ENHANCING INTERACTIVITY IN GEOGRAPHY CLASS: FOSTERING CRITICAL THINKING SKILLS THROUGH TECHNOLOGY

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Abstract

To develop students' critical thinking abilities, teachers must lead students to engage in discussions and to reason within various points of view, while employing evidence to draw conclusions, make decisions or seek solutions. Computer mediates learning by providing students with visualizations of relevant subject content to facilitate their reflection on these experiences. The purpose of this study is to investigate how technology can enable students to develop critical thinking through technology-enhanced interactivity. A geography teacher and 62 grade seven students from two classes participated in the experiment. One class was taught using traditional methods whereas the instructional strategy of computer-mediated learning was adopted in the other. The findings showed that computer media designed for enhancing interactivity would facilitate teacher-pupil interaction and peer discussion, and consequently contributed to improve students' comprehension of the geography curriculum content. In addition, the critical thinking ability of the high-achievement students was significantly improved.
Key words: *computer-mediated learning, computer-assisted learning, critical thinking, geography education, interactivity*.

Introduction

Facing the constantly changing and competitive world, people are required to organize information and to adapt to rapid changes in society. More than a learning expectation or mode of problem solving, critical thinking is a capability to challenge existing knowledge and to seek alternatives for knowledge construction. As an effective learning strategy, critical thinking has been considered as a central and fundamental goal of education (Gadzella & Masten, 1998; Halpern, 1998).

Critical thinking skills are better cultivated through instructional activities of providing comprehensive questions for students to reflect, discuss, debate, or persuade (Ennis, 1996; Freire, 2000; Paul, 1990; Schellens, Van Keer, De Wever, & Valcke, 2009). Therefore, a multidisciplinary course, such as geography, will provide a complex and authentic problem space for developing critical thinking skills. Besides the retention of knowledge, the goal of geography curriculum is, in fact, the development of students' problem-solving, critical analysis and historical thinking abilities (Alibrandi, Beal, Thompson, & Wilson, 2000; Zhou & Smith, 1999). Nevertheless, rote memorization has been the most commonly used instructional method in geography or social studies courses in Taiwan. These instruction modes emphasizing traditional teacher-dominated, exam-oriented, and passive approach, offer little to assist students' higher-order thinking abilities (Yang, 2007; Yang & Huang, 2007).

Teachers are the key to a positive learning environment, and a good teacher-pupil interaction can promote students' academic achievement (Rosenholtz, Bassler & Hoover-Dempsey, 1986; Wubbels & Levy, 1993). Whether a teacher's critical thinking instruction is successful depends on how well it motivates the students to engage in critical discussion (Ennis, 1996). Effective teachers prepare contextual topics to facilitate critical discussion among students. Through the process of communicating, understanding and changing over time, students gradually develop the ability to think critically. While many researches indicated that in computer technology-supported situated learning, by anchoring instruction in students' experiences and interests that promote learning effectively, computers have become a tool for cultivating critical thinking. Several studies have confirmed that technology facilitated in-class communication and thus enabled students to develop arguments supported by evidence, explain opinions by making thinking processes 'visible', and eventually foster enhanced critical thinking skills (Huang, 2011b; Kumta, Tsang, Hung, & Cheng, 2003; Yang, 2007; Yang & Huang, 2007; Yeh, 2009). These studies show that computer technology would provide a medium through which significant facts and events are visualized, in order to facilitate students' reflections on their reactions to these experiences.

This study aims to understand how critical thinking abilities can be developed by means of computer-supported communication in classrooms. In light of the importance of technology-enhanced learning through argumentation and reflection, the researchers select societal or controversial issues in domestic geography curriculum as the teaching content. With media designed for enhancing interactivity within a geography course in a high school, the researchers conduct instruction experiments to investigate the differences of critical thinking abilities. Furthermore, the effect of utilizing computer media to promote content comprehension is tested and discussed as well.

