

# **The effects of guided inquiry questions on students' critical thinking skills and satisfaction in online argumentation**

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Descriptors: guided inquiry questions, critical thinking skills

## **Abstract**

The purpose of this study was to examine the effects of scaffolding in a form of inquiry questions on students' critical thinking and satisfaction in online argumentation. Twenty-two graduate students in a distance learning course were randomly assigned to one of two groups. Each student in the experimental group participated in an online discussion activity a) with guided inquiry questions or b) without these questions. Results indicated that although providing guided inquiry questions had a positive effect on students' critical thinking, it did not have an effect on students' satisfaction. These findings and previous research in this area imply that scaffolding such as guided inquiry questions can be used to promote students' critical thinking in online learning environments and increase students' positive attitudes toward online learning.

## **Introduction**

In online settings, it is important that instructors provide scaffolding to enhance students' critical thinking skills and maintain learner motivation, especially when students are involved in a task that requires higher order processes such as critical thinking. Online argumentation is widely used as a strategy enhancing students' critical thinking process (Nussbaum & Schraw, 2006) and facilitating students' understanding of content. In most cases,

however, online students are asked to communicate with learning materials alone. There are many challenges confronting instructors in online discussion settings, such as lack of efficiency of conversation, interactive guidance, and immediacy of feedback (Wang & Woo, 2007). Without well structured guidance and instructional supports, students may therefore not achieve their learning goals and lose learning motivation.

Providing guided inquiry questions may supports students' critical thinking skills in learning contexts where the instructor's involvement is limited (King, 1992; Belland et al., 2008; Gillies & Khan, 2009). Guided inquiry questions are a set of questions that require students to focus on key factors in learning materials. These questions help students gather information and construct evidence-based arguments. Several studies have investigated the effect of using the inquiry questions in online discussion and argumentation (e.g., Bradley et al., 2008; Ge, Chen, & David, 2005; Golanics & Nussbaum, 2008; Oh & Jonassen, 2007). The Ge, Chen, and David (2005) study showed that the elaborated features in inquiry questions helped students to consider, compare, and determine a reasonable solution as well as to evaluate those thinking processes in ill-structured complex contexts. Furthermore, providing these questions also may increase students' satisfaction, because guided inquiry questions may decrease students' cognitive load which in turn increases learner achievement. Palmer and Holt (2008) found that providing instructional supports in online courses has a positive effect on students' satisfaction.

Although recent studies have attempted to show the effect of the questioning technique in online argumentation reflecting a complex problem (Cho & Jonassen, 2002), few empirical studies provided content-oriented inquiry questions. Earlier studies mostly provided procedural-oriented inquiry questions which only provide directions on how to participate in online argumentation. In addition, no studies have assessed students' critical thinking skills through a separate post-test based on a case analysis problem. Furthermore, few studies have investigated students' satisfaction with online learning activities using guided inquiry questions.

The purpose of this study was to examine the effects of guided inquiry questions on students' critical thinking skills and satisfaction in online argumentation. One group of students in our study received guided inquiry questions while they participated in an online discussion; the other group did not receive these questions. Students' critical thinking skills were measured by an essay writing test. This study defined the critical thinking skills as students' ability to gather and analyze relevant information in order to draw evidence-based conclusions and generate solutions. In addition, the study evaluated students' satisfaction with their online learning activities.

The study hypothesized two results. First, students who were provided guided inquiry questions would score significantly higher on the posttest than their counterparts. Existing research has found that inquiry questions promote critical thinking in online argumentation (Zydney, 2008; Ge & Land, 2003). Second, students who participated in online argumentation with guided inquiry questions would indicate higher satisfaction than students who participated without inquiry questions. Without these questions, students should expend more cognitive effort, which may cause cognitive load and decrease students' motivation.

## **Method**

### **Participants**

The participants in this study were 22 graduate students enrolled in an online graduate course at one of the state universities in Florida. Five students were attending the doctoral program and 17 students were attending the masters program in the College of Education. Nine students were male and 13 students were female. There were 3 international students (all from East Asia) and 19 Americans. All students gave their consent to participate in this experimental study. One student did not participate in the manipulated activity and one student did not submit the post-test. Since this study regarded those two participants as missing data, there were a total of 20 data sets.

