Effects of Critical Thinking Strategies
on Knowledge Acquisition, Learning Outcome and
Student Satisfaction in Web-based Argumentation

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The purpose of this study is to analyze the effects of Critical Thinking Strategy supporting argumentation activities between learners. The research question is whether the form of Critical Thinking Strategy offered to support meaningful interaction of collaborative argumentation between learners influences the knowledge acquisition, learning outcome, and student satisfaction. For this, the collaboration outcome of the group, the level of individual knowledge acquisition, the level of students satisfaction were measured as outcome of argumentation activity and their differences analyzed. This study concludes the following: A comparison of the group that was provided with Critical Thinking Strategy (test group) and the group provided with general argumentation scaffolds (compared group) showed there wasn't statistically significant differences in the quality of the learning outcome of collaboration between the groups and in students satisfaction. But there was significant difference in the degree of individual acquisition depending on the offering of scaffolding for Critical Thinking. Therefore, as premised in this study, supporting meaningful mutual interaction between learners during collaborative argumentation using Critical Thinking Strategy has a positive influence on the individual acquisition of domain knowledge. The group provided with scaffolding for Critical Thinking gained higher effect in the degree of knowledge sharing and individual acquisition of domain knowledge compared to the group provided with general argumentation scaffolding.

Keywords: Critical thinking, Critical thinking strategies, Collaborative learning, Collaborative argumentation, Argumentation

Introduction

Argumentation provides the opportunity for participants to understand the domain knowledge from various perspectives by sharing knowledge and perspectives and to experience conceptual changes, which in turn contributes to building collaborative knowledge of the group. Participants acquired relevant information and knowledge through discussions and collaborative argumentation, promoting their critical thinking ability when presenting their own opinions or criticizing other's thoughts, and enabling them to experience practicability and a relationship of context via interaction of various feedback from others. As a result, such activities brought a learning outcome followed by a deep understanding of the domain knowledge and promoted critical thinking (Andriessen, 2006; Andriessen, Baker, & Suthers, 2003; Bransford, Brown, & Cocking, 1999; Chi, Bassok, Lewis, Reimann, & Glaser, 1989).

Procedures of argumentation proceed with repetitive occurrence with individual argumentation levels reflecting learners' own claims and opinions and collaborative argumentation levels evaluating and accepting others' claims and opinions (Rummer& Spada 2005). Therefore, in the case the individual argumentation level does not properly proceed, collaborative argumentation brings about poor quality in return, ultimately having bad influence on individual argumentation levels. Especially, if attempts are made to deeply understand the domain knowledge with various perspectives via argumentation, it becomes even more important to derive critical thinking from listening to the opinions of others in the collaborative argumentation level along with critical reflection of the individual argumentation level.

Insufficient critical thinking at the stages of individual reflection and collaborative argumentation makes it difficult to derive meaningful activities promoting critical thinking, conveying a mere exchange of thoughts without deep understanding. In general, learners not familiar with argumentation, have difficulties

establishing their own arguments and claims followed by proper grounds, in involving in activities of inference and identifying the gist of issues through mediation of conflicts in opinions(Oh, 2004; Simon, Erduran & Osborne, 2006). In addition, learners are not used to suggesting logical grounds to connect claims and grounds, criticizing or counter-attacking the opinions of others(Felton et al,. 2001; Kuhn et al., 2003), and are psychologically pressured to file set forth counterarguments(Andriessen, Erkens, van de Laak, Peters, & Coirier, 2003). Therefore, they end up reaching out to a quick conclusion without deep argumentation(Andriessen, Erkens, Laak, Peters, & Coirier, 2003) or deriving superficial agreements(Koschmann, 2003). In this case, it is hard to promote reflection normally expected in the procedure of argumentation between learners or to acquire proper knowledge or learning outcome. Therefore, it is necessary to support procedures of critical thinking along with scaffolding of smooth exchanges of deeper arguments without psychological pressure.

Hereupon, this study attempts to provide strategies for critical thinking so that learners may experience proper procedures of critical thinking in web-based argumentation, aims at verifying whether such procedure has a significant impact on the acquisition of knowledge, achievement of collaborative outcome, and satisfaction of learners and approve its necessity.

