakabayashi, K., Wong, S.L., Yang, S.J.H. (eds.) (2009). *Proceedings of the 17th International Conference on Computers in Education [CDROM]*. Hong Kong: Asia-Pacific Society for Computers in Education.

Effects of Knowledge-Building on Teacher-Education Students' Epistemological Belief Change

Huang-Yao HONG[a], Ching Sing CHAI[b], Shu-Ping LIN[c]
[a,c]*Department of Education, National Chengchi University, Taiwan*
[b]*National Institute of Education, Nanyang Technological University, Singapore*
huangyao.hong@gmail.com

Abstract: Previous research indicates that epistemological beliefs are in relation to learning in various ways and have implications for teaching. This study further investigates whether it is possible to change teacher-education students' epistemological beliefs by engaging them in a constructivist way of collaborative knowledge building and learning in an online environment called Knowledge Forum. Findings indicate that Knowledge Forum as a knowledge-building environment is helpful in (1) engaging students in their online knowledge work; (2) making them more collaborative and reflective in the community; and (3) transforming their epistemological and pedagogical beliefs to become more constructivist-oriented.

Keywords: Knowledge building, epistemological beliefs, pedagogical beliefs

1. Introduction

The purpose of this study is to introduce knowledge-building pedagogy and technology into a teacher-education course and to investigate if it has any impacts on the development of students' epistemological and pedagogical beliefs. Epistemological beliefs can be generally defined as one's views about knowledge and knowing (Schommer, 1994). Previous research suggests that people's epistemological beliefs tend to progress slowly from a naïve perspective that views knowledge as certain and is passed down from authority, to a more sophisticated and relativistic stance that emphasizes knowledge as uncertain and constructed by individuals (Chai, Hong, & Teo, 2009; Chai & Khine, 2008; Chai, Khine & Teo, 2006; Magolda, 2004; King & Kitchner, 1994). As for pedagogical beliefs, they are commonly defined as one's views about teaching, and can be broadly classified under the knowledge transmission category or the knowledge construction category (Entwistle, Skinner, Entwistle & Orr, 2000; Samuelowicz & Bain, 2001). The former category is characterized as teacher-centered, content-driven didactic teaching practice that emphasizes on passive reception of knowledge by students; and the later as learning-oriented, student-centered constructivist teaching that encourages students to actively make sense of their experiences. As noted by previous research, epistemological beliefs are closely in relation to learning in various ways and have implications for teaching (Pajares, 1992; Richardson, Anders, Tidwell & Lloyd, 1991; Schommer, 1994; Wilson, 1990). For example, a review by Schommer (1994) has suggested that epistemological beliefs are related to reading comprehension, learning in complex and ill-structured domains, and learners' active participation and persistence in learning. A growing body of evidence also suggests that it is important to consider teachers' pedagogical beliefs in teacher education since such beliefs will influence performance in the classroom (Pajares, 1992; Richardson, Anders, Tidwell & Lloyd, 1991; Wilson, 1990). Yet, such beliefs are often neglected, or not properly addressed, within teacher education programs (Nespor, 1987). Despite studies in general suggest that it is possible to change pre-service teachers' beliefs (e.g., see Brownlee, Purdie & Boulton-Lewis, 2001; Gill, Ashton & Algina, 2004; Howard, McGee, Schwartz & Puecell, 2000), there is no consensus as to what represents a most effective way. The question of how to design instruction accordingly in order to help pre-service teachers or teacher-education students develop more sophisticated and constructivist-oriented knowledge views, so that they can be better prepared for future teaching, remains an important challenge for research.

