Learning methods for teacher education: the use of online discussions to improve critical thinking

Zsuzsanna Szabo[a]; Jonathan Schwartz[b]

[a] Department of Teacher Education, Marist College, Poughkeepsie, NY, USA [b] Division of Elementary Education, University of Hawaii at West O'ahu, West O'ahu, USA

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[a]*Department of Teacher Education, Marist College, Poughkeepsie, NY, USA; [b]Division of Elementary Education, University of Hawaii at West O'ahu, West O'ahu, USA*

Results from this study show that the use of online discussion forums as an instructional tool in a face-to-face course improved undergraduate preservice teachers' critical thinking skills. Participants in the study were 93 students registered in four sections of an Educational Psychology course at a Midwestern university. To control for learning preferences, all participants in the study took the Canfield Learning Style Inventory as a pre-test. Students also completed the Ennis-Weir Test of Critical Thinking as pre- and post-tests. In two of the four sections students used the Blackboard virtual learning environment to complete weekly discussions on course topics as part of their regular coursework. Quantitative analysis results from the critical thinking measure showed an increase in students' critical thinking skills over the course of the semester. The analysis of online postings demonstrates an increase in higher order thinking skills as measured with a rubric based on Bloom's taxonomy. Quantitative and qualitative analyses are presented along with implications for teaching and learning.

Keywords: teacher education; online discussions; critical thinking; Bloom's taxonomy

Use of technology and learning

Argument for developing students' critical thinking

The quality of teacher education is extremely important and is increasingly influenced by technology applications. In order to improve teacher education courses, teacher educators are looking for new ways to create high-quality educational experiences. Technology is not only a useful teaching tool, but also a method that can enhance the process of teaching and learning; this is the reason why many researchers study issues of technology as it relates to teaching (Gerogouli, Skalkidid, & Guerreiro, 2008; Urtel, 2008). One way that technology can serve to enhance the learning process is by offering an environment (online discussions, e-mail, chat rooms, blogs, wikis, etc.) available outside classroom time where students continue to reflect and discuss topics learned during class time. The challenge for teacher educators is to use this environment in a way that offers high-quality educational experiences which promote critical thinking skills. Blackboard discussion forums offer one tool to accomplish this goal. Research on online learning (Chiu, 2009; McLoughlin & Mynard, 2009; Solimeno, Mebane, Tomai, & Francescato, 2008;

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*Corresponding author. Email: Zsuzsanna.Szabo@marist.edu

Yang, 2008) shows that asynchronous discussions can increase professional competencies, develop critical thinking abilities, provide innovative opportunities, and increase student satisfaction.

Critical thinking is often discussed in relation to other cognitive skills such as logical reasoning, analyzing arguments, testing hypotheses, making decisions, estimating likelihoods, and creative thinking (Hallet, 1984; Ruggiero, 1975; Walters, 1994). Considered among higher order cognitive skills, critical-thinking skills differ from simpler, lower order thinking skills such as recall, understanding, and direct application of knowledge (Halpern, 1998). Bloom's taxonomy offers a useful modality to differentiate thinking skills. In its original form (Bloom, Krathwohl, & Masia, 1956), Bloom's taxonomy identifies six types of thinking skills: knowledge, comprehension, application, analysis, synthesis, and evaluation. In recent years, Bloom's taxonomy (Anderson & Krathwohl, 2001) has been revised into a two-dimensional taxonomy that includes knowledge levels (factual, conceptual, procedural, and metacognitive) as one dimension, and the second is the cognitive dimension, listing ways in which the knowledge is utilized (remembering, understanding, applying, analyzing, evaluating, and creating). Higher order thinking on Bloom's taxonomy is found on both dimensions at upper levels of the taxonomy. By definition critical thinking involves metacognition. When students think critically about topics learned they use metacognition. Students who use metacognition not only apply what they learn, but also think about their own processes of thinking. In time, they become self-regulated learners, which is the hallmark of successful education.

Critical thinking skills are essential and need to be fostered as part of any teacher education program. By learning to think critically, preservice teachers develop the ability to synthesize and analyze instructional materials, identify main ideas, cite evidence in support of a conclusion, practice evaluation skills, and become reflective practitioners.

From the above it is clear that preservice teachers should develop higher order thinking. For this to occur, college-level faculty must use instructional methods that engage students in discussions to use critical thinking. One of the effective methods is by using Blackboard forums for course-related discussions.