Theoretical Background

Learning through argumentation

In general, argumentation is a process involving the transition from accepted facts to individual assertion(Toulmin, 1958), meaning an activity of being specifically in favor of or against issues in discussion, proving his or her own opinions by using evidence, or refuting other arguments of counterparts(Bauer,

1999). Broadly speaking, it is the activity of evidencing his or her claims and opinions.

From a learning perspective, learners have opportunities to gain deep understanding of the given field in discussion from various angles through argumentation. Argumentation broadens the learners' horizon of discussion while interacting with people holding other values or induces them to gain better social and perceptual views. Also learners deepen their comprehension of the discussion when examining a subject and jumping into a chain of arguments to better understand related concepts(de Vries, Lund, & Baker, 2002).

Previous studies have shown that argumentation has a positive influence on private knowledge acquisition(Andriessen, Erkens, Laak, Peters, & Coirier, 2003; Chinn, 2006), with the effect of self-explanation from which learners make inferences through argumentation, elaborate their thoughts to explain to others, and reflect on them. These procedures induce learners to reconstruct their existing knowledge(Andriessen, Baker, & Suthers, 2003; Chi, Bassok, Lewis, Reimann, & Glaser, 1989), leading them to a deeper conceptual learning experience(Andriessen, 2006; Bransford, Brown, & Cocking, 1999).

In particular, collaborative argumentation between learners enhances the effect of learning (Kuhn, Shaw, & Felton, 1997; Munneke, 2007; Munneke, Andriessen, Kanselaar, & Kirschner, 2007), because collaborative discussion provides them the opportunity to think critically and compare the importance and value of the subject with others(Andriessen, 2006); to take into consideration the different mutual positions and views about the subject; and to have a better understanding of the subject in the process of clearly explaining the issue of discussion more in detail(Baker, 2003; Munneke et al., 2007).

Baker(2004) explained that the learning mechanism arising from effective argumentation as a process of clarifying knowledge and changing concepts, builds on the collaborative knowledge, and elaborates the theory of learners. The clarifying process of knowledge is an activity in which learners explain their thoughts and

inferences, providing them the opportunity to justify their ideas and defend against counterarguments. It at the same time promotes introspection for in-depth learning. In the process of questioning and solving wrong concepts, learners change concepts, accept knowledge in a new manner, and build shared knowledge together. The collaborative knowledge building also fosters individual knowledge and argumentation with peers and continues to call on learners to clarify questions and statements, leading them to gain knowledge based on deep, clear, and different understandings.

In this regard, the practice of argumentation with members working together in the process of collaborate learning leads learners to elaborating their ideas and claims and to be a critical thinker with an opportunity to deepen their understanding of knowledge of the field. At the group level, sharing views and knowledge between members provides them with the experience of accepting other opinions and the opportunity to bolster the quality of discussion. This collaborative argumentation promotes not only the acquisition of knowledge of the field but also critical thinking, externally making learners see problems from various angles from a peer point of view and internally making them go through the inference of figuring out the relations between claim and evidences. Nurturing the capacity of interacting and cooperating with peers and thinking critically about subjects can ultimately improve the problem-solving capability of learners(Andriessen, 2006).

Support needed for argumentation

Argumentation between learners promotes the acquisition of knowledge, having a positive impact on the qualitative enhancement of collaborative outcome. The effect of this type of learning is only possible when the argumentation deals with proper understanding of claimed intention of others and not mere communication, followed by critical thinking for an issuance of errors or issues. This ultimately leads to significant interaction with others while accepting the arguments with proper

understanding and responding in favor of or against them. Therefore, in order to derive such a meaningful interaction in argumentation, it is necessary for learners to derive critical thinking on each issue(Nussbaum, Winsor, Aqui & Poliquin, 2007).

According to advanced researches, however, learners are often times not familiar with the process of argumentation of offering an explanation for claims based on facts and objecting against them. And it is clear that merely supporting argumentation is not enough for learners to be used to it(Simon, Erduran & Osborne2006).

In other words, learners may have difficulties building evidence and making inferences to insist their opinions; verifying their opinions and solutions; mediating conflicts of opinions; and discussing the gist of an argument (Oh, 2004).