Critical Thinking Instruction

Critical thinking has been researched in many scholarly fields which have provided diverse definitions (Ennis, 1996; Fisher, 2001; Kuhn, 1999; Moore & Parker, 2001; Paul, 1984). For example, Halpern (1998) claimed that critical thinking is purposeful, reasoned and goal-directed in solving problems and making decisions. Fisher (2001) defined critical thinking as "a kind of evaluative thinking which involves both criticism and creative thinking" (p. 13). Recently, Moon defined critical thinking as "a capacity to work with complex ideas whereby a person can make effective provision of evidence to justify a reasonable judgement" (Moon, 2008, p. 126).

Critical thinking has been commonly viewed from the perspective of popular conceptions existing in schools. Claiming that critical thinking is more than an intellectual skill cultivated through education, Paul (1984) broadened the concept of critical thinking from a set of skills to a major aspect of one's character. The importance of moving beyond merely watching, understanding and producing meaning to taking action is further emphasized. He asserted that the practice of critical thinking in school is nothing more than cognitive activity. Asking students to conceptualize, apply, analyze, synthesize and evaluate information gathered from experience reasoning or communication will become mere information acquisition. As highlighted by

Paul, the affective component plays an important role in promoting the development of critical thinking (Paul, 1984; Paul & Elder, 2002).

Critical thinking teaching strategy is the key approach for fostering students' critical thinking ability and intention (Eggen & Kauchak, 1996; Yeh, 2009). An appropriate strategy for critical thinking instruction will cultivate a learning environment in which students are willing to express themselves. For developing students' critical thinking ability, Ennis (1996) emphasized that teachers post comprehensive questions for students to discuss and make assertions. By judging whether the inference is vague or contradicted, students re-examine the outcome and reach a unanimous decision. A synthesis of prior research concluded that the main activities for teachers leading critical thinking instruction were the provision of open, extended questions with reflection, and creating opportunities for group discussion and cooperative learning (Ennis, 1996; Freire, 2000; Paul, 1990). As a part of the process of critical thinking, argumentation is intended to justify beliefs and values in order to influence others. One way to achieve shared understanding is to have students engage in a process of logical reasoning that alters their perceptions or beliefs about social reality (Inch, Warnick, & Endres, 2006; Moon, 2008). Providing scaffolding, both in using technology applications and in orienting learners to the task, is essential to successful implementation of critical thinking activities. Technology, therefore, can be used to facilitate the argumentation process in terms of both visualizing the outcomes and supporting collaborations among students (Chalmers, 2003; Milson & Earle, 2007; Morgan, 2006). To visualize and mediate communication between teachers and students, technology becomes a tool for social reconstruction as it challenges and offers alternatives to traditional frameworks and processes in classrooms. This type of instruction allows both students and teachers to become aware of the nature of geography in new and multifaceted ways.

Interactivity and Technology

Constructivist educational models are based on the theory that instead of being passive receivers of information, learners should be active explorers of their own understandings(Huang, 2011a; Jonassen, 2000). As a vehicle to foster learning, technology is often integrated with instruction at schools. Instead of seeing technology as the main contributor to learning, teachers should use it as a mediator to facilitate students' construction of knowledge (R. E. Clark, 1994). Prior studies confirmed such constructive learning environments would motivate and facilitate the acquisition of knowledge by providing an intuitively comprehensible context (de Freitas & Neumann, 2009; Milson & Earle, 2007).

Socio-constructivists argue knowledge is collaboratively constructed in a social context mediated by discourse. Learning is fostered through interactive processes of discussion, negotiation and sharing with others (Honebein, Duffy, & Fishman, 1993; Jonassen, 2000). Interactivity is often defined as sustained, two-way communication between students and students or, between students and the instructor, with the purpose of task completion or social relationship building (Gilbert & Moore, 1998; Liaw & Huang, 2000). According to Wang, Woo, and Zhao (2009), interactivity involves four types of interaction: learner-content, learner-learner, learner-instructor , and learner-interface.

Learner-content interaction is a process in which learners make sense of subject matter materials. Hillis (2008) illustrates how digital contents can encourage enquiry and investigation through linking of sources such as census databases and film with a range of closed and open-ended tasks. He uses multimedia in history education and receives positive feedback from students for enhancing critical skills.

