Internet and Higher Education 13 (2010) 52–59

Contents lists available at ScienceDirect

Internet and Higher Education

Investigating students' level of critical thinking across instructional strategies in online discussions

Jennifer C. Richardson [a,*], Phil Ice [b]

[a] Purdue University, United States
[b] American Public University System, United States

ARTICLE INFO

Keywords:
Community of Inquiry
Instructional strategies
Online discussions
Critical thinking
Cognitive presence
Distance education

ABSTRACT

Online discussion questions, which reflect differing instructional strategies, can take many forms and it is important for designers and instructors to understand how the various strategies can impact students' critical thinking levels. For the purpose of the study three instructional strategies used in the development and implementation of online discussion questions were examined: a case-based discussion, a debate, and an open-ended (or topical) discussion. Using a mixed method approach, the study focused on critical thinking levels as described in the Community of Inquiry (CoI) framework and operationalized in the Practical Inquiry Model (PIM). The study investigated (1) participants' preferred instructional strategy and rationales for the selection, (2) the contribution of student background and demographic criteria to students' preferred instructional strategy, (3) the contribution of students' strategy preferences in predicting level of critical thinking, based on the Practical Inquiry Model's (PIM) indicators, and (4) comparisons of participants' critical thinking levels across instructional strategies. Implications for the design of online discussions that foster critical thinking are discussed.

1. Introduction

Online discussions have been heralded as a powerful tool that can assist students in the construction of knowledge and serve as a scaffold that allows for multiple perspectives, negotiation of meaning, and an understanding of knowledge gaps a learner may possess (Land, Choi, & Ge, 2007; Haavind, 2006). Discussion questions are generally based on course or learning module objectives and are developed with a variety of purposes in mind: to promote recall of information, to encourage reflection, to diagnose learning difficulties, to focus attention, and to stimulate learners (Berge, 2002). However, online discussions, which reflect differing instructional strategies, can take many forms including article discussions, jigsaws, scenarios, critical incidents or problems, case studies, controversial topics, role play, and debate (Bonk & Dennen, 2007). As Bonk and Dennen (2007, p. 240) explain, it is important to "understand the various types of learning activities that can be effectively used to enhance the quality" of online learning.

The authors of this study were interested in gaining insight into how employing differing instructional strategies via online discussion questions engaged students in meaningful learning, and whether or not there was a connection between student's levels of critical thinking and the different instructional strategies. For the purpose of this study three instructional strategies for the development and implementation of online discussions were examined — a debate, a case-based discussion, and an open-ended (or topical) discussion. The three strategies fall within different pedagogical activity subdivisions according to Bonk and Dennen's (2007) "Online Learning Pedagogical Activities by Thinking and Learning Model." Debates are classified as "structured controversy" and are collaborative learning activities; topical discussions are classified as creative thinking activities; and case-based discussions are classified as "online cases analyses" and are critical thinking activities.

2. Background

2.1. The instructional strategies

In asynchronous online discussions, the traditional instructor-led discussion format is shifted, and student participation is promoted by providing everyone an equal chance to contribute and learn from others at times of their own choosing. Relying on a constructivist learning approach, asynchronous online discussions encourage student interaction, analysis, and collaboration (Bonk & Dennen, 2007; Pilkington & Walker, 2003; Winiecki, 2003). However, whether one considers traditional face-to-face or online learning, different learning goals require different conditions for learning and an appropriate instructional strategy that includes all the necessary conditions to reach the goal (Merrill, 2000). This study examined students' perceptions of, and experiences with, online discussions

* Corresponding author. BRNG 3142, C&I Department, 100 N. University St., Purdue University, West Lafayette, IN 47907, United States. Tel.: +1 765 494 5669.
E-mail address: jennrich@purdue.edu (J.C. Richardson).

1096-7516/$ – see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.iheduc.2009.10.009

utilizing three different learning strategies: a case study, a debate, and a topical discussion.

The object of the case-study approach is to help learners develop skills in dealing with real-life situations by analyzing a typical case, or, alternatively, to reach a better understanding of the general principles that are evoked by the case (Romiszowski, 1995). A central goal is to enable rich discussion among students and between students and the instructor (Webb, Gill, & Poe, 2005) while "bridging the gap between theory and practice and between the academy and the workplace" (Barkley, Cross, & Major, 2005, p. 182). According to Kleinfeld (cited in Hsu, 2004), students have the benefit of "learning to examine problems, reflect on their own values, and weigh the merit of their decisions within a group while demonstrating 'a creative way of thinking, a process of problem framing and inquiry, a process of design'" (p. 682).

The use of debates as an instructional strategy helps develop students' critical understanding in a specialist subject area by encouraging them to explain and justify their reasoning (Pilkington & Walker, 2003). Debating "is a structured contest of argumentation that forces the participants to consider not only the facts of a situation but the implications as well. Participants think critically and strategically about both their own and their opponent's position" (Saskatoon Public Schools, 2008, Index section, paragraph 1).