Studies by Felton, Kuhn (2001) and Kuhn, Udell (2003) point out that learners may insist on their claims without being familiar with the process of supporting their claims based on logic and evidence and of objecting other claims based on them. That is, learners may insist on their claims relatively easily while not being good at providing evidence for the claims based on logical connection of the claims with evidence and at criticizing counterparts' opinions based on facts. They may find it easy to suggest repetitive explanations or instances rather than providing valid and logically correct grounds(Kuhn, 2003).

In addition, most learners are reluctant at suggesting counter-arguments because of psychological pressure(Andriessen et al., 2003).

In this case, it is hard to promote reflection expected in argumentation between learners, leading them to jump to quick conclusions lacking consideration and evaluation of the quality of argumentation and deep discussion about their suitability(Andriessen, Erkens, Laak, Peters, & Coirier, 2003). As such, the learners may end up with superficial compromises(Koschmann, 2003). Therefore, instructional support is necessary to enable smooth communication between learners and lower their psychological pressure for proper argumentative thinking and to reach the expected outcome.

Importance of support for critical thinking for argumentation

As an instructional supportive measure for argumentation between learners, recent studies suggest web based learning for argumentation. This argumentation is based on synchronous and asynchronous argumentation of participants, and it leaves documental records providing learners with more time to make their claims and counterarguments than synchronous argumentation off-line(Nussbaum, Winsor, Aqui & Poliquin, 2007). It also has the advantage of easily providing support for the facilitated interaction between learners and for effective argumentation(Schwarz, Neuman, Gil, & Ilya, 2003).

First, one of various computer-based argumentation support methods is visualizing argumentation with facilitated interaction, displaying the argumentation structure in a diagram form for easy understanding(Chinn, 2006). It is said that it is a more effective way than a bulletin board to visualize the argumentation structure using boxes and arrows. Although this support increases interaction between learners, it does not guarantee the facilitation of significant interaction expected in the course of the collaborative learning(Dillenbourg, 2005: Bhang, 2009).

Other methods are to provide special modifiers used to argumentation and let lost learners   select in advance so as to systemize their thoughts (Anderson et al., 2001); to suggest instances of exemplary discussions(Rummel & Spada, 2005); and to provide scripts to systemize steps and behaviors of argumentation to force learners to follow them (Weinberger, Stegmann, Fischer, Mandl, 2007). Various approaches exist for these supportive methods but they all have something in common: helping learners who are at a loss figure out 'what' to do. But argumentation comes from doubts and critical thinking of subjects, before setting what to do. Therefore, it is necessary to support 'How' to think about each subject critically along with what to do to induce learners' in-depth understanding from argumentation (Bhang, 2009).

Learners need to be able to select the necessary information and evaluate the

value and authenticity of the suggested information(van Drie, van Boxtel & van der Linden, 2006). To this end, the ability to critically think is essential. Studies on critical thinking have been carried out in different fields. They have been dealt with from a formal logical perspective in philosophy; as a factor to evaluate and infer in psychology; and as a thinking skill for problem solving and decision-making in pedagogy(Hwang, 2001). Therefore, it is hard to say that critical thinking is just the process of logical thinking and analyzing relations by abstracting the structure and relations of arguments, and deciding whether to reach a proper conclusion. Critical thinking not only includes logical thinking but also arguing and evaluating the conclusion or suitability of claims and the evidence behind along with logical analysis. Introspective questioning is at the core of critical thinking and the process of deciding the suitability of claims. Knowledge of the given field is necessary for critical thinking to perform the function of introspective questioning. In other words, it is necessary to find out what the assertion and its evidence mean in the field involved to determine the justification of assertion, adequacy of evidence, and validity of evidence. Effective evaluation is possible only with the help of broad background knowledge(McPeck, 1984). This means that deep and significant understanding of the field involved may be expected in critical thinking. In other words, critical thinking requires learners to obtain domain knowledge used to measure and resolve problems, leading learners to profound and significant understanding(Bhang, 2009). In conclusion, this study contributes to providing strategies for critical thinking so that learners may personally experience it and to promoting significant communication leading to the expected learning outcome by visualizing the thinking process of peers during interaction between learners.