For social constructive learning, learner-learner interaction and learner-instructor interaction are the communication between learners and peers and between learners and the instructor for information sharing, negotiation and knowledge construction (Chou, 2003).

Learner-interface interaction refers to how learners use the computer program interface to communicate with the course content or people(Lohr, 2000). As Rick and Lamberty (2005) mentioned, the environment provided learners with opportunities to explore, compare, and share their existing knowledge regarding a specific subject and thus enhanced their critical thinking skills through reflective learner-driven inquiry.

Methodology of Research

Participants

Sixty-one grade seven students from two classes at a school in central Taiwan participated in this study. Most teachers at this school adopted traditional instructional methods. Predictably, teachers believed that a school education aims to promote students' performance on academic examinations, and not on their ability to think critically. Thus, students were asked to memorize and present information, but were not encouraged to infer, interpret or evaluate during classroom activities. To verify no significant differences in critical thinking ability between two classes, a critical thinking abilities test (CTT-I) was conducted before the experiment. The CTT-I pre-test showed no difference in critical thinking ability of two groups, although the experimental group (M=11.97) and control group (M=13.07) scored lower than the national norm (M=14). More specifically, the critical thinking ability of students in experimental group was lower than the control group and the average seven-grade students in Taiwan.

The geography teacher, a young, devoted teacher, had a bachelor's degree in education with a minor in geography. She frequently employed instructional media such as videos in her classes and encouraged students to express their opinions. She had taught geography for three years and was willing to participate in this study to improve her instruction abilities.

Procedure

To understand how the computer-enhanced interactivity influenced students' critical thinking skills and content knowledge, the researchers conducted an eight-week quasi-experiment. The experimental group consisted of a class of thirty-one students, while a class of thirty students formed the control group. Both classes were instructed by the same teacher: the traditional method of lecturing supplemented by the use of instructional media such as pictures and video clips was used in the control group class while integrated animated instruction as designed by the researchers was used in the experimental group. The critical thinking tests were carried out prior to and following the instruction with the geography achievement test administered only after the instruction.

Instruments

The instrument used to evaluate critical thinking was the Critical Thinking Test, Level I (CTT-I), which was based on the Cornell Critical Thinking Test (Ennis, Millman, & Tomko, 1985)and the Watson-Glasser Critical Thinking Test (Watson & Glaser, 1980), and then later developed by Yeh (2003). It consisted of 25 multiple- choice items, which were divided evenly into five subsets: assumption identification, induction, deduction, interpretation, and argument evaluation. Each item was comprised of one statement and three multiple-choice answers. This test displayed an appropriate level of difficulty and an effective discrimination (discrimination index 0.47 and difficulty index 0.61). The subtest scores and total score were significantly correlated (0.228 ~ 0.445).

To test students' achievement in acquiring geographic knowledge, an achievement test of geography was developed by the researchers. The test consisted of 40 multiple-choice questions that evaluated the cognitive abilities of knowledge (15%), comprehension (20%), application (30%), and analysis (35%). The average discrimination index was 0.65 (with a range of 0.31~0.88) and the level of difficulty was 0.58 (with a range of 0.31 ~0.75). With Cronbach's α coefficient of 0.91, this test showed a high degree of reliability.

Another evaluation tool for teacher-pupil interaction is the Checklist for Teacher-pupil Interaction, developed by Yeh (1999). During instruction, researchers observed the dialogues in the classroom and classified them as ***TQ*** (teacher asked questions), ***SQ*** (students asked questions), ***SA*** (students gave answers or evaluations), and ***TA*** (teacher gave answers and evaluations) on the checklist. In addition, the interactions between peer students were identified as ***SS*** (SQ+SQ, SQ+SA, SA+SQ, SA+SA).

To understand students' attitude toward the instruction activities, researchers randomly selected students to interview during the 10-minute break after class. In addition, several focus-group interviews were conducted after the experiment.