Open-ended or topical discussions are a popular way, possibly the most commonly used, to encourage students to explore readings in online and blended courses. They involve "an 'oral' exploration of a topic, object, concept or experience that begins with teacher-posed questions that promote the exploration of a particular theme, topic or issue. Through discussion, students should achieve a deeper understanding of the topic" (Saskatoon Public Schools, 2008, Instructional Strategies section, paragraphs 3 and 4). Research on open-ended discussions suggests that they can be used to promote collaborative learning around unrestricted questions (Sammons, 2007).

2.2. Teaching and assessing critical thinking

There is much talk given to the concept of critical thinking and related skills in learning and instruction, and as many definitions and perspectives as there are disciplines. Facione and Facione (2007) define critical thinking as "reflective decision-making and thoughtful problem solving about what to believe and do" (p. 44). Similarly, Halpern (2003) defines critical thinking as "cognitive skills and strategies that increase the likelihood of a desired outcome… thinking that is purposeful, reasoned, and goal-directed — the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions" (2003, p. 6).

The many approaches to assessing critical thinking skills are parallel to the many approaches to teaching them. Spicer and Hanks (1995) reported on standardized critical thinking tests available as well as several performance assessment approaches that can be used as outcome measures within various subjects. Standardized tests can provide useful information that is diagnostic and may help to guide instruction. However, multiple measures of critical thinking should be used whenever possible, since critical thinking is not a general ability but rather a complex set of general and specific factors.

Studies have shown that online discussions can support critical thinking (c.f. Gunawardena, Lowe, & Anderson, 1997; Yang, 2002). Furthermore, several recent studies have reported on the assessment of critical thinking skills focusing on students engaged in online discussions, and one popular framework is the Community of Inquiry (CoI) model, a conceptual framework that "identifies the elements that are crucial prerequisites for a successful higher educational experience" that makes use of computer-mediated communication (Garrison, Anderson, & Archer, 2000, p. 87). One core aspect of that model is cognitive presence, which is operationalized in the Practical Inquiry Model (PIM); it "reflects the process and the means to create cognitive presence (Garrison, Anderson, & Archer, 2001, p. 11)." The PIM, which focuses on thinking processes versus individual learning outcomes, can be used as a tool to assess critical discourse and reflection, specifically higher-order thinking, in online discussions (Garrison et al., 2001, p. 7). The PIM is a four phase model (triggering, exploration, integration and resolution) that is derived from Dewey's concept of practical inquiry. A *triggering event* is presented in the form of an issue, problem or dilemma that needs resolution; *exploration* is the search for relevant information that can provide insight into the challenge at hand; *integration* involves connecting ideas in the search for viable explanations, and *resolution* is established through the selection and testing (through vicarious or direct application) of the most viable solution. As noted by Swan, Garrison, and Richardson (2009), the phases of practical inquiry should not be seen as discrete or linear and that for each of the phases there may be a need to return to a previous phase. Table 1 presents the categories and subcategories, which serve as indicators for the four phases of the PIM (Garrison et al., 2000).

3. Methods

The central hypothesis of this study was that students' critical thinking levels would vary across instructional strategies and students would achieve higher levels of critical thinking, in accordance with the PIM model's indicators, for the instructional strategy that they preferred. A mixed methods research approach was utilized

Table 1
Using the Community of Inquiry framework to assess critical discourse and reflection in a computer conference.
From Garrison et al. (2001); reprinted with permission of authors.

Category	Indicator	Sociocognitive processes
Triggering events	Recognizing the problem	Presenting background information that results in a question
	Sense of puzzlement	Asking questions, messages that take discussion in new direction
Exploration	Divergence — within the online community	Unsubstantiated contradiction of previous ideas
	Divergence — within a single message	Many different ideas/themes presented in one message
	Information exchange	Personal narratives/descriptions/facts (not used as evidence to support a conclusion)
	Suggestions for consideration	Author explicitly characterizes message as exploration. e.g. "Does that seem about right?" or "Am I way off mark?"
	Brainstorming	Adds to established points but does not systematically defend/justify/develop addition
	Leaps to conclusions	Offers unsupported opinions
Integration	Convergence among group members	Reference to previous message followed by substantiated agreement, e.g. "I agree because…"; building on adding to others' ideas
	Convergence within a single message	Justified, developed, defensible, yet tentative hypothesis
	Connecting ideas, synthesis	Integrating information from various sources — textbooks, articles, personal experience
	Creating solutions	Explicit characterization of message as solution by participant
Resolution	Vicarious application to real world	None
	Testing solutions	Coded
	Defending solutions	

for this study; specifically a sequential exploratory design was employed which allows for a first phase of qualitative data collection and analysis followed by a second phase of quantitative data collection and analysis that builds on the results of the first phase (Creswell, 2009, p. 211). Students participated in a course involving three online discussions, each representing a different instructional strategy, and responded to an end of semester survey that assessed their perceptions of online learning and instructional strategy preferences. Participants' online discussion postings were coded for quality of responses using the PIM indicators.

The research questions that were addressed investigated (1) students' preferred instructional strategy (case-based, debate, and open-ended) and rationales for the selection, (2) the contribution of background and demographic factors to students' preferred instructional strategy, (3) the contribution of students' level of critical thinking, based on the Practical Inquiry Model's (PIM) indicators, to predicting students' preferred strategy, and (4) participants' critical thinking levels across instructional strategies according to the PIM indicators.