One way to help teacher-education students develop more constructivist-oriented beliefs is perhaps to avoid traditional direct teaching and to engage them in self-initiated knowledge building practice (Hargreaves, 1999; Hong, Zhang, Teo, Scardamalia, 2009). Knowledge-building is a social process focused on the production and continual improvement of ideas of value to a community (Bereiter & Scardamalia, 2003) and is supplemented by the use of a software program called Knowledge Forum which enables an online knowledge-building environment. This educational approach is very different from the conventional approach of most teaching programs that highlight the importance of achieving specific content mastery as a desired outcome of educational experiences. Instead, it highlights a dynamic and integrated approach in which participants are encouraged to actively construct their understanding, and/or reconstruct the knowledge represented in the literature, and try to continuously improve it. Previous research suggests that the integral use of knowledge-building pedagogy and Knowledge Forum technology has been an effective means to support such collaborative knowledge-building and learning activities in class settings (Hong & Sullivan, 2009; Scardamalia, 2002; Scardamalia, Bereiter & Lamon, 1994; van Aalst & Chan, 2007; Zhang, Hong, Teo, Scardamalia, & Morley, 2008). Arguably, engaging students in such a collaborative knowledge building environment should also have effects on their views of knowing and teaching. Yet, such assumption remains to be tested. The purpose of the present study is to investigate whether engaging students in their knowledge work in Knowledge Forum would help them become more engaged in their collaborative efforts to building knowledge and would also help transform their epistemological and pedagogical beliefs to become more constructivist-oriented. Our main research question focuses on: How do knowledge-building pedagogy and technology affect students' learning processes and outcomes? Specifically, in terms of processes, we looked into participants' online performance, social interaction patterns, and their portfolio reflection on their own learning experiences throughout the semester; and in terms of outcomes, we looked into changes in students' epistemological and pedagogical views.

2. Methods

2.1 Context and participants

The study was conducted in a university course, titled "Introduction of Living Technology." The course is designed in part to prepare the participating students for their future teaching about natural sciences and technology at the elementary school level. There are two main instructional goals: one was to introduce the participants to some basic content knowledge required for them to teach technology-related subject matter for young students; the other was to engage them in the actual knowledge-building process by solving real-life technology related problems. The semester was 16-week long and was divided into four different phases, including: (1) introduction and exploration phase, in which students were guided to explore various living technologies (e.g., information and communication technology); (2) problem-finding phase, in which students were required to look for real-life problems and then identify a particular problem of interest for further investigation; (3) problem-solving phase, in which students were asked to design some technological solutions to solving their problems at issue; and (4) concluding phase, in which students were required to demonstrate their final technological solutions in class by giving a final presentation. In the meantime, throughout the whole semester, students were encouraged to constantly reflect on what they have learned and record their reflection thoughts in a portfolio note. They were also instructed to post all their key ideas related to their problem-finding and -solving to the Knowledge Forum, regardless of whether the ideas are from individual or group knowledge work, or whether the learning activities occur online or offline. There was no pre-assigned grouping. Instead, students self-direct their own learning by deciding whom to collaborate, or what ideas to interact with, based on the types of problems they are dealing at the moment. Participants were 22 teacher-education students. Their age ranges from 18 and 20. None of them has ever used Knowledge Forum before this course. The instructor has been using Knowledge Forum for three years and was very familiar with knowledge-building pedagogy and Knowledge Forum technology.

2.2 Online Knowledge Building Environment

The technology used to support this research is Knowledge Forum--a multimedia community knowledge space (Scardamalia, 2003). Participants contribute their ideas in the form of notes to "views" (a unique term used in Knowledge Forum), which are virtual spaces for collaborative discourse among community members. The Knowledge Forum environment enables participants to co-author notes, build-on, reference, and annotate the work of others, set problem fields and add keywords, and create "rise-above" notes that bring greater coherence to the contents of the knowledge space. All these features are designed to foster

collaboration in different means and depth. For example, "annotations" allow users to directly comment on an existing note. It is not stored as a separate note. Its purpose is to comment directly and exclusively on a particular piece of work. By contrast, "rise-aboves" allow users to gather theories and ideas that have already been presented and "rise above" these old ideas to new understandings. Reading, linking, referencing, editing, rise-above etc. operations are recorded automatically in the database, and can be summarized statistically by means of an Analytic Toolkit (Burtis, 2002). The Knowledge Forum technology designs—in line with the overarching commitment to continual knowledge improvement—allow students to exchange ideas and continuously improve them. Figure 1 shows a screenshot of a Knowledge Forum view, within which the red and square icons represents notes generated by students.