Media and Interactivity

Subject Content

The unit related to domestic geography in the seventh grade geography curriculum entitled "Introduction to Taiwan" formed the subject content. Such topics as population, economy, settlement and traffic, as well as regional development and environmental protection were covered. With the combination of texts, pictures, digital maps, simulated animations and games, these e-learning resources supporting visual thinking aimed to construct a learning environment to engage students in discussion. These computer animations were adopted as instructional media to foster the students' critical thinking abilities in discussing social issues

Learner-content Interaction

Critical thinking is a manifestation of epistemological and cognitive views of knowledge. The appropriate management of evidence and the qualities of representation are closely related to the development of epistemological beliefs (Sweet & Swanson, 2000). Being able to iterate clearly and precisely the evidence marshaled by a specific point of view is constitutive for understanding. Evidence should be assembled and presented to support the positions, assumptions or claims adopted by a particular point of view (Inch, et al., 2006). Based on dual coding theory (J. M. Clark & Paivio, 1991; Paivio, 1986), data visualization can reduce cognitive load and promote content comprehension. Several statistical tables on the topic of economic progress in textbooks can be presented with animations to show the trend with charts and maps., For example, the graphs of economic development supplemented with the distribution maps of major industrial parks illustrate the process and help students comprehend the data and spatial distribution (see Figure 1).

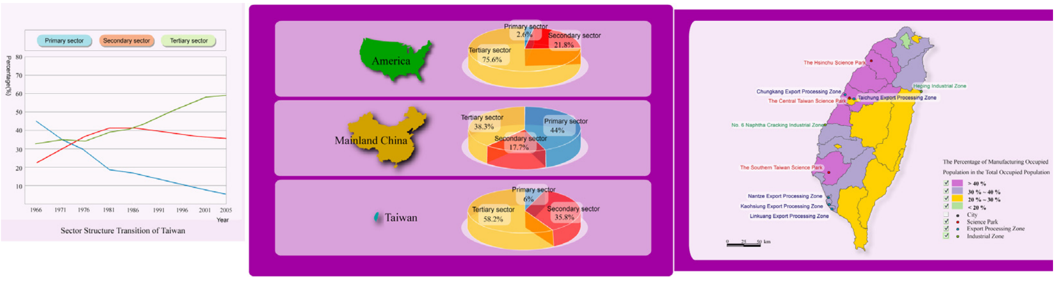

Figure 1: Maps referenced to traffic issues. The left is the population distribution and the right is the traffic network.

Learner-interface and Learner-instructor Interaction

To illustrate abstract concepts, simulations were utilized. For example, the formation of settlement along the Dansuie River was visualized as a three-step animation (see Figure 2). It is helpful for teachers to explain the process of a settlement developing along the river. As Brookfield (1987) pointed out, the process of internally examining and exploring an issue of concern, triggered by a relevant experience, creates and clarifies meaning in terms of self, and results in a changed conceptual perspective. For example, another animation (Figure 3) with different phases of urbanization, aroused students' feelings towards various environments, and provides students with contexts to share their experiences. In addition, the teacher used challenging questions to inspire students to respond, expand and develop the topics introduced in the critical–talk episodes. Following is the description of the instruction:

After watching the simulations, teacher first asked students to share their personal experiences of visiting cities and suburbs as well as their preferred living areas. Students listed several advantages of living in suburban area as 'less pollution', 'low living expenses', or 'close to natures' while some students claimed many 'fun activities' and 'good-paid jobs' in cities. To extend students' arguments, teacher posted a question: "The Beijing government is tearing down old buildings for the Olympic Game. Do you agree?" Most students agreed with the demolishment but proposing criterions for choosing the buildings to tear down. In the end, teacher took 'hutong' as an issue for reflection. Hutong is a neighborhood formed by lines of traditional courtyard residences for generations. Is it a burden to the city renovations or a cultural treasure?

Figure 2: Animations of settlement formation along the Dansuie River.