3.1. Context and participants

In the fall of 2008, students enrolled in an undergraduate educational technology course required of all teacher education majors at a large Midwestern university participated in a blended learning environment. The course consisted of a one-hour lecture and a two-hour computer laboratory experience each week for one semester (15 weeks). The course had 16 lab sections with 18–29 participants per section. As a component of the course, which addressed the fundamentals of educational technology in classroom settings, all students took part in three one to two week asynchronous online discussions based on assigned readings. During the weeks that students were asked to engage in online discussions, they did not meet for the lecture portion of their class. Students participated in three online discussions across the semester hosted in a Blackboard course management system. The course instructor, who has over 10 years of teaching at a distance experience and over 25 years of face-to-face teaching experience, developed the discussions and provided the background information for the discussion topics, guiding questions for students to reflect on when posting to the discussion forum, supplemental readings, directions on developing the content of the postings, and grading criteria. Within their lab sections, students were required to develop their own posts to express opinions and/or arguments concerning the topics, and respond to their lab peers via the discussion forum.

In the case-study discussion, the students reviewed a document which described the case and several relevant readings that dealt with the topic of learning theories. The students actively analyzed the case, explored the relevant information, and exchanged opinions and ideas by responding to each others' posts. The topic of the debate discussion was whether today's learners should be taught differently because they have access to various technologies. In this discussion, the students were required to read two articles which discussed the question from the pro and con sides respectively. They were then assigned to one of the sides of the debate based on alphabetical order. In the open-ended discussion, students read several articles on the topic of plagiarism and plagiarism detection software and discussed the implications within guided discussions.

Only subjects that completed all three of the discussion questions and the end of semester survey were included in the study ($n = 196$). Demographics and background information from the end of semester survey was used to describe the participants in this study. The participants were mostly females (67%) and mostly underclassmen, with 76% at the freshman and sophomore level. Of the participants, 40% had no previous experience with online discussions in their courses, 28% had used online discussions in one course, and 32% had used online discussions in two or more courses.

3.2. Data collection and analysis

3.2.1. Online discussions

The three online discussions, also referred to as the three instructional strategies, were coded by lab sections; each discussion represented a different instructional strategy (DQ1: case-based, DQ2: debate, and DQ3: open-ended). Participant's online discussion postings were coded using NVIVO qualitative software using the four phase Practical Inquiry Model indicators (triggering, exploration, integration, and resolution) (see Table 1) (Garrison et al., 2001). The unit of analysis was a single posting which could have multiple codes. Initial inter-rater reliability for coding was 71% among the four scorers for 200 discussion postings but after coming together to discuss discrepancies, compare rationales, and achieve consensus inter-rater reliability was found to be 100% among the coders. A total of 2516 postings were coded.

3.2.2. End of semester survey

Following the completion of the online discussions students were given a survey that asked about their previous experiences with online discussions, their comfort levels with contributing to the online discussions and commenting on online discussion posts, and the strategy they preferred along with rationales for their selection (see Appendix A).

3.2.3. Data analysis procedures

Descriptive statistics were used to portray student demographics and answer the first research question, which looked at students' preferred instructional strategy. Additionally, content analysis procedures were used to examine responses to open-ended questions regarding participants' preferred strategy allowing for a better understanding of their selections. After reviewing the data several times, an inductive coding technique was employed (Miles & Huberman, 1994) which allowed for multiple codes within a single response. Coding of the open-ended responses allowed codes and categories to emerge from the open-ended responses.

The second research question, which examined the contribution of demographic and background factors (including including their comfort levels with posting and responding to online posts) to students' preferred instructional strategy, employed descriptive statistics and three standard regressions, one with each instructional strategy serving as the dependent variable.

The third research question, which investigated the contribution of students' strategy preferences in predicting level of critical thinking, based on the Practical Inquiry Model's (PIM) indicators (triggering, exploration, integration, and resolution) utilized regression analysis with dummy independent variables. For each of the instructional strategies standard regression were conducted to examine differences in PIM indicators as a function of students' preferred instructional strategy (independent variable); a total of 12 multiple regressions were run to answer this RQ.

Finally, to answer RQ4, which compares participants' critical thinking levels by instructional strategy; frequencies and percents were calculated for category and associated indicators of the Practical Inquiry Model (PIM). The frequencies were obtained by counting occurrences for each category and subcategory during the coding of students' online discussions; the codes were then placed into SPSS to derive the descriptive statistics.

4. Results and discussion

4.1. Students' preferred instructional strategy

To answer the first research question, descriptive statistics were used to provide not only participants' preferred instructional strategy but also the rationales provided for that selection. Determining the

preferred strategy of participants was based on their responses to the follow-up survey question: "Which discussion topics/formats did you like participating in the most? Please describe." Students indicated they preferred the open-ended discussion the most (47%), followed by the debate discussion (36%), while the case-based discussion was preferred by the least number of students (17%).