Technology, teaching, and learning

The use of discussions in a traditional classroom can contribute to the development of students' critical thinking skills. However, discussions are often hindered by the time limit, the number of students participating in the class, as well as by the unequal access to interaction (e.g., students who dominate the class discussions). For this reason, the challenge for instructors is to offer learning experiences that allow more discussion time. Research (Yang, 2008) shows that technology has a positive effect on student success and is an effective way to enhance teaching and learning. Technology in the form of Blackboard discussion forums used outside the classroom is a good way to involve students in content-related discussions.

Sivin-Kachala and Bialo (1993) report on the effects of computer technology in education in a meta-analysis based on 311 research studies that were conducted between 1980 and 2000. They show that the use of technology in teaching results in a significant positive effect on student achievement. In the same study, technology is shown to have a positive effect on student attitudes toward learning and self-concept. Along with the effects on students, technology influences teachers as well. Teachers'

instructional practices become more student centered, and student-to-student and student-to-teacher interaction increase when technology is a part of the instruction. Based on findings of their study, Sivin-Kachala and Bialo conclude that 'it is not the technology that makes the difference but rather how teachers adapt and apply technology that makes the difference' (p. 389).

Similarly, McFarlane (1997) recognizes the complexity of using technology in the classroom. McFarlane states that there are advantages as well as limitations to using technology. She stresses that the most important issue is related to *how* technology is used in education: 'Computer use alone, without clear objectives and well-designed tasks, is of little intrinsic value' (p. 35). It is important that the use of technology be purposeful and related to the content of teaching in order to be effective. Thus, one effective way to use technology is with the goal to enhance critical thinking skills.

McLoughlin and Mynard (2009) stress that 'the correct conditions need to be presented in order for higher-order thinking to arise' (p. 147). They emphasize that tasks need to be appropriate, the instructor needs to provide prompting, and guidelines should be provided to facilitate the development of higher order thinking. Research was conducted (Overbaugh, 2007) to see the effect of the online discussion format, comparing synchronous with asynchronous use of online discussions. The results show that asynchronous discussions were more effective. The author concludes that most students may not be capable of self-regulating their learning in online environments. This highlights the need for instructional regulation, especially when online discussions may lack guidelines and/or requirements, as is the case with most chat rooms. For this reason instructors can make a difference by focusing their teaching on students' metacognition skills (p. 411), and providing them with monitored and/or moderated environments that require higher order thinking.

Schumm, Webb, Turek, Jones, and Ballard (2006) conducted a study that compared face-to-face and online courses and evaluated students' critical thinking skills. They found that the use of online discussion boards increases critical thinking, and students demonstrated more complex questions, and increased contact, in online format. Similar findings by Derry, Hmelo-Silver, Nagarajan, Chernobilsky, and Beitzel (2006) show the effective use of online discussion boards in college-level courses. Their research demonstrates that technology helps students develop higher order thinking and enhanced critical thinking skills. Ryan and Scott (2008) conducted a longitudinal study with preservice teachers which showed that online discussions need to be conducted by active and experienced instructors in order to promote critical thinking.

Many researchers (Bigge & Shermis, 1992; Mayer, 1992; Swan & Shea, 2005) believe that technology used as part of course instruction facilitates active student involvement, and students are able to apply higher order thinking skills in multiple settings. Online threaded discussions, for example, enhance the process of teaching and learning by offering students opportunities to communicate thoughts and develop understandings in and outside of the classroom.

Several researchers (Ellis & Calvo, 2006; Garrison, Anderson, & Archer, 2000; Meyer, 2003; Pawan, Paulus, Yalcin, & Chang, 2003) examined online discussion forums as communities of inquiry that include the integration of cognitive, social, and teaching presence. Garrison and Cleveland-Innes (2005) note that the 'quantity of interaction does not reflect the quality of discourse' (p. 135). On a similar line of thought, Roblyer (2002) found that voluntary and required message posting that was pertinent to the purpose of the discussion created higher student engagement. Roblyer

and Wiencke (2003) show that consistent interaction in courses that use technology is associated with higher achievement and student satisfaction.

Our research study presents instructional methods used in teaching preservice teachers that involve the use of Blackboard discussions. The question addressed in this study is whether the use of Blackboard discussions increases critical thinking skills in preservice teachers as measured by: (1) changes in critical thinking when measured with the Ennis-Weir Test of Critical Thinking (Ennis & Weir, 1985), and (2) changes in the level of thinking across the semester reflected through the postings on the Blackboard discussion forums.