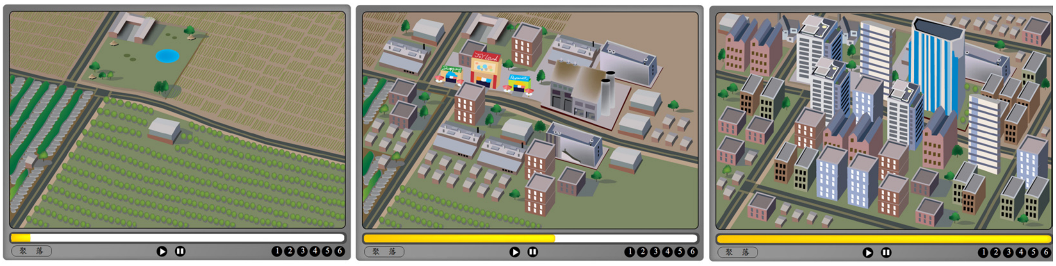

Figure 3: Simulation of the urbanization process. From left to right: Phase 1, 3, and 6.

To encourage students to reason and seek evidence for arguments, animations provide cross references associated with a particular topic. According to Inch, Warnick and Endres (2006), evidence can be divided into fact and opinion. When advocates make arguments that are based on their own firsthand knowledge and understanding of the facts, then they are making arguments grounded in fact-based evidence. However, sometimes the facts surrounding an issue are excessively complex or large to permit complete reviews, so arguers then use opinion, that is, the statements of others' judgments and estimations, to support his or her own claims (Inch, et al., 2006). To develop one's perspective critically, students need to reason within various points of view and use evidence in order to draw conclusions, make decisions or seek solutions. For example, to answer why the intensive construction of traffic infrastructure was needed on the west coast, a link to a map of population distribution and a map of traffic network provide evidence for reasoning (see Figure 4).

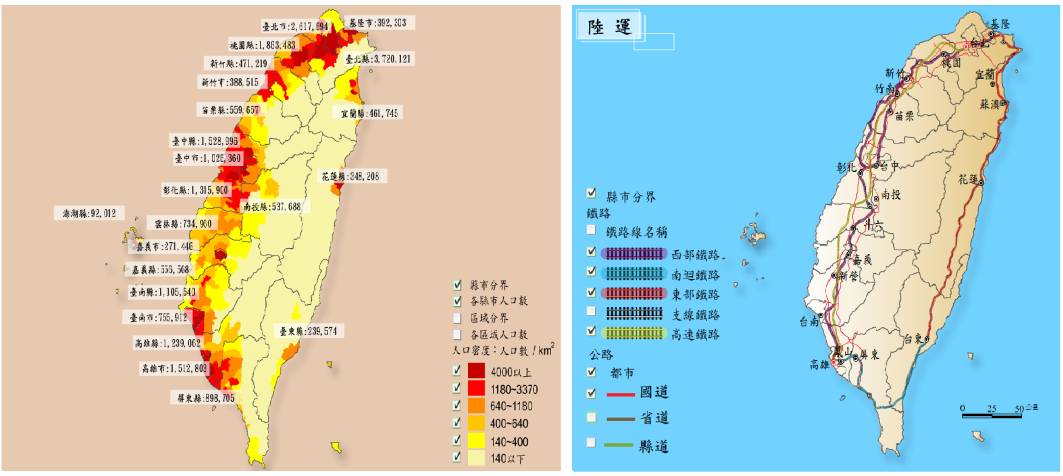

Figure 4: Visualization of economy transition and distribution of industrial parks.

Learner-interface and Learner-learner Interaction

As shown in Figure 5, interactive design tools such as a web-based tool for settlement planning was developed for students to practice their urban design. With drag-drop operation, students arrange constructions like buildings or airports according to their ideal locations to build a village or city. Students' works will then be presented and evaluated by classmates. With the nature of argumentation, critical thinking has local significance in different contexts (Inch, et al., 2006; Moon, 2008). Students with diversified backgrounds and values designed cities with a variety of features and functionalities.

In addition, an interactive quiz to compare traffic infrastructure was used to attract students' attention and efforts on reaching consensus (see Figure 6). According to Moon (2008), peer assessment provides practice in making judgments on the basis of evidence. The act of assessing the work of another is a matter of making a judgment. It involves learners more in the process of meta-cognitive critical thinking skills.