Of the forty-seven percent of participants that selected the open-ended discussion as their preferred strategy, some indicated that they liked this strategy because they had more freedom to express their personal opinions ($n=28$) or because there were no right or wrong answers ($n=14$). As one student stated, "Open-ended discussion allowed students to freely contribute their ideas and stances without too many regulations." Some students also mentioned that in this format they were motivated to learn ($n=5$) because there were less restrictions and guidelines ($n=7$). Also, they noted that they were able to see and compare different opinions ($n=17$), that the open-ended question required creative ideas and thoughts ($n=3$), and that it helped them understand the material better ($n=11$). Several students also explained that they were able to understand and learn material better ($n=9$) by seeing and comparing different opinions ($n=6$). For instance, one student explained, "I liked the open-ended material because I felt like I learned the most during that discussion. It was beneficial to me to be able and look at other sources to see the differences."

Thirty-six percent of participants selected the debate discussion as their preferred strategy. Several of the students that selected this format indicated that they had freedom to express personal opinions ($n=12$), they were able to see and compare both sides of the arguments ($n=13$), they had freedom to express personal opinions ($n=12$), and support their own viewpoints ($n=7$). For example, one student said, "It was interesting to see people take different sides to issues and how they defended them, even if they disagreed with the view they had to defend. It was also interesting for me to see how many things the viewpoints of both sides had in common." Students also suggested that this format was easier to respond to ($n=6$) and required creative application of knowledge and/or challenged students to support their own opinions ($n=5$). One student commented that, "I liked to participate in the debate discussion because it was a good way to apply what you know as well as express your opinion. To me, this was the most interesting type of discussion." Finally, several students contended that the debate discussions were more interesting and motivating ($n=4$) as compared to the other two discussion formats; "I found this discussion to be most interesting, which led me to be motivated to research the topic more thoroughly."

Finally, seventeen percent of the participants indicated they preferred the "case-based discussion," several because they felt this format really helped them to view different ideas/opinions ($n=17$). As one of the student stated, "I thought that the case-based discussion was a great discussion, this way you were able to see all points of views on different topics and on different examples. You were also able to see what others thought on the same thing that you read." Moreover, students contended that they were able to learn the material better ($n=6$) because it was more relevant and applicable to the real life ($n=7$). As one student stated, "I liked this format the best because it allowed me to apply what I was learning about to a real situation." Several students also thought that this format required creative thoughts ($n=6$) as well as creative application of knowledge learned from the readings ($n=6$). For instance, one student explained, "I liked being able to be creative and open and thinking of a new idea. It was helpful to put the idea into something that I came up with. I felt like I had more freedom to talk about something I enjoyed and tied it into the discussion topic."

However, the findings for this research question were not as straightforward as the researchers had hoped for. It is important to note that when students were asked to complete the survey and provide a rationale for their preferred strategy, they were asked to consider the strategy apart from the topic; nonetheless many students linked their preferred strategy to the topic. For example, within the data relating to the open-ended strategy several students stated that because the issue was relevant to real life ($n=10$) they liked it the best; "I liked this one because I felt I could relate to it better than the others because it wasn't just reading facts and writing about it. With the plagiarism discussion, it was a real-life situation that happened." Similarly, several of the students that selected the debate strategy indicated that this topic was more relevant to them ($n=10$). One of the respondents commented that, "I like this specific discussion because it directly related to me and allowed me to express my own opinion as well as use textual evidence." While the total number of participants that selected their preferred strategy based in part or whole on the topic and its potential relevance to them is impossible to parse out, it is evident that at least a portion did so. This finding, while potentially impacting our results, also speaks to one limitation of this study, namely that each instructional strategy was employed only once. This also should serve as a cautionary point for future research, indicating the efficacy of including multiple examples of each strategy to help overcome this limitation.

4.2. Contribution of participants' background to preferred instructional strategy

Aside from the demographic data (see *Context and Participants*, Section 3.1) descriptive data were also collected on students' comfort levels with (1) contributing to the online discussions and (2) commenting on online discussion posts.

Descriptive statistics based on a 5 point scale (1 = very uncomfortable, 5 = very comfortable) show that participants had a slightly higher than moderate level of comfort with contributing to the online discussions ($M=3.77$; $SD=1.04$) and for commenting on online discussion posts ($M=3.65$; $SD=1.11$).

In examining the results for the three regressions for the variables related to RQ2 (the contribution of student background and demographic factors to students' preferred instructional strategy) several statistically significant findings arose. While no significance was found for any of the factors in the model that used the *debate strategy as a dependent variable*, the other two models each demonstrated a negative relationship with students' comfort level in contributing to the online discussions. In the *case-based model*, the variable made a significant unique contribution to the prediction of preferred instructional strategy (semi partial correlation = .12) accounting for 2% of the variance. In the *open-ended model*, the variable made a significant unique contribution to the prediction of preferred instructional strategy (semi partial correlation = −.16) accounting for 3% of the variance. While this may only account for a small portion of the overall variance it is still a puzzling finding that would seem to indicate that students who were less comfortable contributing to online discussions (independent variable) preferred the case-based and open-ended strategies (dependent variable). A more general approach to interpreting this data would be that as students become more comfortable with posting to and responding to online discussions they may also become more comfortable with the varying strategies. Moreover, given that the debate strategy was not found to have the same relationship with this variable one may want to look at the three variables and ask — what was different about them? In fact, the debate strategy was much more defined in terms of what role each student would play (pro or con); this may have allowed students with less confidence or a lower comfort level to be able to post without the same level of apprehension about how their peers might perceive their position. Associated with these findings is research conducted by Shea and Bidjerano (2009) which suggests that it is crucial to assist learners "to gain comfort and confidence in the online discussion format in order to foster cognitive presence…[and] a sensible approach would be to encourage students to reflect on their comfort

