Using a discussion forum to enhance technical students' critical thinking ability through the Internet learning system

Ya-Huei Wang

Chung-Shan Medical University
Taichung, Taiwan

ABSTRACT: On-line discussion forums have been emphasised as a tool for learning and instruction in recent decades. By using the on-line discussion forums to post and respond to messages for academic discussion and communication, technical students can enhance their active learning and critical thinking. The purpose of this article is to explore whether the use of discussion forums through the Internet learning system can enhance students' critical thinking ability, critical thinking disposition and student satisfaction. The study reveals that technical students going through the discussion forum have better critical thinking skills and critical thinking disposition, and experience higher levels of student satisfaction.

INTRODUCTION

In today's ever-changing information technology-driven society, students are required to equip themselves not only with professional knowledge but also with the critical thinking abilities needed for making appropriate professional judgments in the workplace. Since critical thinking has been recognised as a necessary competency for college graduates, teachers have the responsibility of cultivating students' critical thinking skills, such as analysing, reasoning, inference, etc, to facilitate their reflective and evidence-based thinking [1][2]. Therefore, to motivate students to attain higher levels of intellectual development, teachers should incorporate activities that develop students' critical thinking, for it is impossible to achieve a higher level of professional judgment without going through a critical thinking training process [3].

LITERATURE REVIEW

Critical thinking is a cognitive process of developing reasonable, logical and reflective judgments about what to believe or what to do [4][5]. Through the application of cognitive skills and strategies, students can learn how to elicit inferences and make decisions in order to solve problems better. Kuhn asserts that critical thinking involves a number of skills [6]. People with critical thinking are the people who can differentiate and support their own point of view or theory based on existing evidence. Such thinkers can also evaluate, accept or reject possible alternatives based on the existing evidence or theories. Ferrett [7] and the American Philosophical Association [8] explain that persons with a critical thinking disposition possess the following characteristics. They are inquisitive, truth-seeking, open-minded, analytic, cognitively mature, systematic and self-confident. Hence, they know not only how to reject information that is incorrect, illogical or irrelevant but also how to question, argue and seek further evidence to support their thoughts and beliefs.

Research shows that students with critical thinking ability are more self-confident, more open-minded, and more inquisitive about different points of views. Moreover, they can use their reflective thinking to decide what to believe or what to do to solve problems that have uncertain solutions [9-11]. Through the intellectually disciplined critical thinking process, students can conceptualise, apply, synthesise and evaluate information based on their observations, experiences, reflections and reasoning [12]. In Anderson, Krathwohl and Bloom's critical thinking model, students should go through knowledge, comprehension, inference, application, analysis, synthesis and evaluation stages to become critical thinkers [13].

Critical thinking cannot be developed only through class lectures but also requires a series of real-life scenarios. Studies have shown a high correlation between critical thinking disposition and the use of critical thinking skills [9][10][14]. Hence, teachers should apply diverse instruction methods, such as using creative approaches, to open students' minds

and broaden their thinking perspectives to develop their critical thinking competencies. King suggests that critical thinkers should be good questioners [15]. They should always raise questions in their minds whenever they see or experience. Moreover, based on their experiences and prior knowledge, they can evaluate, analyse, infer, reason and reflect in order to find a solution or an alternative to solve their problems [16]. Since the critical thinking training process is a long-term task, teachers should use teaching strategies to guide and induce students' critical thinking, such as using computer-mediated communication, interactive multimedia, etc, to let students get involved in simulating real life situations in order to learn how to approach problems, propose hypotheses, analyse information, synthesise knowledge and solve problems [17][18].

Research has shown that on-line discussion forums have been emphasised as a tool for learning and instruction in recent decades [19-21]. An on-line discussion forum is an on-line bulletin board on which students can post and respond to messages for discussion, communication and interaction. Garrison, Anderson and Archer declare that the use of a discussion forum for learning and instruction can enhance students' active learning and critical thinking ability [22]. By giving students more time to prepare, reflect, think and seek extra information, the discussion forums help students attain higher cognitive levels. Interaction on the discussion forum offers students a chance to raise questions, to reflect on questions and to find solutions for questions. Hence, it can be used as a tool to foster critical thinking, because it focuses on issue analysis, stimulating students' constructive reflection [2].