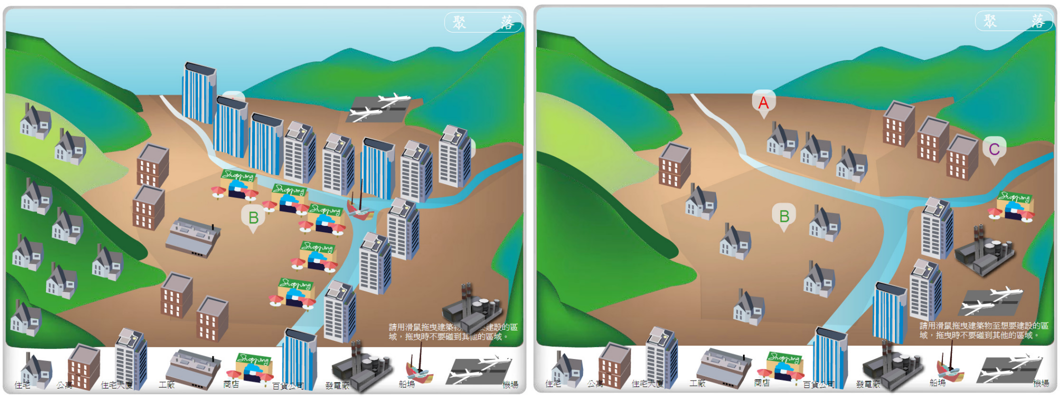

Figure 5: Settlement designs by two students.

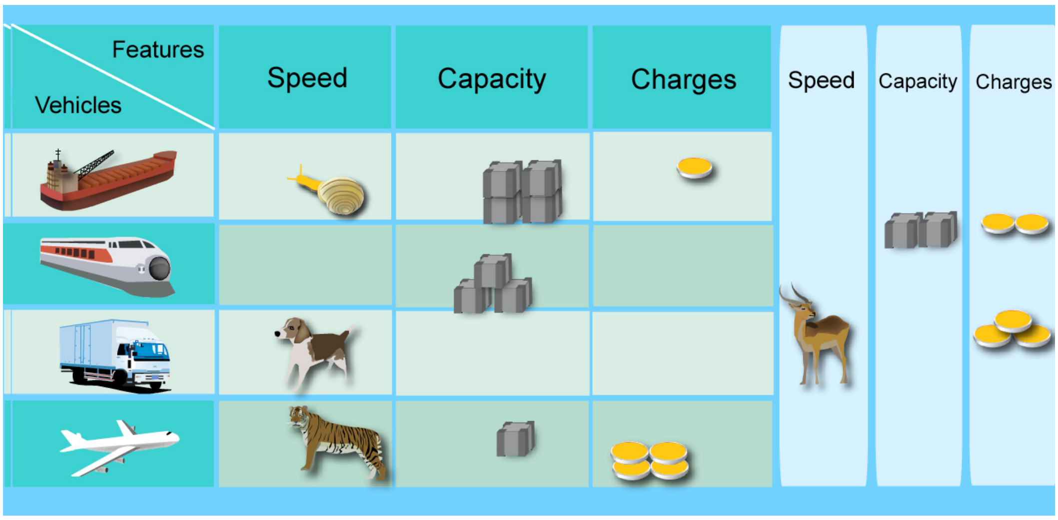

Figure 6: Interactive matching quiz partly completed by a student.

Results and Discussion

Interaction

Technology, used by the instructor as a scaffolding tool for connecting learning with experiences, mediates communication between peer students on subject topics. The result of teacher-pupil interaction is shown in Table 1. The experimental group had significantly more interactions in ***TQ*** (teacher ask questions), ***SQ*** (students ask questions), ***SA*** (students give answers or evaluations), and ***SS*** (peer interaction) than did the control group. In other words, students with technology-enhanced interactivity more actively engaged in-group discussion. In addition, the teacher tended to be less dominant in leading the classroom activities.