levels with online discussion (p. 549)." For example, students who agreed more strongly with the statement "I felt comfortable participating in the course discussions" reported significantly higher levels of cognitive presence than those who were more neutral or who disagreed (Shea & Bidjerano, 2009).

4.3. Significance of preferred instructional strategy on participants' level of critical thinking

Standard regressions were conducted to examine differences in PIM indicators (triggering, exploration, integration and resolution) for each instructional strategy (DQ 1, DQ2, DQ3) as was necessary due to the binary function of dummy variables (each model was run with one strategy serving as the dummy variable, "0" = not selected as preferred strategy, "1" = selected as preferred strategy). In addition, the use of regression analyses eliminated Type II error that would be inherent in other statistical procedures. While using dummy variables may lead to the possibility of exaggerated results the results are nevertheless useful as a guide (Cohen, Cohen, West, & Aiken, 2002).

Three multiple regressions were conducted to examine differences in PIM indicators as a function of students' preferred instructional strategy for DQ1 (case-based). In the first, the dependent variable was students' scores that were classified under exploration. In the second, the dependent variable was students' scores that were classified under integration. In the third, the dependent variable was students' scores that were classified under resolution. The independent variables, in each of the regressions, were students' preferred instructional strategy (case-based, debate, open-ended).

Three multiple regressions were conducted to examine differences in PIM indicators as a function of students' preferred instructional strategy for DQ2 (debate). In the first, the dependent variable was students' scores that were classified under exploration. In the second, the dependent variable was students' scores that were classified under integration. In the third, the dependent variable was students' scores that were classified under resolution. The independent variables, in each of the regressions, were students' preferred instructional strategy (case-based, debate, open-ended).

Three multiple regressions were conducted to examine differences in PIM indicators as a function of students' preferred instructional strategy, for DQ3 (open-ended). In the first, the dependent variable was students' scores that were classified under exploration. In the second, the dependent variable was students' scores that were classified under integration. In the third, the dependent variable was students' scores that were classified under resolution. The independent variables, in each of the regressions, were students' preferred instructional strategy (case-based, debate, open-ended).

The multiple regression analysis examining critical thinking levels achieved for each of the three instructional strategies found none to be statistically significant ($p<.05$). Again, as with the interpretation of comfort levels for posting, this may be an indication that as students become more adept or exposed to various strategies they may achieve higher levels of critical thinking. In the context of this study, the fact that many of the participants were freshman is critical in that the findings might differ once the aforementioned comfort levels were attained and proficiency acquired.

While the regression analyses portion related to critical thinking may seem to provide limited information, the results can nonetheless tell us much. For example, while students may prefer a particular type of instructional strategy, their work in other kinds of online discussions is essentially the same in terms of effort and results. This may indicate that students are in fact adaptable across instructional strategies, at least in this context and with these particular strategies. This may be due in part to the external motivation provided by the points or grades that are attached to each activity and their impact on students' final grades. As mentioned earlier, this orientation might differ in learners at different levels, causing generalizability of findings to be problematic.

4.4. Comparing participants' critical thinking levels by instructional strategy

While the standard regressions for the third research question yielded limited information for predicting students' levels of critical thinking as a function of their preferred strategy, the descriptive data, which was used to compare participants' critical thinking levels across instructional strategies, provided several interesting findings. Table 2 presents the frequencies and percents of posts for each phase of the PIM (triggering, exploration, integration, and resolution) for each of the three instructional strategies.

For example, when the percentages of posts were examined for each of the three strategies we found that 78% of the posts for the case-based strategy, 77% of the posts for the debate strategy, and 60% of the posts for the open-ended strategy were at the integration stage. This differs considerably from previous findings which say that most online discussions never move beyond the exploration stage (Garrison & Arbaugh, 2007). Additionally, it is important to note that a percentage of the posts were found to be at the resolution phase for each strategy, albeit at very low levels, with the case-based strategy demonstrating the highest level (3%).

Aside from the four phases of critical thinking provided by the PIM many subcategories, or indicators, also exist (see Table 1). Table 3 provides an overview of students' responses or discussion posts, coded by these subcategories, in terms of frequencies and percents for the three instructional strategies.