This study intends to explore whether the use of discussion forums through the Internet learning system can enhance technical students' critical thinking ability, critical thinking disposition and satisfaction. To test whether the discussion forum application can bring positive effects to student learning outcomes, the following hypotheses are proposed:

H1: Technical students, using the discussion forum, will acquire better critical thinking skills than those not using the forum.

H2: Technical students, using the discussion forum, will have better critical thinking dispositions than those not using the forum.

H3: Technical students, using the discussion forum, will attain a greater level of satisfaction in their classes than those not using the forum.

METHODOLOGY

Sample and Experimental Design

In order to explore whether the application of a discussion forum can positively affect students' critical thinking skills, critical thinking disposition and satisfaction, 82 freshmen technical students were selected as the experimental sample. By flipping a coin, class A1, totalling 42 students, was chosen as the experimental group, while class A2, totalling 40 students, was chosen as the control group. Before the experiment, all students took the English entry test at the beginning of the academic year to demonstrate their initial English proficiency. Both groups belonged to the intermediate level class; hence, being at the same proficiency level, the groups can be considered to be homogenous. The only difference between the experimental group and control group was that in the experimental class, the discussion forum had been incorporated into the English communication class. The experiment lasted 12 weeks at a rate of three hours a week. All students had to take the critical thinking skills and critical thinking disposition pre-tests before the experiment, as well as post-tests after instruction. In addition, after the experiment, a post-experimental student satisfaction questionnaire was used to elicit students' responses to the courses they took.

In the critical thinking skills pre-test, there were no significant differences between the mean scores of the experimental group (Means=2.26, 3.76, 3.14, 3.02, 1.52 and 13.71 respectively; S.D.=0.45, 0.48, 0.52, 0.41, 0.63 and 1.63 respectively) and the mean scores of the control group (Means=2.30, 3.75, 3.35, 3.08, 1.43 and 13.90, respectively; S.D.=0.46, 0.49, 0.49, 0.51, 0.55 and 2.05; $p>0.05$) in terms of the length, focus, content, organisation, style and overall sections. In the critical thinking disposition pre-test, there were no significant differences between the mean scores of the experimental group (Means=29.20, 30.32, 30.91, 23.09, 23.14 and 136.65, respectively; S.D.= 4.31, 3.81, 4.93, 3.52, 4.20 and 17.59, respectively) and the mean scores of the control group (Means=30.28, 30.03, 29.31, 24.16, 22.92 and 136.70, respectively; S.D.=5.15, 5.02, 5.63, 4.85, 4.73 and 22.82, respectively, $p>0.05$) in terms of the truth-seeking, open-mindedness, analyticity, systematicity, inquisitiveness and overall sections. Hence, it can be concluded that the experimental group and the control group were homogeneous in terms of their critical thinking skills and critical thinking disposition.

Both the control group and the experimental group received the same teaching material, mainly from *Communication Strategies*, published by David Paul in 2003 [23]. However, only the experimental group went through the critical thinking skills learning process. In the first two weeks, the teacher spent some time helping the experimental group students get familiar with the critical thinking skills. In this critical thinking learning process, students had to go through the following phases, namely: knowledge, comprehension, inference, application, analysis, synthesis and evaluation. The learning process is mainly adapted from Bloom's [24] and Kinsella's critical thinking model [25]. In the knowledge phase, students were required to learn how to experience, observe, intuit and research. After that, they stepped into the comprehension phase, in which they had to learn how to internalise, recall and connect with other information. After the

comprehension phase, they had to learn how to put what they had known to use in the application phase. Then, they needed to learn how to determine the necessary procedures and possible consequences in the analysis phase. After that, in the synthesis phase, they had to learn how to recognise parts and subparts and put them together. Finally, in the evaluation phase, they learned how to render judgment based on their knowledge and experience.