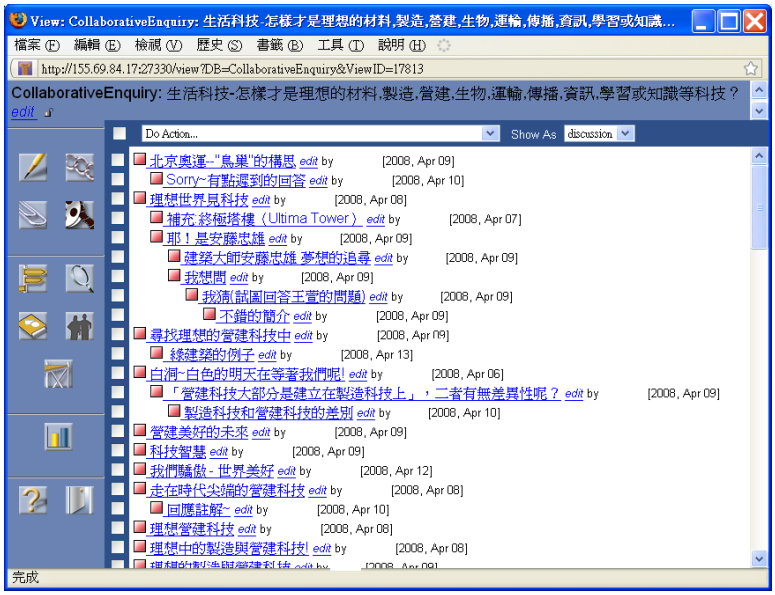

Figure 1. A screenshot of a Knowledge Forum view

2.3 Data sources and analysis

The current research employed a multi-method design approach to collecting and analyzing data. The main data sources include: (1) students' online discourse as recorded in a Knowledge Forum database; (2) students' portfolio notes, which contains students' self-reflection on what they have learned throughout this course; and (3) a belief survey. In the current study, our analyses focus on the processes of students' online collaboration (the first three research questions) and on the outcomes of students belief change (the last research question).

To analyze, a descriptive analysis was first performed on the recorded dataset in the Knowledge Forum to describe the overall online knowledge building activities. Second, a social network analysis (SNA) was conducted on the same dataset to illustrate the social dynamics of online interaction in the community (e.g., note posting, reading, and linking, etc.). Thirdly, to analyze students' portfolio notes, an analytic procedure referred to in grounded theory as "the constant comparative method of analysis" was adopted for open coding (Strauss & Corbin, 1990). Two researchers independently coded the student notes (inter-rater agreement =.95; differences resolved by discussion). Eight themes, emerged from the open coding, were then combined into two general aspects of knowledge building: (1) Knowledge exchange (including "willing to share", "receiving ideas from others", "sharing my ideas with others", and "reciprocal exchange of ideas"); (2) Knowledge improvement (including "integrating multiple perspectives"; "not just share but improve ideas"; "knowledge construction"; and "knowledge co-construction"). Table 1 shows the codes emerged, and related examples excerpted, from the open coding process. The results were then further quantitatively analyzed (Chi, 1997) by means of descriptive statistics to show the exact number of students who reported changes in terms of the processes of their learning and collaborative knowledge building. Excerpts of students' reflection were also reported to demonstrate the quality of such changes.

Table 1. Coding scheme employed for analyzing student reflection on their online learning experience (N=22)

Category	Code	Example (translated from Chinese)
Knowledge exchange	Willing to share	"Willing to take risks to express one's half-baked notions and ideas is important." (S21)

		"All ideas are important for sharing; one should not be afraid of receiving criticism." (S3)
	receiving ideas from others	"I learned to capitalize on other members' ideas to improve my own thinking" (S13)
	Sharing my ideas with others	"Knowledge Forum allows one to share their ideas to others." (S16)
	Reciprocal exchange of ideas	"Everyone in the community can quickly respond to each other's thinking; knowledge sharing and growth is mutual, not one way." (S15)
Knowledge improvement	Integrating multiple perspectives	"[Knowledge Forum] makes me realize and see that people can have very different ideas and see things from very different perspectives." (S19) "Other people's different viewpoints can be very interesting and imaginative to me". (S20)
	Not just share but improve ideas	"Many valuable ideas and concepts have transformed my prior thinking and concepts." (S3) "Because others helped me see things that I did not see, I have the opportunity to change my original thoughts." (S18)
	Knowledge construction	"We have created a unique technological product by means of sustained innovative thinking." (S9)
	Knowledge co-construction	Our final product can not be accomplished by anyone alone; it is gradually emerged and crystallized based on everyone's ideas." (S15)