It is within the subcategories that with the effects of differing instructional strategies on students' responses become apparent. This finding demonstrates students' adaptability to instructional strategies. When Table 3 is examined, you can see that a majority of students' discussion postings or responses fell into the "creating solutions" subcategory for the case-based strategy while "convergence in a single message" held the majority of coded responses for the debate and open-ended strategies. While both of the subcategories are at the "integration" level, they do in fact differ (see Table 1 for descriptions). In addition, the highest level (resolution) appears to be more compatible with the case-based instructional strategy. These findings would appear to coincide with the literature on how learners engage with various discussion questions. Arnold and Ducate found that depending on the type of discussion questions with which students were engaged, such as "practical applications [tasks requesting solutions], discussions did progress to the synthesis and resolution phase" (cited in Garrison, 2009). Similarly, Murphy (2004) found that where learners were specifically tasked to formulate and resolve a problem, "participants engaged more in problem resolution than in problem formulation (cited in Garrison, 2009)."

5. Conclusions

The central hypothesis of this study was that students' critical thinking levels would vary across instructional strategies and

Table 2
Frequencies and % of posts per phase of Practical Inquiry Model ($n=196$).

	Case-based (DQ1)		Debate (DQ2)		Open-ended (DQ3)	
	Frequency	%	Frequency	%	Frequency	%
Triggering	16	3	7	1	17	3
Exploration	83	16	105	21	216	36
Integration	393	78	378	77	360	60
Resolution	15	3	3	<1	3	<1
	507	100	493	100	596	100

Table 3
Frequencies and % of posts per Practical Inquiry Model subcategory by the three instructional strategies.

Phases	Subcategories	Case-based ($n=507$)		Debate ($n=493$)		Open-ended ($n=596$)	
		Frequency	%	Frequency	%	Frequency	%
Triggering phase	Triggering phase — general	1	<1	0	0	2	<1
	Recognizing the problem	8	2	5	1	0	0
	Sense of puzzlement	7	1	2	<1	15	3
Exploration phase	Exploration phase — general	24	5	25	5	40	7
	Divergence within the online community	10	2	19	4	39	7
	Divergence within a single message	1	<1	3	<1	3	<1
	Information exchange	15	3	5	1	6	1
	Suggestions for consideration	15	3	5	1	3	<1
	Brainstorming	14	3	16	3	53	9
	Leaps to conclusions	4	<1	32	7	72	12
Integration phase	Integration phase — general	64	13	76	15	65	11
	Convergence among group members	129	25	134	27	138	23
	Convergence within a single message	63	12	144	29	136	23
	Connecting ideas/synthesis	23	5	24	5	16	3
	Creating solution	114	23	0	0	5	1
Resolution phase	Resolution phase — general	3	<1	0	0	0	0
	Vicarious application to real world	5	1	0	0	0	0
	Testing solutions	1	<1	0	0	0	0
	Defending solutions	6	1	3	<1	3	<1
Totals		507	100	493	100	596	100

students would achieve higher levels of critical thinking, in accordance with the PIM model's indicators, for the instructional strategy that they preferred. The research found that the majority of students preferred open-ended discussions (47%), followed by debate (36%), and then case-based (17%). However, critical thinking achievement levels (PIM) indicated that students generally scored lower on the open-ended discussion. Perhaps one could infer from this that students don't always realize what is good for them, or that they are not truly conscious of their meta-cognitive strengths and abilities or how to employ learning strategies. How do these findings transfer to the development and implementation of online discussions? Shea and Bidjerano (2009) suggest that a crucial factor in effective use of online discussions for higher-order thinking resides with students' comfort levels and to foster critical thinking, instructors need to assist learners in gaining comfort and confidence in the online discussion format. The research reported here may be indicative of a trend or pattern that suggests the same conclusion: as students become more comfortable with online postings and exposed to instructional strategies beyond the commonly used (and possibly least complex) open-ended format, they may (1) increase the level of critical thinking achieved, and (2) find that their instructional strategy preferences change or at least become more broad.

Findings related to the critical thinking indicators based on the PIM provided some additional insights into how students responded to the various strategies. When the four major phases of the PIM were examined (triggering, exploration, integration and resolution) the frequencies and percents were similar across the three instructional strategies and seemingly showed little difference between the instructional strategies. However, once the subcategories were examined, the case-based strategy differed considerably from the debate and open-ended discussions. These findings are compatible with research by Arnold and Ducate (2006, as cited by Garrison, 2009) and Murphy (2003, as cited by Garrison, 2009) which determined that depending on the types of instructional strategy or format that is presented to students, instructors should expect the levels of the critical thinking achieved to be parallel but not identical. This finding, especially the variety of subcategories that mirror the type of instructional strategy implemented, demonstrates that this is a valid line of research.

Interestingly enough, the research also found much higher levels of critical thinking than most research utilizing the PIM have found to date (see Garrison & Arbaugh, 2007; Garrison et al., 2001; Kanuka & Anderson, 1998; Luebeck & Bice, 2005; Meyer, 2003, 2004; Murphy, 2004) with 81% of students at the integration or and resolution levels for the case-based strategy, 78% for the debate strategy, and a comparatively lower level (61%) for the open-ended strategy (see Table 2). This finding, however, does make one ponder whether the resolution phase is the outcome we should always aspire to within online discussions. Typically online discussions last 1–2 weeks each, hardly enough time, regardless of topic, to move students through the entire critical thinking process. Perhaps we should instead look to online discussions as the beginning of or the continuation of the scaffolding process. Perhaps instructors should be looking to online discussions as a gauge, evidence of where students' critical thinking levels are at a particular point in time, and then help them achieve the next level through additional scaffolding.