Instruments, Validity and Reliability

In this study, a critical thinking disposition survey, a critical thinking skills test, and a student satisfaction questionnaire were used to collect data.

Critical Thinking Skills Test

Critical thinking skills pre- and post-tests were in the essay-format, which were used to measure the students' reasoning and reflective thinking competency. In addition, by demonstrating the interrelationships among their ideas, students could generate higher levels of critical thinking [26]. Further, the essay-format tests provided students with the freedom to express and show their capacity to organise, synthesise and express knowledge [27]. The critical thinking skills test and the test evaluation criteria were reviewed by three experienced English teachers. After the test, two evaluators were used to grade the essay papers. The evaluators scored the essay papers independently of each other on the basis of the evaluation criterion for the test. The measure of the Pearson product-moment correlation between the first and second evaluator revealed that based on the interrater comparisons, the reliability estimates were 0.86, 0.78, 0.85, 0.79, 0.81 and 0.84 in terms of length, focus, content, organisation, style and overall sections. All the p-values were less than 0.01, hence, it could be concluded that the resulting correlation coefficients reflected the overall agreement between the two graders.

Critical Thinking Disposition Survey

The critical thinking disposition survey was adapted from California Critical Thinking Disposition Inventory. After being translated into Chinese, the survey was reviewed by two bilingual English teachers. The test consisted of 45 questions and was categorised into five subscales - truth-seeking, open-mindedness, analyticity, systematicity and inquisitiveness, based on a five-point Likert scale, ranging from 5 (always) to 1 (never) to measure student disposition toward critical thinking. The higher the score, the stronger the disposition. After the pilot study, the reliability coefficients for the subscales and overall sections in the critical thinking disposition survey were 0.73, 0.84, 0.90. 0.93, 0.85 and 0.96 when 80 students were tested.

Student Satisfaction Questionnaire

After completion of the coursework, a student satisfaction questionnaire was administered to establish students' satisfaction with the course, which could serve as a feedback for the teacher to improve the quality of class instruction [28]. The student satisfaction questionnaire, made up of 34 multiple-choice questions, was rated on a five-point Likert scale varying from (1) strongly disagree to (5) strongly agree. Based on the feedback of three experienced teachers, some modifications were made to the questionnaire to make the statements clearer. After the pilot study, the reliability coefficients for the categories in the student satisfaction questionnaire were 0.75, 0.88, 0.89, 0.93, 0.84 and 0.96 in terms of the instructional objective, instructional material/method, teacher's qualities, class climate/environment, assessment and overall sections when 80 students were tested.

RESULTS

This study explored whether the use of a discussion forum through the Internet learning system can enhance students' critical thinking ability, critical thinking disposition and student satisfaction. The research results show that the use of a discussion forum through the Internet learning system can positively affect student learning outcomes. The results of hypothesis testing are as follows:

To test Hypothesis 1, the results of both the control group's and experimental group's pre-tests and post-tests were examined by using t-tests and compared. As previously illustrated, in the length, focus, content, organisation, style and overall sections of the pre-test, there were no significant differences between the mean scores of the experimental group (Means=2.26, 3.76, 3.14, 3.02, 1.52 and 13.71, respectively) and the mean scores of the control group (Means=2.30, 3.75, 3.35, 3.08, 1.43 and 13.90, respectively; $p > 0.05$). That is, before the treatment, these two groups were homogeneous in the critical thinking skills category. However, after the treatment, significant differences between the two groups' critical thinking skills arose in the post-test (see Table 1). Notably, in the length, focus, content, organisation and style sections of the post-test, the mean scores of the experimental group (Means=9.76, 6.83, 6.05, 5.95 and 3.98, respectively) were significantly higher than the mean scores of the control group (Means=2.90, 5.13, 5.10, 5.13 and 2.23, respectively; $p < 0.01$). In the overall section, the mean score of the experimental group (Mean=32.57) was significantly higher than the mean score of the control group (Mean=20.48; $p < 0.01$). Hence, it can be concluded that the experimental group using the discussion forum through the Internet learning system outperformed the control group in critical thinking skills.