Methods

Procedures

The study took place in four sections of an Educational Psychology course at a university in the Midwest of the USA (two sections in the Spring of 2007 and two in Spring 2008). The sections were identical with respect to length of semester, student learning outcomes, requirements, assignments, examinations, and grading criteria. All four sections used the same text book, the syllabus for each section followed the same calendar of topics, and the content of study was the same for each week. Sections were taught by two different instructors, both of whom had equal teaching experience. Two sections were considered the 'traditional' groups and the other two were considered the 'technology' groups.

Teaching methods for the traditional groups included lectures, in-class discussions, homework assignments consisting of short reflections on the topics of study, and an in-class comprehensive test as the final examination. As part of their coursework, students in the technology group participated in both in-class and online activities. The in-class activities were similar to those used for the traditional group: lectures, in-class discussions, and in-class comprehensive test as final examination. Online activities required students to post reflections on the Blackboard discussion forums. To compensate for the difference in workloads, students in the traditional groups were asked to complete short reflections on the topics studied as part of homework assignments. Students from all groups were provided with the same grading rubrics for the common assignments. Students in the traditional groups were welcome to use the Blackboard discussion board; however, this was not required, nor were they required to respond to peers' postings.

Researchers studying the role of online discussions in the teaching–learning process (Holmes, 2004; Ryan & Scott, 2008) mention the importance of online discussions as part of the assessment methods used in a course. They stress the need to provide students with guidelines concerning the expected quality of posting. In line with this research we considered it necessary to set posting requirements and consider discussion board postings as part of the grading system. We set a minimum of six required postings (half the number of topics covered), which were reflections on the topics studied across the semester. Students were also instructed that it would be expected that they respond to postings made by peers. Grading rubrics for each assignment and Blackboard postings were provided, specifying that students were expected to show higher order thinking. From these they could draw on the guidelines of expected quality for their work.

The course instructor moderated the discussion board more actively in the first three weeks in the semester, then as semester progressed the instructor only

monitored and occasionally posted explanatory messages where students stumbled on a theoretical concept. This strategy was adopted based on research results from Holmes (2004), and Whipp and Lorentz (2009), who also found that the increased communication, help, and guidance between instructor and students in the online environment is important in the beginning of the semester, and leads to maximized learning opportunities. Other researchers (An, Shin, & Lim, 2009; Zhang, Gao, Ring, & Zhang, 2007) also show the importance of balanced instructor participation in online class discussion across the semester. Based on this research, the instructors for the technology groups modeled several reflections on the topic under study. They also asked open-ended higher order thinking questions, and encouraged students to post personal reflections of how they experienced in real life the theories they learned across the semester. As the semester progressed, the instructor simply monitored the discussions, answering questions that needed a larger or expert response. The role of the instructor became one of background and eventual facilitator. Students became part of a community to discuss, explore, reflect on, and critique the theories they learned.

Ryan and Scott (2008) specify that when using online discussions as part of course assessment methods, postings should allow students 'avenues for telling personal narratives' (p. 1640). In our research study the purpose of online discussion board postings was to provide students with opportunities to discuss and post their reflections on the course topics. Along with analytical thinking on the topics they posted, students were also required to give personal examples of how they would apply the theory in their teaching practice as future teachers, and/or to give examples of personal experience pertaining to the theory.

In order to evaluate students' attitudes concerning their course experience, all students in the technology groups were asked to complete an 'end of semester feedback' survey with questions related to the teaching methods, the use of and value in the learning process of Blackboard, and posting reflections on the discussion board.

The present study took place in two consecutive semesters. In Spring 2007 two sections of the same Educational Psychology course were randomly assigned, to the two groups (traditional or technology group) described above. In Spring 2008, the instructors switched their format. The instructor who taught the traditional group in Spring 2007 now taught using the Blackboard discussion board postings. The instructor who had taught the technology section in Spring 2007, now used traditional methods. In order to keep complete confidentiality each student was assigned a numerical ID code that reflected the modality of instruction.

Participants were 93 undergraduate students (82% were preservice teachers) (see details in Table 1).

Table 1. Demographic data by semester, teaching method, and gender.

Semester	Teaching method	Female	Male	Total
Spring 2007	Traditional	14	7	21
	Technology	20	7	27
Spring 2008	Traditional	17	5	22
	Technology	15	8	23
Total		66	27	93

All participants in the study took the Canfield's Learning Style Inventory (Canfield, 1992) during the first week in the semester to control for any learning environment predispositions. Canfield's Learning Style Inventory (CLSI) determines which learning environments and which types of instructors are best for particular students (Canfield, 1992). Participants taking CLSI respond to an inventory of 30 questions by ranking each response to questions on a scale of 1 to 4. A total score can be calculated.