Experimental Study

This study observed a total 58 of pre-service teachers divided into two groups; an experimental group carrying on argumentation using critical thinking formed

through advance checking of their background knowledge and will to collaborate to learn and a control group learning without support for critical thinking. The experiment lasted for approximately five weeks. Then, a total of 29 sub-groups of twos with different opinions were formed.

This study premises that argumentation between learners and the promotion of critical thinking have a positive impact on the acquisition of knowledge and the quality of the collaborative learning outcome. To verity this, this study treated whether or not critical thinking is strategically used as an independent variable and the learners' acquisition of knowledge and quality of the collaborative learning outcome as dependent variables. Table 1 shows the process of this experimental study.

As conditions of this study, first, learners had to be able to log in at their preferred time and communicate by posting comments in either real-time or non-real-time. Second, it had to be conducted in an environment where learners are given support for the use of strategies for critical thinking while reading and responding to comments posted by others. Hereupon, this study establishes that a learning environment fulfilling the requirements mentioned above is the open function of public pages consisting of individuals with common interest and sub-groups offered by one of the representative web community sites of Korea, 'Daum.'

Support for Exploitation of Critical Thinking Strategy Provided to Experimental Group

This study used the concept of critical thinking defined by Delphi in a survey based on 46 authoritative members of the American Philosophy Committee carried out in 1990 and elements defined by the Korean Educational Development Institute in 2001 as the basis to derive scaffolding for the promotion of critical thinking of the experimental group.

Table 1. Process of the experimental study

| Stage	Content	Purpose
Present ill-structured problem (issues of classroom environment, teacher-student relationship)	Submission of personal opinions and positions on the problem by learners ↓	▫ Sampling of the experimental group and control group ▫ Formation of groups
Pre-test	Evaluation of their domain knowledge, will to collaborate and ability to use computers ↓	▫ Check the affinity of the group
Access to a Learning Environment and practice	Access to an experimental environment and its application on the learning environment and functions ↓	
Collaborative Leaning Start	Discussions to grasp the gist of the problem presented as a task and on measures to solve the problem (Experimental group) Use of a framework for critical thinking ↓ | (Control group) Use of a framework for general argumentation ↓	
Unified conclusion (agreement)	Presentation of analysis of The problem derived from collaborative activity, specific measures to solve the problem, expected effect and items to improve based on logical grounds ↓	
Post-test	Evaluation of the team collaborative learning outcome and measurement of the individual acquisition of knowledge, student satisfaction about scaffolding	▫ Verify the differences
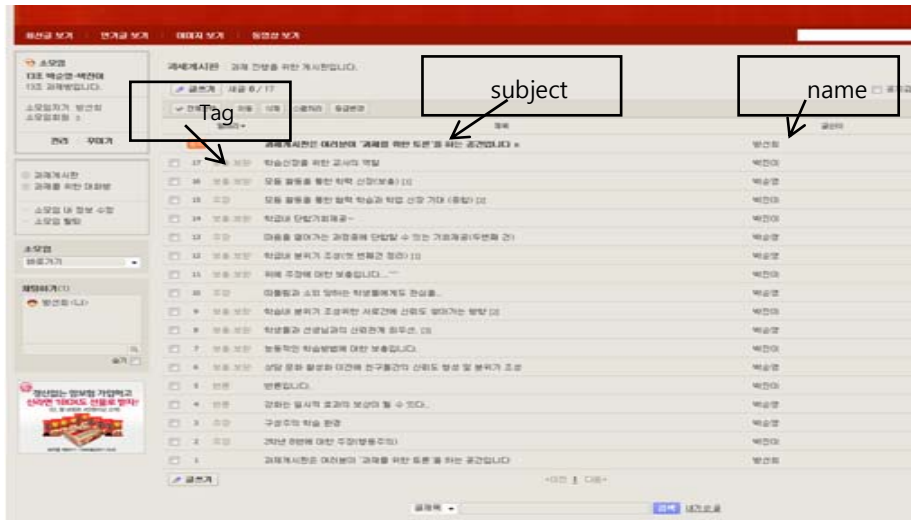
Figure 1. Image of learning environment

As for critical thinking strategies of this study, first, five of activity elements, that is, interpretation, analysis, evaluation, inference, and explanation mentioned above, have to be supported during interactive argumentation between learners.