Table 1: Independent t-test results of the critical thinking skills post-test.

Test	Group	Mean	S.D.	t	p-value
Length	Experiment	9.76	0.66	61.278	0.000**
	Control	2.90	0.80		
Focus	Experiment	6.83	0.44	13.369	0.000**
	Control	5.13	0.69		
Content	Experiment	6.05	0.38	9.743	0.000**
	Control	5.10	0.50		
Organisation	Experiment	5.95	0.31	8.761	0.000**
	Control	5.13	0.52		
Style	Experiment	3.98	0.41	17.686	0.000**
	Control	2.23	0.48		
Overall	Experiment	32.57	1.64	28.945	0.000**
	Control	20.48	2.12		

Experimental group: N=42; control group: N=40
**$p < 0.01$

To test Hypothesis 2, the critical thinking disposition pre-test was used. The test demonstrated no significant differences between the mean scores of the experimental group (Means=29.20, 30.32, 30.91, 23.09, 23.14 and 136.65, respectively) and the mean scores of the control group (Means=30.28, 30.03, 29.31, 24.16, 22.92 and 136.70, respectively; $p > 0.05$) in terms of the truth-seeking, open-mindedness, analyticity, systematicity, inquisitiveness and overall sections (see Table 2). However, after the treatment, the results of both groups' critical thinking disposition were illustrated and compared.

The results show there were significant differences in all dispositions toward critical thinking, except inquisitiveness. In the truth-seeking, open-mindedness and analyticity sections, the mean scores of the experimental group (Means=36.57, 36.26 and 36.14, respectively) were significantly higher than the mean scores of the control group (Means=33.85, 33.55 and 32.95, respectively; $p < 0.05$). Notably, in the systematicity section, the mean score of the experimental group (Mean=29.64) was significantly higher than the mean score of the control group (Mean=26.98; $p < 0.01$). Nonetheless, it should be noted that in the inquisitiveness section, there was no significant difference between the mean score of the experimental group (Mean=27.62) and that of the control group (Mean=26.28, $p > 0.05$). However, in the overall section, the mean score of the experimental group (Mean=166.02) was significantly higher than that of the control group (Mean=153.60; $p < 0.01$). Accordingly, it could be concluded that the use of a discussion forum could bring positive effects to technical students' critical thinking disposition.

Table 2: Independent t-test results of the critical thinking disposition post-test.

Test	Group	Mean	S.D.	t	p-value
Truth-seeking	Experiment	36.57	4.64	-2.254	0.027*
	Control	33.85	5.42		
Open-mindedness	Experiment	36.26	4.00	-2.602	0.011*
	Control	33.55	5.37		
Analyticity	Experiment	36.14	5.11	-2.627	0.011*
	Control	32.95	5.89		
Systematicity	Experiment	29.64	3.68	-2.790	0.007**
	Control	26.98	4.92		
Inquisitiveness	Experiment	27.62	4.44	-1.302	0.197
	Control	26.28	4.90		
Overall	Experiment	166.02	18.51	-2.645	0.010**
	Control	153.60	23.82		

Experimental group: N=42; control group: N=40
*$p < 0.05$; **$p < 0.01$

To test Hypothesis 3, a post-experimental questionnaire, employing a five-point Likert scale, was given to both the experimental group and the control group. Examined by t-tests, the results of student satisfaction were illustrated and compared (see Table 3). In the instructional objective, instructional material/method and assessment, the mean scores of the experimental group (Means=12.58, 58.98 and 16.07, respectively) were significantly higher than the mean scores of the control group (Means=10.67, 52.90 and 14.08, respectively; $p < 0.05$). Notably, in the teacher's qualities and class climate, the mean scores of the experimental group (Mean=21.43 and 32.43, respectively) were significantly higher than the mean scores of the control group (Mean=18.25 and 28.10, respectively; $p < 0.01$). In overall, student satisfaction, the mean score of the experimental group (Mean=141.49) was significantly higher than that of the control group (124.00;

p<0.01). Therefore, it can be said that the use of a discussion forum through the Internet learning system can enhance student satisfaction.