In order to observe any changes that might have taken place in students' critical thinking over the course of the semester, participants completed the Ennis-Weir Test of Critical Thinking (Ennis & Weir, 1985). The Ennis-Weir Test of Critical Thinking (EWCT) was developed (Ennis & Weir, 1985) to help evaluate a person's critical thinking ability. Those taking the EWCT are asked to write a critical argument to a given situation. Participants are required to respond in writing to an eight-paragraph fictitious letter written by a 'concerned citizen' to a journal editor in regards to night parking on streets. The writer of the letter presents eight specific reasons. Respondents need to present their logical and critical reasoning for each of the eight points (showing their reasoning in agreement or disagreement, and logical thinking about the arguments from the fictitious letter), and lastly give a general comment. Scoring is done using the specially designed scoring rubric provided with the test manual. Scores can be obtained for each of the eight points and total scores.

This was administered as a pre-test during the first week of the semester and administered again as a post-test during the last week in the semester. In this study, critical thinking was considered as being the core thinking behind 'deciding what to believe and do' (Ennis, 1987, p. 11), specifically, as being the critical examination of a statement by examining its assumptions, the accuracy of supportive evidence and the logical reasoning in reaching conclusions based on a given context (Lipman, 1995; Paul, 2003).

The EWCT pre- and post-tests were scored using a double-blind review process (controlling for condition and time of assessment). There were two raters. The first rater was one of the instructors who taught the students involved in this research. The second rater was a faculty member teaching the same content at another university. The second rater was chosen intentionally from another university to control for rater bias. Results show high inter-rater correlation (inter-rater r = .79). Data were then analyzed to observe any changes in critical thinking as demonstrated by the students across semester and between groups.

A rubric based on Bloom's revised taxonomy (Anderson & Krathwohl, 2001) was used to score students' online postings. The rubric measured factual, conceptual, procedural, and metacognitive levels of knowledge for each posting for the following cognitive levels: remembering, understanding, applying, analyzing, evaluating, and creating. Quantitative analysis was performed to study the changes concerning the writing level of students' online postings, across the semester. Postings at the higher levels of Bloom's taxonomy were considered as higher levels of thinking, and use of critical thinking. There were 12 topics of study across the semesters that were used for comparison. All Blackboard discussion postings were scored separately by the two raters (inter-rater reliability r = .82).

Qualitative analysis of student attitudes concerning their course experience with the online Blackboard postings was performed using the 'end of semester feedback' survey.

Results

Quantitative analysis

The main purpose of this study was to determine whether the use of Blackboard discussion forums as an instructional tool in a face-to-face course would result in increased critical thinking and use of higher order thinking for undergraduate preservice teachers.

Results from the comparison across groups at the beginning of semesters showed that there were no statistically significant differences in the learning styles and instructional preferences between students in all groups as measured by Canfield's Learning Style Inventory (t = 1.67, df = 91, p = .098; Cohen's d = .068).

Data analysis from the Ennis-Weir Test of Critical Thinking at pre-test revealed no statistically significant differences in critical thinking between participants in the traditional and the technology groups (F(3, 89) = .390; p = .76).

Data analysis comparing results from the EWCT across semester (between pre- and post-test) for all groups showed that there was a statistically significant increase in critical thinking skills as presented by students in the technology groups. This was not the case for students in the traditional groups. Post-test results revealed that there were statistically significant differences in critical thinking abilities between technology groups and traditional groups (F(3, 89) = 37.46; p = .0001) with students from technology groups demonstrating higher levels of critical thinking skills. The effect size was quite large in both semesters: Spring 2007 Cohen's d = .71; Spring 2008 Cohen's d = .75. Statistically significant changes in critical thinking from pre- to post-test were found only for participants in the technology groups (t = 15.04, df = 49, p = .001).

The quantitative analysis of Blackboard discussion board postings using the scoring rubric (revised Bloom's taxonomy; Anderson & Krathwohl, 2001) showed an increase in student performance levels and use of higher order thinking skills. Rating each reflection and comment posted on Blackboard by each student, the two raters used the same rubric, and classified the posting at the appropriate level. Then in a spreadsheet we transposed the results from all postings by level and by student for all 12 topics of study across the semester. Results were quantitatively analyzed. They show that over the course of the semester, students' online postings presented statistically significant increases for levels of application, analysis, evaluation, and creation, at the conceptual, procedural, and metacognitive levels (results in Table 2 below).