Education, through "a constant unveiling of reality", invites students to develop a critical awareness of their social worlds. A more balanced teacher-student relationship will thus help teachers and students to be jointly responsible for, and simultaneously engaged in, learning (Freire, 2000). However, cultivating critical thinking in a geography course poses tremendous challenges to both teachers and students, who have become accustomed to traditional instruction. In this study, the computer-mediated environment increased in-class interaction and facilitated active learning and efficient comprehension of course content. As previous studies asserted that the enhancement of critical-thinking skills relies on interaction and discussion (Yeh, 2009), the study result confirmed that the atmosphere of the classroom using computer-mediated communication became more student- centered, which is suitable for fostering students' critical thinking abilities.

Table 1. Group differences in teacher-pupil interaction.

Interaction type	Experimental Group			Control Group		t
	M	SD		M	SD	
TQ	27.1250	3.97986		19.3750	2.97309	4.413*
TA	508750	3.60307		9.1250	3.90741	-1.729
SQ	9.2500	5.20302		1.5000	0.92582	4.148*
SA	25.5000	7.28991		11.1250	2.23207	8.301*
SS	23.8750	2.69590		6.3750	1.92261	14.948*

*p < 0.05

Critical Thinking Capabilities

An ANCOVA analysis was conducted to examine the students' progress in critical thinking abilities after the instruction. As shown in Table 2, there was no significant difference on post-test scores between the two groups. In other words, the experimental group, in spite of dramatic improvement, did not perform significantly better than the control group in the critical thinking test. Although students made some progress after instruction, the critical thinking capabilities of both groups were still below the national average (see Table 3).

Table 2. Between-group ANCOVA test on critical thinking scores after instruction.

Factors	Analysis of Covariance (ANCOVA)					Adjusted Means	
	Mean Square	df	Sum of Squares	F	Sig.	Experimental Group	Control Group
Assumptions Identification	2.269	1	2.269	1.998	0.163	3.341	2.954
Induction	0.300	1	0.300	0.355	0.554	2.547	2.687
Deduction	1.690	1	1.690	1.509	0.224	3.461	3.128
Interpretation	0.747	1	0.747	0.765	0.385	2.206	1.975
Argument Evaluation	4.347	1	4.347	3.612	0.062	1.851	2.386
Total Scale	0.327	1	0.327	0.046	0.831	13.252	13.103

$\alpha = 0.05$

Table 3. Comparison of critical thinking capabilities.

		Assumptions Identification	Induction	Deduction	Interpretation	Argument Evaluation	Total Scale
National Norm (N=256)							
	Mean SD	3.43 1.05	2.73 1.05	3.21 1.25	2.59 1.15	2.04 1.10	14.00 3.40
Control Group (N=30)							
Pre-test	Mean(M) SD	3.30 1.79	2.60 1.22	2.83 1.34	2.47 1.33	1.87 1.01	13.07 3.79
Post-test	Mean(M) SD	2.97 0.96	2.70 0.84	3.13 1.14	2.07 1.08	2.40 1.10	13.27 2.98
Experimental Group (N=31)							
Pre-test	Mean SD	3.16 0.90	2.45 1.29	2.77 1.09	1.81 0.98	1.74 1.06	11.97 2.89
Post-test	Mean(M) SD	3.32 1.17	2.52 1.12	3.45 1.03	2.16 0.93	1.84 1.10	13.10 2.80

Nevertheless, further analysis revealed that certain subgroup of students improved their critical thinking abilities significantly. The researchers divided the students of the experimental group into subgroups according to their grades in the achievement test: high achievement subgroup (higher than 66%), average achievement subgroup (between 66%~34%), and low achievement subgroup (below 34%). As seen in Table 4, the within-group t-test showed that the high achievement subgroup of the experimental group significantly improved in their critical thinking skills after the instruction. Meanwhile, there was no significant improvement for the average achievement subgroup and the low achievement subgroup in the test.

Table 4. Within-group difference in critical thinking test between achievement groups.

Achievement	Pre-test		Post-test		t	df	Sig.
Group	M	SD	M	SD			
High	12.6000	3.40588	15.6000	2.54733	-3.451	9	0.007*
Average	12.6364	2.37749	12.8182	1.94001	-0.187	10	0.855
Low	10.6000	2.63312	10.9000	1.72884	-0.262	9	0.799

*$p < 0.05$

It seemed that the student with higher grades in the achievement test also performed better in the critical thinking test. Students in the experimental group performed significantly better than the control group did in the achievement test (see Table 5). The post-test scores in the critical thinking test of the two groups correspond with the achievement test, with the correlation coefficient values of 0.61.