Table 3: Independent *t*-test results of the student satisfaction questionnaire.

Test	Group	Mean	S.D.	*t*	*p*-value
Instructional	Experiment	12.58	3.50	2.432	0.017*
Objective	Control	10.67	3.62		
Instructional	Experiment	58.98	13.12	2.198	0.031*
Material/Method	Control	52.90	11.84		
Teacher'	Experiment	21.43	5.29	2.955	0.004**
Qualities	Control	18.25	4.38		
Class Climate/	Experiment	32.43	8.38	2.707	0.008**
Environment	Control	28.10	5.96		
Assessment	Experiment	16.07	3.76	2.416	0.018*
	Control	14.08	3.72		
Overall	Experiment	141.49	15.94	4.682	0.000**
	Control	124.00	17.87		

Experimental group: N=42; control group: N=40; S.D.=Standard Deviation
p-value＜0.05; **p*-value＜0.01

In conclusion, based on the statistical test results summarised in Tables 1-3, it can be demonstrated that technical students going through a discussion forum can attain better critical thinking skills, critical thinking disposition and student satisfaction than those not going through the forum.

DISCUSSION AND CONCLUSIONS

The study investigated whether the use of a discussion forum on the Internet learning system can enhance technical students' learning outcomes in terms of critical thinking skills, critical thinking disposition and student satisfaction. The study reveals that the students participating in the discussion forum activities attain better critical thinking skills, critical thinking disposition and student satisfaction.

In the critical thinking skills post-test, the experimental group outperformed the control group in the length, focus, content, organisation, style and overall sections. At the beginning of the experiment, the experimental group students were helped to go through critical thinking skills learning phases - knowledge, comprehension, application, synthesis, and evaluation [24][25]. Hence, they knew how to recall and connect their experience and put what they have known to use and application. Moreover, they can use their analysis skills to deconstruct the information to detect needed procedures and possible solutions and further use their synthesis skills to reconstruct the knowledge based on prior knowledge and experiences.

In addition, in the critical thinking disposition, the experimental group outperformed the control group in the truth-seeking, open-mindedness, analyticity, systematicity and overall sections. It should be noted that in the inquisitiveness section, though the mean score of the experimental group (27.62) was higher than that of the control group (26.28), there was no significant difference between the two groups (p>0.05). It could be possible that in traditional authoritative Chinese classrooms, teachers are in complete control of the class instruction while transmitting knowledge to students, who can only sit quietly in class. Student inquiries about a teacher's lecture would be regarded as *back talking*, which would be interpreted as an insult to the elders [29]. Hence, being accustomed to an authoritative lecture, students do not dare to ask questions.

However, discussion forum activity creates a more equal and comfortable discussion climate in which both teachers and students can have equal opportunities to share their opinions and experiences and to listen to different views. In the discussion forum activities, both teachers and students have been trained to express and to listen to different opinions, to demonstrate interrelationships among their ideas, and to use their own methods and organisations. Hence, students generate higher levels of critical thinking [26]. That is, through a discussion forum, technical students develop their capacities to organise, synthesise, express originality and reflect upon the topic. Through mutual self-reflection, they can not only analyse but also appreciate multiple and contradictory arguments and viewpoints. In addition, in the discussion forum activities, these students are empowered to influence the knowledge construction; they can detect needed procedures and possible consequences to develop a systematic thinking disposition. To sum up, after going through the critical thinking learning phases, technical students can enhance their disposition to be truth-seeking, open-minded, analytic, systematic and inquisitive. In a traditional teacher-centred class, students lose the opportunity to become critical and reflective thinkers [30]. However, in the critical thinking communication class, a student-centred thinking process is emphasised [31].

The study proves that the use of a discussion forum can help technical students move from being passive learners to being active learners. When utilising a discussion forum, teachers should remind themselves that they should relinquish

some aspects of authority coming from their positions, such as controlling discussion and dominating the class. Teachers' roles should be modified from being a teacher to becoming a facilitator, allowing students to have more power over the learning process.

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