A one-way analysis of covariance (ANCOVA) was conducted for this study. The independent variable (course) included four groups (students in the different sections across the two semesters the study took place). The dependent variable was the students' post-test scores on the EWCT, and the covariate was the students' pre-test scores on the same test of critical thinking. A preliminary analysis evaluating homogeneity-of-regression assumption indicated that the relationship between the covariate and the dependent variable did not differ significantly as a function of the independent variable (the different sections of the course), F(3, 8) = 1.215, p = .309. The ANCOVA was significant F(3, 92) = 53.36, p < .001 (see Table 3). However, only 5% (ω^2 = .05) of the total variance for the EWCT test scores was accounted for by the four groups the students belonged to at the beginning of the semester.

Follow-up tests were conducted to evaluate pairwise differences among adjusted means for groups. The Bonferonni procedure was used to control for Type I error across the six pairwise comparisons (α' = .1/6 = .0017). The results showed that students who belonged to the technology groups had statistically higher EWCT

Table 2.   Quantitative results from Blackboard discussion postings.

		Sum of squares	df	MS	F	Sig.
Factual	Between groups	147.48	11	13.41	4.94	.001
	Within groups	844.74	311	2.72		
	Total	992.22	322			
Conceptual	Between groups	187.39	11	14.04	6.02	.001
	Within groups	879.77	311	2.83		
	Total	1067.16	322			
Procedural	Between groups	425.17	11	38.65	11.41	.001
	Within groups	1053.09	311	3.39		
	Total	1478.27	322			
Metacognitive	Between groups	240.69	11	21.88	7.06	.001
	Within groups	963.96	311	3.1		
	Total	1204.66	322			

Note: Results of students' postings were compared across the 12 topics of study in the semester.

Table 3.   Analysis of covariance for score on the Ennis-Weir Test of Critical Thinking by course section.

Source	SS	df	MS	F	p
Pre-test scores	561.35	1	561.35	49.86	.000
Course section	1802.33	3	600.78	53.36	.000
Error	990.71	88	11.26		
Total	3512.28	92			

post-test scores than students who belonged to the control groups, controlling for the effect of all students' EWCT scores at pre-test. The difference effect size measures were as shown in Table 4.

Qualitative analysis

Blackboard reflections

There is a strong evidence of change in the quality of postings. Postings on topics studied at the beginning of the semester tended to repeat the content and pose questions at lower cognitive levels (e.g., remembering and understanding).

Table 4.   Pairwise comparisons and effect sizes of EWCT scores by groups.

			Adjusted mean differences $(X'_i - X'_k)$			
Group	Mean	Adjusted mean	1.	2.	3.	4.
1. Technology group	18.59	18.20	–			
2. Technology group	21.35	21.37	3.16	–		
3. Control group	10.19	10.58	7.62* (2.27)	10.79* (3.22)	–	
4. Control group	11.64	11.70	6.50* (1.94)	9.67* (2.88)	1.11	–

Note: Statistically significant p < .0017 effect sizes are indicated in parentheses.

Emily (names have been changed for all examples for confidentiality purposes) is one student who demonstrated increased ability to think critically over the course of the semester. Early postings by Emily showed thinking at lower levels of Bloom's taxonomy including factual – remembering, understanding and applying. Emily's writings consistently recalled facts about theories and theorists:

> According to the text, critical periods are time spans that are optimal for the development of certain capacities of the brain. Critical periods coupled with optimal environments further cognitive development. Since it is possible for children to develop at different times, how is a teacher supposed to create optimal environments for all students?

Later Emily makes attempts to analyze and relate the topic in study with previously studied topics:

> According to the textbook some factors influence self-efficacy: previous experiences, observing others, teacher's comments, environmental and physiological aspects. From what we learned previously I think students with high motivation probably have also high self-efficacy. I also would relate self-efficacy with the way a person makes causal attributions. … Therefore, as future teachers, one of our goals should be to help increase self-efficacy in our students. I think I would be able to come up with some methods I could apply in classroom setting.