Finally, to evaluate participants' possible changes in their personal epistemology and conceptions about teaching, a belief survey was administered. There were two parts in this survey. The first part is a version of Schommer's Epistemological Beliefs Questionnaire (EBQ) that was further adapted in Chan and Elliott's (2004) study. This modified version covers four dimensions: Certain Knowledge (CK), the Authority/Expert knowledge (AEK), Innate/Fixed Ability (IA), and the Learning Effort/Process (LEP). The second part of the survey examines the participants' conceptions about teaching (traditional/constructivist), which is also developed by Chan and Elliot (2004). All items employed a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). A high score indicates favorable respond towards the measured construct. Table 2 shows the six measured dimensions. The data was analyzed using SPSS and the results were also reported.

Table 2. Dimensions and sample items

Belief	Dimension	Sample Item
Epistemological Beliefs	Innate/Fixed Ability (8 items)	The ability to learn is innate/inborn. Our innate ability limits what one can do.
	Learning Effort/Process (11 items)	Getting ahead in study takes a lot of time. Everyone needs to learn how to learn.
	Authority/ Expert Knowledge (5 items)	Even advice from experts should often be questioned. I often wonder how much experts really know.
	Certainty Knowledge (6 items)	If scientists work hard enough, they can find the truth to almost anything
Pedagogical Beliefs	Traditional teaching (12 items)	The ideas of students are important and should be carefully considered. Good teachers always make their students feel important.
	Constructivist teaching (18 items)	The major role of a teacher is to transmit knowledge to students. Learning occurs primarily through drill and practice.

3. Results and discussion

3.1 Learning Processes

3.1.1 Overall online performance

The overall online activity and performance in this community is shown in Table 3. Throughout the whole semester, the participants have contributed a total number of 391 notes with a mean number of 18.59 (SD=5.51) notes generated per person. The percentage of participants' notes that are linked is 53% (SD=12.12%) and the percentage of notes that have been read per person is 46% (SD=20.38%). In addition, Table 3 also shows other related online knowledge-building activities recorded in this community, including number of revisions, number of references in notes, number of scaffold supports used, and number of build-on notes created. Overall, the online activities were quite sustentative as we designed and expected for this course. Nevertheless, while these behavioral measures give a general picture of participants' online activities in this database, they do not tell much about the processes of how participants actually interacted with one another. To better understand the social dynamics in the community, an additional social network analysis (SNA) using the same dataset was further conducted.

Table 3. Descriptive analysis of online knowledge-building activities in the community

	Mean	SD
# of notes created	18.6	5.51
% of notes linked	52.90%	12.12%
% of notes read	45.80%	20.38%
# of revisions	10.4	11.11
# of references in notes	2.6	3.67
# of scaffold supports used	12.1	7
# of build-on notes created	8.7	4.47

3.1.2 Online interaction patterns.

SNA was conducted to investigate social interaction patterns in the community by using the automatic assessment tools embedded in the Knowledge Forum. Table 4 shows detailed results of participants' interactions in each of the four knowledge-building stages throughout the semester. In this particular analysis, edge is defined as the total number of connections (or links) between pair of contributors (or members) in this community, and density is defined as the proportion of connections in a network relative to the total number possible. The higher the number of the edge or density is, the stronger the social dynamics a community is implied. A main purpose of this course is to transform the traditional way of knowledge-transmission mode of learning that is commonly practiced in Taiwan into engaging these students in collective problem-solving and knowledge work. Therefore, it was expected that providing a knowledge-building environment should help them work more collaboratively. As it can be seen, there was an increasing trend of social interactions as reflected by the measures of edge and density recorded online for this community from phases 1 to 4. While there is a slightly drop in stage 4, this is likely because students' online participants were diverted to preparing for their final project presentations. But overall, the findings indicate a desirable social dynamics of this community. Nevertheless, the SNA findings alone do not tell us much about the quality of students' interaction and collaboration. To answer this question, we further content-analyzed students' portfolio reflection notes to illustrate the processes of how they actually learn and build knowledge together in the Knowledge Forum.