The results presented here have been primarily based on student preferences for particular strategies; however, more questions arise as the research in this area continues. For example, it would be important to research whether varying instructional strategies impact student participation in online discussions, as one would be led to believe via the comments students included on their surveys. Similarly, additional research needs to be conducted to confirm whether the topic for discussion questions has a major impact on students' preference for a strategy, as was a potential limitation of this study as indicated by a subset of students in their open-ended responses. One way to do so would be to examine an environment in which multiple discussion questions were provided for each instructional strategy. The researchers are currently investigating this line of research. Moreover, additional strategies and techniques need to be investigated to further inform instructors and designers of online discussions of the effectiveness and efficiency of these strategies and techniques.

Another feature of this study that should be examined more fully in future research is the indicators of the PIM. As Garrison et al. (2001) state in their work, the indicators provided in the PIM should serve as examples; in other words the list of indicators should not be considered to be exhaustive. Moreover, in the ten years since the

development of the CoI, distance education and online discussions have matured, and instructors have become more adept at using the technology and implementing broad pedagogical approaches, all of which may also indicate that it may be time to revisit the PIM indicators.

Finally, while the regression analyses accounted for a very small amount of the variance, wherein lies the remaining variance? What additional factors need to be accounted for? Perhaps sustained critical discourse is a prerequisite for higher-order thinking (Garrison et al., 2001, p. 11) but not the only factor that one needs to consider. First, as Akyol and Garrison (2008) suggest, there may well be significant higher-order thought that is not captured in the discourse process, but in other course projects and artifacts, with discourse serving as a catalyst.

Second, Ice, Akyol, and Garrison (2009) found that socio-epistemological orientation can influence students understanding of the conceptual nature of communities of inquiry. Specifically, an objectivist tilt to learning outcomes can cause students to view cognitive outcomes as being synonymous with the teachers' intent. Even if the inclusion of objectivist orientations is inadvertent, there remains the potential for students understanding of discourse to be viewed through a more constrained lens. In the case of freshmen, who have limited frames of reference, the potential for this negative influence on discourse, and constructivist interactions in general, would likely be enhanced.

On a final note, while this research examines discussion questions based on instructional strategies it is important to remember that asking the right question is key for a good discussion. To quote Berge and Muillenberg (2002), " In a constructivist learning environment, the instructor always needs to keep in mind that when facilitating online discussion, asking the right questions is almost always more important than giving the right answers (in Bender, 2003, p. 69)."

Acknowledgements

The authors would like to thank the FIPSE research team at Purdue University who contributed their efforts on varying aspects of this project, including Janet Alsup, Xi Cheng, Peg Ertmer, James Lehman, Tim Newby and Ayesha Sadaf. The authors also wish to thank Karen Swan for her valuable comments on earlier drafts of this manuscript.

The contents of this paper were developed in part under grant # P116B060421 from the Fund for Improvement of Post-Secondary Education (FIPSE), a program of the U.S. Department of Education. The contents of this paper were developed with the support of the grant, but the contents do not necessarily represent the views or policies of the Department of Education, and you should not assume endorsement by the Federal Government.

Appendix A

Sample questions from the end of semester survey

How many other courses have you taken that have used online discussions?
- ○ 1
- ○ 2–3
- ○ 4 or more

How would you rate your comfort level contributing responses to the online discussions?
- ○ 1 Very uncomfortable
- ○ 2
- ○ 3
- ○ 4
- ○ 5 Very comfortable

How would you rate your comfort level commenting on the responses of others in the online discussions?
- ○ 1 Very uncomfortable
- ○ 2
- ○ 3
- ○ 4
- ○ 5 Very comfortable

Which discussion topics/formats did you like most to participate in? (e.g. Which strategy did you prefer?)
- ○ The case-based discussion format (i.e., the format used for the discussion on learning theories — where each of you attempted to create instruction based on a different theoretical perspective)
- ○ The debate discussion format (i.e., the format used for the discussion on Millennium Students)
- ○ The open-ended discussion format (i.e., the format used for the discussion on plagiarism)

Please explain or describe why you selected this strategy as your preferred strategy.

References

Akyol, Z., & Garrison, D. R. (2008). The development of a community of inquiry over time in an online course: Understanding the progression and integration of social, cognitive and teaching presence. *Journal of Asynchronous Learning Networks*, *12*(3), 3—22.

Bender, T. (2003). *Discussion-based online teaching to enhance student learning*. Sterling, VA: Stylus Publishing.

Berge, Z. L. (2002). Active, interactive, and reflective elearning. *The Quarterly Review of Distance Education*, *3*(2), 181—190.

Barkley, E. F., Cross, K. P., & Major, C. H. (2005). *Collaborative learning techniques: A handbook for college faculty*. San Francisco, CA: Jossey-Bass.

Bonk, C., & Dennen, V. (2007). Frameworks for design and instruction. In M. G. Moore (Ed.), *Handbook of distance education* (pp. 233—246)., 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates.