### **Materials**

This online course was served by its own website embedded in BlackBoard which is widely used as a learning management system in many universities in the US. The course website serves text-based weekly instruction including learning objectives, hyperlink resources, and activity descriptions. During week 7, students

were required to read book chapters and journal articles about needs and barriers in developing distance education. All students had opportunities to review what they read in a summary page which contained important information excerpted from the week 7 readings. The information in the summary page guided students to consider key factors in developing a distance education program. To make sure students understood all the key factors, an optional quiz was provided. In the subsequent online argumentation, the case analysis problem required that students argue whether or not a make-believe country should develop a distance education program. Online discussion forums were developed by functions in BlackBoard system.

### Independent Variable

The independent variable in this experiment was the set of guided inquiry questions for the online argumentation. The guided inquiry questions, constructed by synthesizing given reading materials, were designed to guide students in applying important information to a situated learning activity. Students in the treatment group participated in online argumentation with the guided inquiry questions, while students in the control group participated in online argumentation without the guided inquiry questions.

The set of guided inquiry questions (totaling 19 questions) was developed by an instructor and three graduate assistants. The questions covered nine key factors and one supplementary factor, so that students could justify their decision-making on the case analysis problem by responding to those questions. Given factors in content-oriented inquiry questions were matched with the information presented in the summary page. The questions were expected to assist students in elaborating rationales for supporting their arguments. For example, having a question such as “what kind of media may support the delivery of a distance program?” might lead students to reason whether the make-believe country has an appropriate delivery condition for distance education or not. A set of inquiry questions was provided on the left side of the screen as a separated frame (see Figure 1), so that students could follow the questions without changing the screen while analyzing the given case and writing evidence-based arguments.

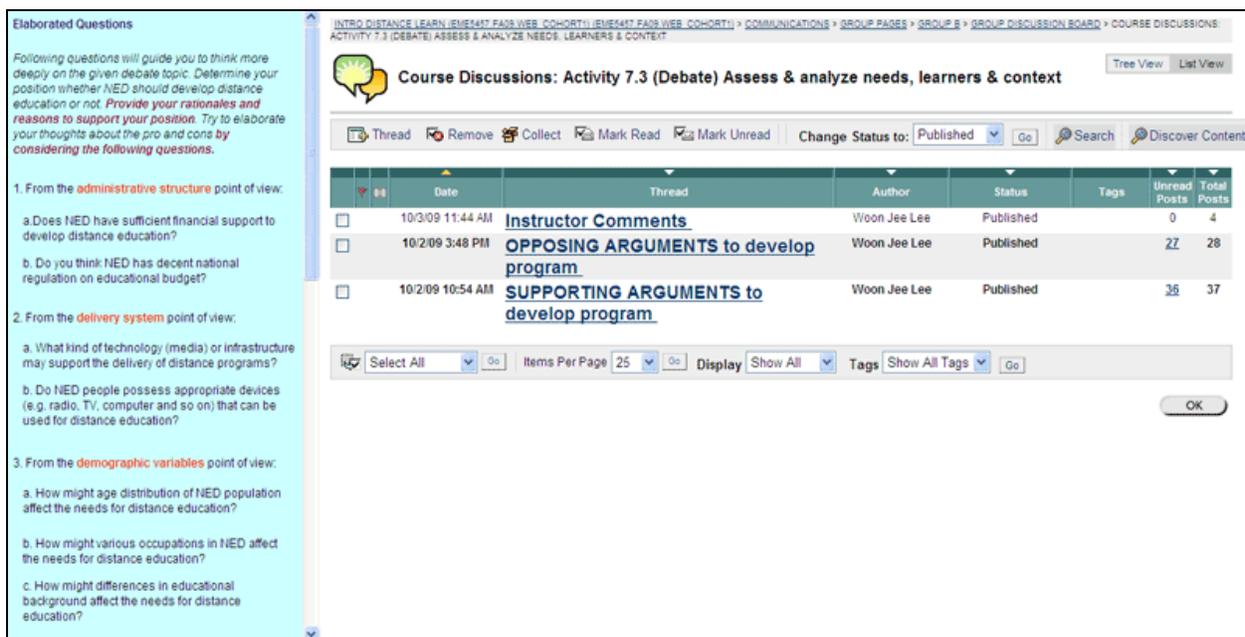


Figure 1. Screen capture of the BlackBoard discussion forum with guided inquiry questions

### Dependent Variables

This experimental study measured students’ critical thinking skills and students’ satisfaction after finishing the required online argumentation activity.