Table 4. Social network analysis (SNA) of online knowledge-building activities in this community

	Phase 1 (weeks 1-4)	Phase 2 (weeks5-8)	Phase 3 (weeks 9-12)	Phase 4 (weeks 13-16)	Whole semester (weeks 1-16)
Edge					
Reading	172	211	228	218	173
Building on	16	15	54	38	96
Reference	2	3	23	14	35
Annotation	1	35	66	57	115
Density					
Reading	74.45%	91.34%	98.70%	94.37%	74.89%
Building on	6.92%	6.49%	23.37%	16.45%	41.55%
Reference	0.86%	1.29%	9.95%	6.06%	15.15%
Annotation	0.43%	15.15%	28.57%	24.67%	49.78%

3.1.3 Reflection on knowledge building and learning processes.

Table 5 shows analysis on participants' reflection that describes their learning experiences in Knowledge Forum. First, of the eight themes emerged from the open coding, we first calculated frequency of each theme being highlighted as important in the community. Then, of the two general aspects of knowledge building, we calculate the total percentage of students who highlighted the importance of at least one theme in each given aspect. As it shows, there was 90.4% of students (19 out of 21) who highlighted the importance of "knowledge exchange", while there was 85.7 % of students (18 out of 21) who emphasized the importance of "knowledge improvement" as an important part of their online learning experience. The finding suggests that towards the end of the course, most students were able to appreciate the value of knowledge building for their own individual knowledge growth and for their collective knowledge advancement in the community. An excerpt from a student's portfolio reflection note further corroborates this transformation among students (translated from Chinese):

> "…by means of Knowledge Forum, all members in the community share an equal opportunity to propose their ideas. The interaction between each other's ideas allows me to continuously improve my design concepts which evolved from very rough ideas to more refined ones, and my thinking also changed from more single-minded to more multiple-perspective oriented. My main design ideas was concerned with bedding technology, which changed from ones that only tries to provide an easy solution for bed-making and self-cleaning, to ones that also have the capacity to enhance quality sleep. During the process of idea improvement, I try to assimilate others' ideas on one hand, and to integrate them into my core ideas, on the other hand. Finally, I was able to design a whole series of bedding technology products. This whole process makes me feel very excited and surprised, because I never thought it is possible for a simple idea that only intends to save the trouble of making bed, to eventually evolve into a complete series of full-grown bedding technology products." (S17)

Table 5. Student reflection on their learning and knowledge building experience in Knowledge Forum (N=22)

Aspect of Knowledge building	Theme	Frequency of a theme being highlighted as important in the community	% of students who highlighted the importance of at least one theme in a given aspect
Knowledge Exchange	Willing to share	16	90.40%
	receiving ideas from others	11	
	Sharing my ideas with others	13	
	Reciprocal exchange of ideas	10	
Knowledge improvement	Integrating multiple perspectives	10	85.70%
	Not just share but improve ideas	16	
	Knowledge construction	5	
	Knowledge co-construction	18	

3.2 Pre-post changes in participants' epistemological and pedagogical beliefs

Finally, to understand if engaging students in knowledge building also has impact on their epistemological and pedagogical views, we conducted paired-sample t-tests to see whether there were any changes between pre- and post-surveys. Table 6 shows the results. In terms of epistemological beliefs, it was found that while there is a desirable drop in the two dimensions of Authority/Expert Knowledge (AEK) and Certainty Knowledge (CK), the results were not significant. Moreover, it was found there is no significant change in the Learning Effort/Process dimension, either. This may be because of a ceiling effect. Also, it appears that time may be a critical factor, as simply engaging students in knowledge building for a semester is not enough to overcome their deep-rooted knowledge-transmission view that has been gradually developed over years of their prior schooling experience. On the other hand, regarding the dimension of Innate Ability (IA), the results indicate that there was a significant change between pre- and post-ratings, indicating that students became less likely to believe in inborn ability as a fixed quality after involving in knowledge building and construction in Knowledge Forum for a semester.