Cohen, J., Cohen, P., West, S., & Aiken, L. (2002). *Applied multiple regression/correlation analysis for the behavioral sciences*, 3rd edition Mahwah, NJ: Lawrence Erlbaum.

Creswell, J. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*, 3rd edition. Los Angeles: Sage Publications.

Facione, P. A., & Facione, N. C. (2007, Mr/Ap). Talking critical thinking. *Change*, *39*(2), 39—44.

Garrison, D. R. (2009). Roles of authentic activities for online learning. *2009 Conference on Distance Teaching & Learning: Madison, WI.*

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, *2*(2–3), 87−105.

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education*, *15*(1), 3−21.

Garrison, D. R., & Arbaugh, J. B. (2007). Researching the community of inquiry framework: Review, issues, and future directions. *The Internet and Higher Education*, *10*(3), 157−172.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research*, *17*(4), 397−431.

Haavind, S. (2006). Key factors of online course design and instructor facilitation that enhance collaborative dialogue among learners. Paper presented at the Annual meeting of the American Educational Research Association, San Francisco, CA.

Halpern, D. (2003). *Thought and knowledge*, 4th ed. Mahwah, NJ: Erlbaum.

Hsu, S. (2004). Using case discussion on the web to develop student teacher problem solving skills. *Teaching and Teacher Education*, *20*(7), 681−692.

Ice, P., Akyol, Z. & Garrison, R. (2009, January). The relationship between instructor socioepistemological orientations and student satisfaction with indicators of the Community of Inquiry Framework. Paper presented at the 7th Annual Hawaii International Conference on Education, Honolulu, HI.

Kanuka, H., & Anderson, T. (1998). Online social interchange, discord, and knowledge construction. *Journal of Distance Education*, *13*(1), 57−74 [viewed 25 Mar 2002, verified 18 Jun 2004] http://cade.athabascau.ca/vol13.1/kanuka.html.

Land, S. M., Choi, I., & Ge, X. (2007). Scaffolding online discussions to promote reflection and revision of understanding. *International Journal of Instructional Media*, *34*(4).

Luebeck, J., & Bice, L. (2005). Online discussion as a mechanism of conceptual change among mathematics and science teachers. *Journal of Distance Education*, *20*(2), 21−39.

Merrill, M. D. (2000). Instructional transaction theory (ITT): Instructional design based on knowledge objects. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* Mahwah, NJ: Lawrence Erlbaum Associates.

Meyer, K. A. (2003). Face-to-face versus threaded discussions: The role of time and higher-order thinking. *Journal of Asynchronous Learning Networks*, *7*(3), 55−65.

Meyer, K. A. (2004). Evaluating online discussions: Four different frames of analysis. *Journal of Asynchronous Learning Networks*, *8*(2).

Miles, M., & Huberman, A. M. (1994). *Qualitative data analysis.* Thousand Oaks, CA: Sage Publications.

Murphy, E. (2004). Identifying and measuring ill-structured problem formulation and resolution in online asynchronous discussions. *Canadian Journal of Learning and Technology*, *30*(1) Retrieved August 9, 2009 from: http://www.cjlt.ca/index.php/cjlt/article/view/122/116

Pilkington, R. M., & Walker, A. S. (2003). Facilitating debate in networked learning: Reflecting on online synchronous discussion in higher education. *Instructional Science*, *31*, 41−63.

Romiszowski, A. J. (1995). Use of hypermedia and telecommunications for case-study discussions in distance education. In F. Lockwook (Ed.), *Open and distance learning today* (pp. 164−172). New York: Routledge.

Sammons, M. (2007). Collaborative interaction. In M. G. Moore (Ed.), *Handbook of distance education* (pp. 311−321)., second ed. Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Saskatoon Public Schools (2008). Instructional strategies online Retrieved on August 2, 2009 from: http://olc.spsd.sk.ca/de/pd/instr/strats/discussion/index.html

Shea, P., & Bidjerano, T. (2009). Community of inquiry as a theoretical framework to foster "epistemic engagement" and "cognitive presence" in online education. *Computers & Education*, *52*(3), 543−553.

Spicer, K-L., & Hanks, W. E. (1995). Multiple measures of critical thinking skills and predisposition in assessment of critical thinking (ERIC Document Reproduction Service No. ED391185).

Swan, K., Garrison, R., & Richardson, J. C. (2009). A constructivist approach to online learning: The Community of Inquiry framework. In C. Payne (Ed.), *Information technology and constructivism in higher education: Progressive learning frameworks* (pp. 43−57). Hershey, PA: IGI Global.

Webb, H. W., Gill, G., & Poe, G. (2005). Teaching with the case method online: Pure versus hybrid approaches. *Decision Sciences Journal of Innovative Education*, *3*(2), 223−250.

Winiecki, D. J. (Ed.). (2003). *Instructional discussions in online education: Practical and research-oriented perspectives* Mahwah, New Jersey: Lawrence Erbaum Associates.

Yang, Y-T. C. (2002). Use of structured web-based bulletin board discussions with Socratic questioning to enhance students' critical thinking skills in distance education. Unpublished doctoral dissertation; Purdue University, West Lafayette.