In later stages of the class, Emily showed more of a tendency to reflect on her own thinking. She demonstrated evidence of analysis, evaluation and, in one instance, creation. Below is Emily's last posting:

> Motivation is such a key component to learning. It is the drive behind children that makes them want to learn. Without a reason to want to learn, why should they? It doesn't always have to be a treat. In fact my biggest motivation as a high school student was my desire to grow up go to college and become a teacher. It is all about what makes the child value education. The hard part is that it [motivation] is different for each student. That is our job as teachers, we need to motivate and reach as many of our students as possible. But first of all I think we must get to know our students, and know what they value, and what motivates them.

Analysis of the excerpt shows how Emily started to make connections to previous experience by relating the concept of motivation to her desires as a high school student. She goes on to evaluate motivation and identify her role in the process. In her later postings, it was not uncommon for Emily to project forward and evaluate how student motivation would affect her teaching.

Students' reflections during the semester evolved from simple reporting of the content learned and proof of understanding of the information, to proof of reflective and critical thinking, application, and analysis of the content. One example of reflection posted by Mary shows evaluation of the theoretical concepts:

> I think Piaget's theory makes more sense than the Classical behaviorist theory. In the end we are thinking beings, we might be able to learn something from reflex but we also think about what we learn.

Michael is another student who made explicit connections in his postings between the course content and home life.

> This is a subject that is very close to home for me right now. My son is completely unmotivated. I have tried punishment, encouragement, giving money but nothing works. He refuses to do his home work and would have straight A's if not for home work. I liked the different approaches that we talked about, especially letting him come up with his own ideas. I am going to try this approach with him and see if letting him have ownership of what happens can help him. I hope something will work soon for him. Thank you all for the ideas.

Here Michael demonstrates that he is able to apply and test the theory learned in the course. This demonstration of analysis and evaluation shows Michael's ability to demonstrate higher order cognitive processes. Later, Michael again shows metacognitive abilities when he writes:

> It seems that Operant Conditioning and Motivation do fit hand in hand, however, I feel that there is a difference. A student who does not study for an exam and does well, may not be inclined to study for the next test … But with motivation (to learn), its definition is the 'student's tendency to find academic activities meaningful and worthwhile and to try and get the intended learning benefits from them' … Operant conditioning is voluntary and the behavior precedes the stimulus, with Motivation students are presented with a challenge and it's at that point they decide whether or not it's something they are interested in and if they want to learn the information.

End of semester feedback

Analysis of statements from the 'end of semester feedback' (only from participants in the technology group) shows that participants reported feelings of enhanced performance owing to team discussions, and enjoyed the weekly Blackboard discussion postings because they were able to share more information, reflections, and questions outside the classroom. For example, one student wrote:

> I have found in the beginning of the semester very difficult to write reflections on the topic of the week; by around midterm I felt more comfortable and now when I think back I really enjoyed the Blackboard discussions and I think I learned more through reflecting on the topics than by only reading the book and in class small groups discussion.

Students also reported that the out-of-class discussion opportunities helped foster understandings by allowing for the sharing of learning on course topics. Students benefited by making connections to real-life educational situations.

> If I were to modify anything to this course I would want to have weekly reflections as requirement, not only a minimum of six. I think that even if they were a big effort in the beginning, we learned from each other and had a place to continue our discussions after class, especially when we had more ideas of how to apply a concept.

> I liked that we could share ideas, and help each other come up with a better understanding of the content.

The opportunity to explore, reflect, and share was often mentioned by students in the technology groups as a positive part of the posting online:

> personally I found annoying in the beginning to post responses to other postings, but as the semester progressed more interesting reflections and examples were posted, so I found myself replying to many more postings from peers.

Some participants reported that before taking the course they had limited knowledge about Blackboard. At the completion of the course, these students learned not only what a discussion board is for, but they expressed their enjoyment for online discussions and planned on exploring this as a method for instruction.

> This was my first semester to use Blackboard and I was really afraid that I will not be successful. But I felt comfortable sharing with everyone. I think we helped each other and by the end of semester I am glad that we used the Blackboard.

> Using Blackboard helped me develop new skills and I think I will be more inclined to use technology in my future teaching.

Discussions

Quantitative results

The results from the Canfield Learning Style Inventory indicate that students at the beginning of the two semesters did not have significantly different learning and instruction style preferences.

Results from the Ennis-Weir Test of Critical Thinking, after controlling for their pre-test scores, show that only students in the 'technology' groups demonstrated an increase in critical thinking skills across the semesters. Since the content, textbook, and syllabus calendar were similar for all groups, it seems that using the Blackboard discussions board helped students in the technology groups increase their critical thinking skills. Given that each of the two technology groups was taught by different instructors, the results are more robust and support the hypothesis that the difference in critical thinking among students in different groups is due to the work posted to the Blackboard discussion board.