Table 5. Between-group differences in the geography achievement test.

Group	df	Avg.	SD	t
Experimental Group	31	65.2419	18.32979	2.189*
Control Group	30	53.3333	28.89212	

*p=0.03 <0 .05

Students' Reaction

The interviews showed that most students generally found their initial experiences with computer-integrated instruction to be a joyful, rewarding, frustrating, empowering, and challenging mixture. Students appreciated the series of critical thinking discussions that followed the computer presentation or exercises. They particularly valued the interactive communication during the discussion.

Constructive instructor pedagogy, computer visualization, and the group-based assignment were designed to prompt some reluctant learners to take primary charge of their own learning. Nevertheless, those students who were not active in discussion revealed in private interviews that they were not comfortable or capable of expressing themselves. Some students complained that the teacher overrated their abilities to make judgments on textbook content. In fact, many students, encouraged or pressured by the teacher and peers to speak, just repeated some factual information or presented ideas contributed by other group members.

On the contrary, the high achievement students were more active in discussion and had the confidence to express their opinions. For instance, in the activity of planning an investment for a certain industry, the high achievement students often synthesized different opinions or gave comments in discussion and grasped the opportunities to practice argumentation. As they engaged in the activities more, the better their abilities would enhance.

Conclusions

The prevalence of computer usage in school drives the need to understand its effects on critical thinking when technology is integrated with instruction. Such knowledge will definitely become a useful resource when examining issues related to educational practice. As Clark(1994) claimed, however, technology does not influence learning. Technology is a mediator that teachers include in the instruction activities to facilitate students' learning. With the successful integration of computers and constructive instruction in this study, the interaction between peers as well as between teacher and pupils was effectively increased. In-class observation and discourse analysis confirmed that technology integration changed the teacher-dominant instruction mode to a student-centered one that promoted active learning.

A computer environment can increase social interactions and presumably contribute to the improvement of students' critical thinking ability; however, critical thinking ability of students was not significantly improved. Although the critical thinking ability of the high achievement students was effectively developed, the research findings do not support the theory that computer-media argumentation is an effective instructional strategy for critical thinking. As McLaughlin and Devoogd (2004) mentioned, becoming critical is a process that involves learning, understanding and changing over time. Under the long-term influence of traditional instruction and cultural deprivation in the less urbanized area, students in this study rarely had opportunities to practice critical thinking. With greater confidence or knowledge background, those with higher academic performance benefited from the opportunities to practice critical thinking. Nevertheless, the result implied an optimistic direction. Extended instructional time and appropriate grouping would continue to improve students' critical thinking abilities.

With computer-enhanced discussion, course content comprehension was also significantly improved. Mediated by computer, students in the experimental group were encouraged to participate in discussion and took active roles in learning. They paid attention to the topics and elaborated on possible problems and solutions. Consequently, students' cognitive efforts on content comprehension and problem solving led to better performance on the achievement test.

Although reactions varied when students were asked to express themselves instead of listening to the teacher's lecture, the researchers observed that some students' attitudes toward geography course changed, and that some held critical views on the textbook content. Nevertheless, when the teacher-dominant instruction turned into elite-dominant learning, students with good grades were more capable of, and responsible for, engaging in argumentation; they eventually gained better geography knowledge and learned how to make inquiries and judgments. The high achievement students were willing to discuss and were bold in presenting alternative ideas; however, the low achievement students' contribution to the group was limited to facts rather than opinions based on analyzing and reasoning. Consequently, the high achievement students benefitted the most from the group discussion and made remarkable progress after the instruction. Those who passively participated in group discussion missed the critical thinking opportunities as they lacked confidence, knowledge or the ability to argue and reason. Teachers need to pay more attention to those students and to dispatch cognitive tasks to build up these students' confidence and knowledge. In addition, further research should focus on exploring how to encourage low-achievement students to participate more actively in group discussion.

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