Students' critical thinking skill was measured by a post-test which asked students to write an essay of at least 300 words. In the essay test, students were given a new case analysis problem in which they were asked to determine whether a different make-believe country should develop a distance education program or not. The test instructions indicated that students should provide a rationale for their position. To evaluate the essay, the instructor and three graduate assistants developed a standard assessment rubric based on McLean's (2005) criteria for evaluating the quality of critical thinking: clarity, relevance and breadth (or depth). The standard assessment rubric contains 10 items: one item for evaluating clarity in posing the position and rationale; one item for evaluating relevance of focus on the topic and the case; and eight items for evaluating how broadly or deeply the evidence is considered in their reasoning process. To ensure a fair assessment, required elements in the last eight items were matched with the key factors in the summary page, which every student could access. The score range for each item was 0 to 2 points. The possible maximum score was 20 points.

The students' satisfaction survey was conducted by an online assessment tool in BlackBoard, using 10 items. Seven items focused on learner-content interaction and three items on general satisfaction, based on Strachota's (2006) five constructs of measuring student satisfaction with online learning. Learner-content interaction is satisfaction with the subject matter which includes course content, lessons, learning activities, assignments, and the course website. General satisfaction focuses on whether students' needs have been met (Strachota, 2006). Responses to the items were in the form of a five-point Likert scale: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree.

## **Procedures**

Stratified random assignment was used to allocate subjects to the treatment group with guided inquiry questions and the control group. Because of the small sample size, pure random assignment potentially threatened the homogeneity between the two groups. In this experiment, gender and level of participation were used in the stratified random assignment. In particular, the number of messages posted in the previous online discussion was used to determine the stratification of high and low participation. Each group had 11 students. After eliminating the missing data, the number of participant in each group was 10 subjects.

During week 7, students in both groups were asked to finish given readings and to review the readings through the summary page and the optional quiz. They were then required to participate in online argumentation with the same case analysis problem, but using two different web pages. Students could access only one of two group discussion forums. The activity description indicated that students in both groups should write their rationale to support their determined position by posting a minimum of 4 messages in the discussion forum. In the online argumentation, only those students working with the guided inquiry questions were asked to answer each question to support their arguments, while students in the control group made their arguments without guided questions.

During week 8 and week 9, as a portion of the midterm exam, students were required to write an essay of at least 300 words about the new case analysis problem. Two graduate assistants evaluated the students' essay writings based on the standard assessment rubric. In addition, students were asked to complete the online satisfaction survey.

## **Results**

All statistical tests were conducted using an alpha level of .05. No serious violation of normality or homogeneity of variance was found. The data were analyzed using an independent-sample t test for each dependent variable.

### **Critical thinking skills**

Two raters separately evaluated the post-test. Both raters used a blind grading method and followed the standard assessment rubric for the essay writing. The score range in the standard assessment rubric was 0 to 20 points. The allowed rate of score difference was 15% (3 points) in this experiment. Based on Pearson's Correlation, the inter-rater reliability for the post-test was .876. A review of the data revealed that there was no violated

assumption of normality and homogeneity variance ( $p=.331$  based on Levene's Test). With alpha set at .05, two-tailed condition, and 10 participants per group, the probability of detecting a difference between means was .62.

Table 1 presents the means and standard deviations on the post-test scores of critical thinking skill across the two groups, with and without the guided inquiry questions. *T* test analysis was applied to compare the mean difference between two groups. The group provided with guided inquiry questions scored significantly higher on the essay writing test than the group not provided with inquiry questions,  $t(18) = 2.392$ ,  $p = .028$ . Effect size was  $d = 1.07$ , indicating a large effect (Cohen, 1988). Consistent with the first hypothesis, students who participated in the online argumentation with guided inquiry questions demonstrated higher critical thinking skills than students who participated without inquiry questions in the post-test.

Table 1  
*Means and standard deviations of students' critical thinking skill across groups*

Groups	Essay writing test <sup>a</sup>	
	Mean	SD
Without guided inquiry questions (n=10)	13.40	2.97
With guided inquiry questions (n=10)	16.35	2.53

<sup>a</sup> Maximum possible score was 20.

### Satisfaction

Of the 10 items in the students' satisfaction survey, the first 3 items measured general satisfaction and the last 7 items measured satisfaction with the learner-content interaction. Each item was answered using a five-point Likert scale. Based on Cronbach's Alpha, satisfaction survey items had a reliability of .894.