To encourage the use of higher order thinking, students were required to post to Blackboard discussion forums reflections on topics studied in class, and to respond to peers' reflections. Reflections that demonstrate higher order thinking implied mastery of the topic, proof of ability to apply the content to real-life situations, analysis and comparison of different theories learned, and development of new ideas (creativity). These abilities also demonstrated the use of metacognition in learning and the use of critical thinking skills. As a comparable task, students from the 'traditional' group were asked to show their reflection on the topics of study through the homework assignments; however, these students did not have the opportunity to read each other's reflections, neither to comment on those. An open exchange of homework assignments would be possible also for paper format; however, it would definitely be extremely cumbersome, and would take more time and energy than the use of the online system where the students choose to respond to their colleagues' reflections posted to the discussion forum. We believe that the results from our study can be attributed in the same measure to the process of reflective thinking and also to the exchange of ideas provided by the Blackboard discussion board. Reading the reflections and being required to comment on them helped students think critically and use metacognition in the process of Blackboard discussions.

These results support our hypothesis that the use of Blackboard discussion forums as instructional tool in a face-to-face course helps undergraduate preservice teachers use higher order thinking in learning (given that appropriate tasks are required through the discussions). Also our results support findings from other research, concerning the

effectiveness of use of technology for teaching college courses, conducted by Derry et al. (2006) and Elder and Paul (2002).

Results from the quantitative analysis of students' postings suggested an increase in the number of well-developed ideas and higher levels of thinking as measured with Bloom's revised taxonomy as scoring rubric. Similar to the results from the critical thinking test analysis, the number of postings categorized at higher levels of Bloom's taxonomy increased over the course of the semester.

Results from this research study support findings by Biggs (1987, 1998, 1999), Koehler, Mishra, and Yahya (2007), and also other authors (Bigge & Shermis, 1992; Mayer, 1992; Swan & Shea, 2005), who report that the use of online discussion as a teaching method needs to be purposeful in order to serve higher levels of learning through improved pedagogies. Our research results also support research conducted by Schumm et al. (2006) who demonstrate that the use of online discussions in face-to-face courses to supplement classroom teaching increased students' critical thinking skills. Our study demonstrates that Blackboard discussions also helped students develop more complex comments and reflections, and increased contact in online format across the semester as compared to only face-to-face teaching methods.

Qualitative results

Blackboard reflections

There is strong evidence of change in the quality of postings across the semester. Postings for topics at the beginning of the semester were mostly repeating the content and asking questions at the level of factual and conceptual understanding.

Analysis of the postings from the beginning of the semester shows that students typically repeat the content and give simple examples, and there is not much evidence that students analyze and make connections between the topics studied. Analysis also shows that the level of questions posed by students at the beginning of the semester was rhetorical; most of these were ranked at lower levels of Bloom's taxonomy.

As the semester progressed, students' reflections developed from simple reports on the course content to reflective and critical thought. There was more evidence of application, and analysis of the content. Students also showed evaluation of the theoretical concepts, and use of metacognition to evaluate and/or come up with new ideas. Many reflections posted after the mid-semester showed evidence of creative application of theories to real-life situations. As can be seen from the several examples provided in the section above, there was demonstration of analysis and evaluation, critical thinking, metacognition and creative thinking.

Teaching methods by instructors included monitoring and facilitation, mostly in the beginning of the semester (first three weeks). This proved to be necessary (An et al., 2009; Zhang et al., 2007) for helping students to develop higher order thinking. Even though traditional group students were required to write reflections (homework assignment), they did not benefit from timely monitoring and facilitation, and did not have the opportunity to read and comment on their colleagues' reflections (they received feedback on homework but only after turning in the assignment). Our results support the idea that the use of online discussions through posting reflections and comments helped students in the technology groups to develop critical thinking and to improve across the semester the quality of the written reflections.

End of semester feedback

As could be seen from the examples in the above section, 'end of semester feedback' from students in the technology group demonstrates the positive effect of the weekly Blackboard discussion postings. Students had the opportunity to explore, think, discuss, and analyze the topics they learned outside the class. As students stated, it seems that they not only gained a better understanding of the content, but also learned how to use the Blackboard for course purposes. Through facilitation, modeling, and giving timely feedback the instructor not only helps the students learn the content, but gives an example of how to teach using online discussion; and this is a very important class management lesson especially when we teach preservice teachers.