In terms of pedagogical beliefs, it was found that students tend to rate the Constructivist Conception (CC) of teaching as more important at the post test, although the statistics is not significant. At the same time, it was found that there is a decrease in students' rating in the dimension of Traditional Conception (TC) of teaching, which however is statistically significant, indicating that students tend to view the traditional notion of instruction as less important, towards the end of the semester. This is important as these participants are future teachers and their pedagogical views are likely to affect how they may perform in their actual teaching practice in the near future.

Table 6: Mean, SD and t-test values for the measured constructs

	pre-assessment		post-assessment		t-value
	M	SD	M	SD	
Epistemological beliefs					
Authority/ Expert Knowledge (AEK)	3.02	0.30	2.96	0.45	0.797
Certain Knowledge (CK)	2.89	0.56	2.73	0.55	1.344
Innate Ability (IA)	2.70	0.64	2.44	0.73	2.343*
Learning Effort/Process (LEP)	3.91	0.52	3.81	0.34	0.953
Pedagogical beliefs					
Constructivist conception (CC)	4.19	0.55	4.27	0.50	-1.047
Traditional conception (TC)	2.71	0.45	2.48	0.48	2.948**

* p<.05, ** p<.01

4. Summary and conclusion

In summary, the findings indicate that Knowledge Forum as an online knowledge-building environment is quite helpful in engaging students in their collective problem-solving about technology-related problems. It also helps make students become more socially collaborative and reflective as evidenced by the social dynamics analyzed in the community and participants' portfolio reflection. Moreover, it was found that engaging students in knowledge-building is helpful in transforming their epistemological and pedagogical beliefs to become more constructivist-oriented. Previous research has pointed out the important relationships between students' beliefs and their learning. This study further suggests that the development of students' epistemological and pedagogical beliefs can be greatly influenced by how they learn (i.e., knowledge building pedagogy) and by the kind of learning environment (i.e., Knowledge Forum) they are engaged. To help teacher-education students to become more constructivist-teaching oriented teachers in the future, it is therefore important for teaching programs to divert away from traditional direct teaching that emphasizes knowledge achievement through specific content mastery. More importantly, it is necessary for teacher-education programs to provide students with more opportunities to engage in a more constructive way of knowing and learning, so that they can develop more constructivist-oriented epistemological and pedagogical beliefs. Admittedly, as there was not control group for comparison in this study, it remains inconclusive as to whether knowledge building pedagogy and technology alone is accountable for all the changes observed in the current study. Further comparative research will be conducted to help fully answer the research questions.

Acknowledgement

The preparation of this paper was supported in part by National Science Council, Taiwan, grant NSC 97-2511-S-004-001-MY2.

References

[1] Brownlee, J., Purdie, N., & Boulton-Lewis, G. (2001). Changing epistemological beliefs in pre-service teacher education students. *Teaching in Higher Education, 6*(2), 247-268.

[2] Chan, K. W., & Elliot, R.G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education,* Vol 20, pp 817-831.

[3] Chai, C. S., Hong, H.-Y., Teo, T. (2009). Singaporean and Taiwanese pre-service teachers' beliefs and their attitude towards ICT use: A comparative study. *The Asia-Pacific Educational Research, 18*(1), 117-128.

[4] Chai, C. S., & Khine, M. S. (2008). Assessing the epistemological and pedagogical beliefs among pre-service teachers in Singapore. In M. S. Khine (Ed.), *(in press). In Knowing, knowledge and beliefs:*

Epistemological studies across diverse cultures. Netherlands: Springer. (pp. 287-299). Netherlands: Springer.

[5] Chai, C.S., Khine, M.S., & Teo, T. (2006). Epistemological beliefs on teaching and learning: a survey among pre-service teachers in Singapore. *Educational Media International, 43*(4), 285-298.

[6] Entwistle, N., Skinner, D., Entwistle, D., & Orr, S. (2000). Conceptions and beliefs about "good teaching": An integration of contrasting research areas. *Higher Education Research & Development*, Vol 19, No. 1, pp 5-26.