Table 2. Composition of critical thinking (Korean Educational Development Institute, 2001, modified)

Element	Specific actions
Interpretation	Understanding and expressing the meaning of experiences, situations, materials, and events
Analysis	Analyzing the inference relations of testimonies, concepts and materials presented for the expression of judgments, reasons and opinions
Evaluation	Evaluating reliability
Inference	Forming assumptions and hypotheses and considering related information to draw logical conclusions
Explanation	Justifying and presenting the results of inference by considering proof, concepts and context

Second, the study had to be carried out with support. Learners had to ① determine their perspectives via headers, ② show their brief opinions on the 'explanation' and title of comments made. This was to enable learners to identify opinions of others during interaction. ③ After showing their brief perspectives and opinions as in Figure 2, comments of others as the learners understood and concluded according to their perspectives were analyzed based on the five elements composing critical thinking. Support for the five elements of critical thinking was provided on the screen for every posted comment. Based on this support, learners analyzed in detail their own opinions and comments made by others according to the five elements of critical thinking, leading to their sharing with other groups. This made it easier for learners to understand comments made by others. In addition, it enabled members of specific groups to identify what parts of the argumentations they had misunderstood or led them to proper conversation by realizing errors in the logic.
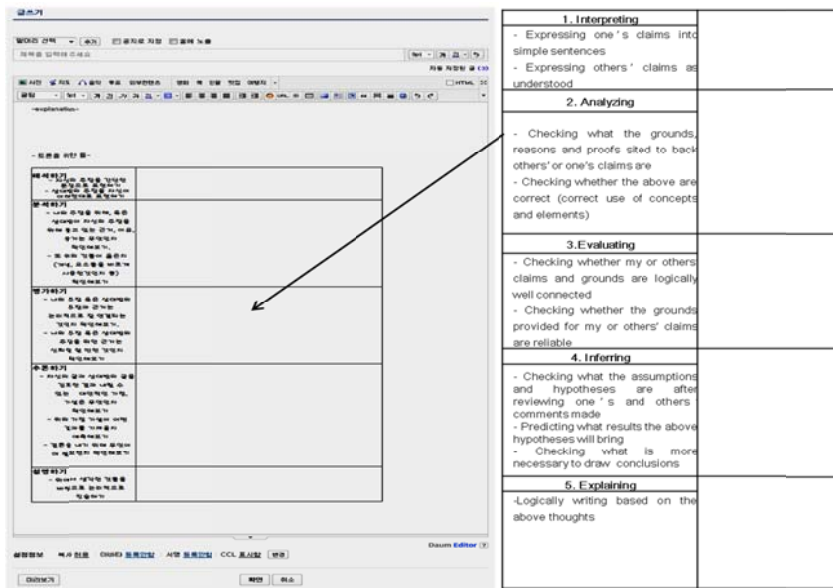

Figure 2. Learning environment supported by the five elements consisting critical thinking

Treatment of control group

The control group proceeded collaborative activities in the same environment as experimental group but was given normal logical scaffolding, not the one for critical thinking. Normal logical scaffolding given to control group consisted of three procedures of opinion-grounds-explanation.
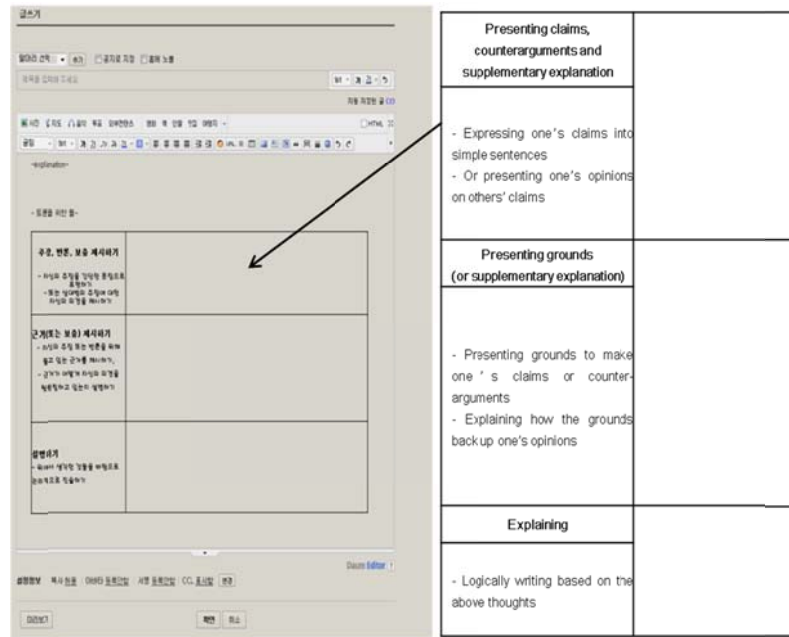