The results of this study support Elder and Paul (2002), as well as results from research by Krentler and Willis-Flurry (2005), that show the use of technology and online discussions increase student learning and critical thinking abilities. Our study results show that the use of Blackboard postings, in the form of weekly reflections and reciprocal comments, was the factor that improved students' critical thinking skills and helped them demonstrate higher order thinking. Students using asynchronous discussion forums to post their reflective thinking had the opportunity, outside the classroom, to explore ideas and think about the concepts they have learned. It also gave them the ability to see other colleagues' thoughts and descriptions of how others experienced the theory in their lives. The asynchronous discussion forum created opportunities for further reflection, exploration, and application of the theory into practice. These online forum discussions and reflections were like an extension of the in-class activities. The exchange of reflective thinking and the opportunity to critique and comment on each other's reflections helped students in this research improve their critical thinking.

For this reason, we suggest that the use of online discussion forums as part of the instructional methods needs to be purposeful. It is not sufficient to ask students merely to write a reflection, even if posted online (in that case, the traditional groups who had to complete the reflection task, but did not comment on each other's reflections, would have had the benefit of reflective thinking). This study suggests that reflective thinking posted to an open online forum associated with substantial comments on other reflections results in an increase in critical thinking and use of the higher order thinking approach in learning. Exploration, reflection, and the exchange of ideas and comments that are commonly shared in an open forum bring the benefit of creating higher levels of thinking. We further suggest that a certain amount of intervention and guidance from the instructor is necessary: modeling comments, asking open-ended higher order thinking questions, and encouraging students to share their reflections and experiences.

Limitations

Despite the positive results from this study, there are several limitations. Even though sections of this course were randomly assigned to different instructional methods (traditional or technology), the entire research took place using one course; and the study had a small sample size (four sections). For this reason the present research has a limited generalizability; only to Educational Psychology courses taught for under-graduate preservice teacher education students. Future research is needed to evaluate changes in critical thinking in other types of courses that offer different types of

content. There is a further limitation which is related to the required use of Blackboard discussions (six reflective postings across the semester). Even though the traditional sections could use the Blackboard forums, they were not required to do so and participation was not part of the grade. The students in traditional groups did not have the advantage of open discussions outside class time and were not able to read and respond to their peers' reflections on the topics studied. It is known that higher order thinking and critical thinking develop through discussions and feedback from peers and instructor. Compared to their peers in the technology sections, students from traditional sections were limited in their access to discussion outside class time, and exchange of ideas.

Conclusions

Results of this study show that instructional methods which used online discussion forums, beyond the normal in-class lecture and discussions, increased critical thinking skills and generated higher order thinking in preservice teachers as demonstrated by results from the critical thinking test, and discussion board postings.

Along with an increase in critical thinking and creating higher order thinking, the use of online discussions gives preservice teachers experience with the use of technology for teaching purposes. In the new era when teachers must develop the same technology-related skills as their future students, the teaching of future teachers should go beyond the theoretical content of human development, learning, and classroom assessment. In the process of teaching future teachers, college faculty should prepare preservice teachers to 'walk the talk' by providing them with numerous and diverse high-quality classroom experiences. Preservice teachers should learn skills pertaining to the new multi-tasking and technology-savvy generation of students. Through the use of individual and team work, the implementation and use of technology, and asking preservice teacher education students to reflect, present, evaluate, and apply the content learned in new and creative modalities, we also help them to improve their critical thinking abilities. The results from this study show that the use of asynchronous Blackboard discussions in a face-to-face course will increase critical thinking among preservice teacher education students. The next question for a future research project would be, 'What is the optimal combination of face-to-face and online discussions used to maximize student learning?'

Notes on contributors

Zsuzsanna Szabo is Associate Professor in the Department of Teacher Education at Marist College, Poughkeepsie, NY. Her research interests include human cognition and learning, student learning assessment, team learning, and gender issues in education. She received her BSc in Civil Engineering from Technical University Cluj, and BSc in Psychology from University Babes-Bolyai, both in Romania, an MEd from SUNY at Buffalo, NY, and a PhD from the University of Arizona. She also worked for nine years as a civil engineer.

Jonathan Schwartz is Assistant Professor in the Division of Elementary Education at the University of Hawaii at West O'ahu. His research interests include inquiry, curriculum and instruction, and human cognition. He earned his doctorate from the University of Arizona, an MSc from Nova University, and a BSc in business marketing from Ithaca College.

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