Table 2 presents the means and standard deviations for the satisfaction survey for the two groups. *T* test analysis was applied to compare the mean difference between two groups. The groups did not differ significantly on general satisfaction,  $t(18) = .109$ ,  $p = .362$ , on learner-content interaction,  $t(18) = .113$ ,  $p = .635$ , or on total satisfaction,  $t(18) = .116$ ,  $p = .467$ . Students who participated in online argumentation without guided inquiry questions expressed a level of satisfaction with their learning activities as high as students who participated in online argumentation with guided inquiry questions.

Table 2  
*Means and standard deviations of students' satisfaction across groups*

Groups	Satisfaction survey <sup>a</sup>					
	General satisfaction		Learner-content interaction		Total	
	Mean	SD	Mean	SD	Mean	SD
Without guided inquiry questions (n=10)	4.17	.63	4.16	.53	4.16	.54
With guided inquiry questions (n=10)	4.20	.76	4.19	.58	4.19	.62

*Note.* Among total 10 items in satisfaction survey, item 1 through item 3 asked general satisfaction and item 4 through item 10 asked satisfaction of learner-content interaction.

<sup>a</sup> A five-point Likert scale ranged from 1 (strongly disagree), to 5 (strongly agree).

### Discussion

Supporting the first hypothesis of the study, students provided with guided questions showed a higher level of critical thinking in their evidence-based arguments than students not provided with these questions. The positive effects of guided questions on critical thinking were believed to be because students were able to use various points

of view. This finding is consistent with past studies which have shown that guided questions stimulate students' deep thinking process to generate evidence-based arguments in solving a complex problem (Bradley et al., 2008; Ge, Chen, & David, 2005; Golanics & Nussbaum, 2008; Oh & Jonassen, 2007).

This positive effect of the guided inquiry questions can be explained by the fact that responding to inquiry questions helps students' cognitive and metacognitive activities. The process of responding to inquiry questions stimulates students to analyze information in a given complex context, and then thinking more broadly or deeply to articulate, justify, and reflect on their arguments (Ge & Land, 2003). In this study, the students with guided inquiry questions were well scaffolded to foster their critical thinking skills which involved processes of analysis, articulation, justification, and reflection.

Contrary to the second hypothesis, there was no difference between two groups in relation to levels of satisfaction. Students in both groups reported high general satisfaction and high satisfaction of learner-content interaction. There may not be one reason for their high level of overall satisfaction, because different learners have different perceptions or standards in relation to their learning. In the satisfaction survey, some of descriptive responses said that the argumentation activity motivated students in the online course. The online argumentation has been considered an alternative strategy to engage students more in online discussion (Golanics & Nussbaum, 2008). In addition, some students mentioned that they felt an authenticity from the invented case which presented a complex problem that was likely to happen in the real world.

In distance learning, improving students' critical thinking and increasing students' motivation are important issues. These findings provide empirical evidence for distance learning educators and instructional designers to use guided inquiry questions when they want to enhance students' critical thinking as students solve complex problems in online learning environments. Although this study did not support the effect of scaffolding on students' satisfaction with online learning, providing appropriate scaffolding may increase students' motivation in terms of confidence and satisfaction. This study indicates that providing guided inquiry questions may be a good strategy to improve students' critical thinking skills and suggests future research on the effects of scaffolding on students' satisfaction in online learning would be valuable.

### **Limitations and future suggestions**

The study had some limitations. First, we administered the post-test immediately after the one week online argumentation activity. Consequently the results do not indicate the effect of the guided inquiry question on retention of improved critical thinking skills. Second, the post-test provided a new case analysis problem which was very similar to the case provided in the online argumentation. As a result we cannot assume that students can transfer their critical thinking skills to new learning situations. Additional research is needed in which a long-term assessment with different cases analysis problems in the post-test is administered.

In future research, the attributes of participants could be treated as an independent variable in order to determine how the guided inquiry questions might affect learners who differ by gender, age, prior experience in either domain knowledge or an online course, and the level of self-regulation. Moreover, there are other types of scaffolding suggested by other researchers in the area of pedagogical approaches (Hmelo-Silver et al., 2007). In the satisfaction survey one student described the need for a step-by-step exercise in analyzing the given case which can be presented as a fill-in response by sequential questions. Building on this, future research could consider the different types of scaffolding such as the process work sheet and the worked example in evidence-based argumentation.

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