Figure 3. Learning environment supported for the control group

Measurement

How to measure the level of knowledge acquisition of individual learners

Learning assignments and contents of collaborative discussions used in this study were related to learning theory of behaviorism, cognitivism, and constructivism. In order to estimate the knowledge level of learners, two essay type questions were used for each theory. Each question asked learners to describe the assumptions of

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learning, major theory, and instruction method to estimate the knowledge acquisition level of a total of 30 points. Each question consisted of five points. Essay type questions were corrected are follows.

Table 3. Standard for grading questions provided to measure the individual acquisition of knowledge

Category	Evaluation standard	Points		
		High	Middle	Low
Evaluation of content	Whether the assumptions of learning are well explained	1	0.5	0
	Whether major theories are presented If properly presenting all theories learned, 2 If presenting all theories with partial errors, 1 If partially presenting major theories, 1 If presenting wrong theories, 0 If not presenting, 0	2	1	0
	Whether major theories are properly explained (average points) Points for the explanation of each major theory / total number of presentations	2	1	0
	Whether instruction methods are presented If properly presenting all methods, 2 If presenting all methods with partial errors, 1 If partially presenting major instruction methods, 1 If presenting wrong methods, 0 If not presenting, 0	2	1	0
	- Whether the instruction methods are properly applied - Appropriateness of application - Uniqueness of application - Points for explanations of each instruction method / total number of presentations	3	1.5	0
Total		10 points each X 3 = 30 points		

Questions were composed to measure the level of understanding of learning theories by supplementing and modifying the preliminary study carried out from preliminary research in November 2007 and through verification by two scholars with doctoral degrees in educational technology.

How to measure the quality of the collaborative learning outcome

Evaluation of collaborative learning outcome proceeded with the evaluation of the quality of argument and specific solutions provided. First, for the evaluation of the quality of argument, the widely used criteria of Toulmin (2003) were modified and supplemented and criteria for claims and grounds among claims, grounds, supplement, support, and objection of the argumentation model presented by Toulmin were used.

Table 4. Standards for evaluating claims and grounds

Classification	Points	Standards
Claims	2	Clear and precise thesis and related generalizations
	1	Stating thesis and related generalizations but unclear and of little relevance
	0	No claims made related to the thesis and unclear claims
Grounds	3	Clear and relevant grounds to back up claims
	2	Relevant to the claims, but incomplete and improperly presented reliability of proof
	1	Using unclear and unverified grounds and information not confirmed or experienced by the individual
	0	No grounds to back up the claims

For the evaluation of specific solutions presented, whether they are linked with claims-grounds presented earlier and whether they present the expected effect and proper application were evaluated. The specific standards for evaluation are as follows.

Table 5. Standards for evaluating specific solutions presented

Category	Evaluation standard	Points		
		High	Middle	Low
Evaluation of specific solutions	Whether presenting proper teaching and learning activities as solutions	1	0.5	0
	Whether presenting various solutions	1	0.5	0
	Whether the presented solutions are clear	1	0.5	0
	Whether presenting proper application principles for teaching strategies (solutions)	1	0.5	0
	Whether presenting proper expected effect from the application principles	1	0.5	0
	Whether the particularities of learners and learning environment are considered	1	0.5	0
	Whether proper ways of conducting a class are presented to reach the class targets	1	0.5	0

How to measure the level of student satisfaction

This study intended to find out how the use of critical thinking strategy was recognized by learners by identifying their degree of satisfaction with argumentation. Schemes for estimating student satisfaction consisted of 15 questions related to the use of critical thinking including ① the effect of supporting interaction followed by an understanding of others' opinions and expression of own thoughts; ② the effect of promoting learning; ③ the effect of introspection; and ④ the effect of support provided for cooperation divided into five stages based on the Likert Scale.