[7] Gill, M. G., Ashton, P. T., & Algina, J. (2004). Changing pre-service teachers' epistemological beliefs about teaching and learning in mathematics: An intervention study. *Contemporary Educational Psychology, 29*, 164-185.

[8] Hargreaves, D. H. (1999). The knowledge-creating school. *British Journal of Educational Studies,* Vol 47, No. 2, pp 122-144.

[9] Hong, H.-Y., & Sullivan, F. R. (2009). Towards an idea-centered, principle-based design approach to support learning as knowledge creation. *Educational Technology Research & Development, 57*(5), 613-627.

[10] Hong, H.-Y., Chen, F. C., Chang, H. M., Liao, C. C. Y., & Chan, W. C. (2009). Exploring the effectiveness of an idea-centered design to foster a computer-supported knowledge building environment. In C. O'Malley, D. Suthers, P. Reimann, A. Dimitracopoulou (Eds.), *Computer Supported Collaborative Learning Practices: CSCL2009 Conference Proceedings* (pp. 142-150). Rhodes, Greece: International Society of the Learning Sciences, Inc.

[11] Hong, H.-Y., Zhang, J., Teo, C. L. & Scardamalia, M. (2009). Towards Design-Based Knowledge-Building Practices in Teaching. In C. O'Malley, D. Suthers, P. Reimann, A. Dimitracopoulou (Eds.), *Computer Supported Collaborative Learning Practices: CSCL2009 Conference Proceedings* (pp. 257-261). Rhodes, Greece: International Society of the Learning Sciences, Inc.

[12] Howard, B. C., McGee, S., Schwartz, N., & Puecell, S. (2000). The experience of constructivism: Transforming teacher epistemology. *Journal of Research on Computing Education,32* (4), 455-465.

[13] King, P. M., & Kitchener, K. S. (1994). Developing reflective judgment: *Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass.

[14] Magolda, M. B. (2004). Evolution of a constructivist conceptualization of epistemological reflection. *Educational Psychologist, 39*(1). 31-43.

[15] Nespor, J. K. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies,(19)*4, pp 317-328.

[16] Pajares, M. F. (1992). Teacher's beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research,* Vol 62, No. 3, pp 307-332.

[17] Ravindran, B., Greene, B. A., & DeBacker, T. K. (2005). Predicting pre-service teachers' cognitive engagement with goals and epistemological beliefs. *The Journal of Educational Research*, Vol 98, No. 4, pp 222-232.

[18] Richardson, V., Anders, P., Tidwell, D., & Lloyd, C. (1991). The relationship between teachers' beliefs and practices in reading comprehension instruction. *American Educational Research Journal,* Vol 28, No. 3, pp 559-586.

[19] Samuelowicz, K. & Bain, J. D. (2001). Revisiting academics' beliefs about teaching and learning. *Higher Education*, Vol 41, pp 299-325.

[20] Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal education in a knowledge society* (pp. 67-98). Chicago: Open Court.

[21] Scardamalia, M. (2004). CSILE/Knowledge Forum®. In *Education and technology: An encyclopedia* (pp. 183-192). Santa Barbara: ABC-CLIO.

[22] Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In *Encyclopedia of Education* (2nd ed., pp. 1370-1373). New York: Macmillan Reference, USA.

[23] Scardamalia, M., Bereiter, C., & Lamon, M. (1994). The CSILE project: Trying to bring the classroom into World 3. In K. McGilley (Eds.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 201-228). Cambridge, MA: MIT Press.

[24] Schommer, M. (1994). Synthesizing epistemological belief research: Tentative understandings and provocative conclusions. *Educational Psychology Review*, Vol 6, pp 293 -319

[25] van Aalst, J. & Chan, C. K. K. (2007). Student-directed assessment of knowledge building using electronic portfolios. *Journal of the Learning Sciences, 16*(2), 175-220.

[26] Wilson, S. M. (1990). The secret garden of teacher education. *Phi Delta Kappan,* Vol *72*, pp 204-209.

[27] Zhang, J., Hong, H.-Y., Teo, C. L., Scardamalia, M., & Morley, E. (2008). *"constantly going deeper:" knowledge building innovation in an elementary professional community*. Paper presented at the annual conference of American Educational Research Association (AERA), New York.