The survey to measure each student's satisfaction was distributed in the form of questionnaires and the questions were modified and supplemented after being used in a preliminary study, and approved by two scholars with doctoral degrees in educational technology. Reliability coefficient of Cronbach α was 81.

Table 6. Evaluation of student satisfaction

Category	Sub-category	Questions
Effect of using critical thinking strategies recognized by learners	Supporting clear expression of opinions	1, 3, 12,
	Supporting understanding of the presented opinions	2, 4, 10, 11
	Supporting the promotion of learning	7, 8, 9, 13
	Supporting introspection	5, 6
	Supporting agreement between members	14, 15
Usability of critical thinking strategies recognized by learners	Ease of executing critical thinking	16
	Level of understanding of the presented explanations	17
	Whether critical thinking helped or obstructed the learning process	18, 19
	Whether reused	20

Results

Comparison results of a degree of acquisition for domain knowledge of individual learners

Estimation for the degree of acquisition for domain knowledge of each individual learner derived t-test of independent samples results of points for domain knowledge acquisition between groups or individuals as to average and standard deviation via preliminary inspection, and they are as follows in Table 7.

As a result of analysis, it turned out that groups given support of critical thinking strategy had higher average of the knowledge acquisition of individual than groups given support of normal logical, showing a statistically significant difference

Table 7. Average, standard deviation, and t-test results of the points of individual knowledge acquisition between groups

Group	number	Average (Standard Deviation)	t	p
experimental group (Critical Thinking Strategy)	28	20.93(4.24)	-2.92	.005
control group	30	16.87(6.11)		

Results of approval for quality difference of collaborative outcome

Average and standard deviation from the estimation of the difference of collaborative outcome and independent samples t-test results from the average point between groups or individuals are as follows in Table 8.

Table 8. Average, standard deviation, and t-test results of collaborative outcome between groups

Group	number	Average (Standard Deviation)	t	p
experimental group (Critical Thinking Strategy)	14	23.00(1.10)	.815	.422
control group	15	23.27(0.59)		

It turned out that control groups had higher average point than experimental group in terms of collaborative outcome, but it was statistically insignificant.

Results of approval for difference of satisfaction from learners

Estimation of the degree of satisfaction from learners was based on questionnaire distributed immediately after learning activities were finished. There were total 58 copies of questionnaires distributed, consisting of 26 copies that were collected, and, hereupon, this study took only collected questionnaires into account

for an analysis. Average, standard deviation, and independent samples t-test results between groups or individuals are as follows in Table 9.

Table 9. Average, standard deviation, and t-test results of descriptive statistics in terms of overall satisfaction between groups(effectiveness, and usability)

Group	N	Total Statistics			Effectiveness			Usability		
		Average (SD)	t	p	Average (SD)	t	p	Average (SD)	t	p
Experimental group (Critical Thinking Strategy)	13	3.97 (.36)			4.04 (.37)			3.74 (.44)		
			.153	.880		-.514	.612		1.651	.112
Control group	13	3.98 (.28)			3.97 (.29)			4.02 (.42)		

It turned out that the result of overall satisfaction in terms of an exploitation of critical thinking between groups was statistically insignificant, and the difference of satisfaction estimated along with effectiveness aspect and usability aspect of an exploitation of critical thinking strategy was statistically insignificant either.

Conclusions

This study is based on assumptions that promotion of critical thinking in the activity of argumentation enhances quality of collaborative outcome along with positive influence on acquisition of domain knowledge for individual. As for the results of the study, a procedure for individuals to experience critical thinking via its exploitation during the argumentation showed statistically significance when comparing with groups given support of normal logic. This matches with the gist of previous studies that argumentation conveys a positive influence on knowledge acquisition for individuals (Andriessen, Erkens, Laak, Peters, & Coirier, 2003; Chinn, 2006). In other words, it can be inferred that an exploitation of critical thinking enhanced an understanding of opinions from others, helping them file

objection with proper grounds in the argumentation, and conveying a positive influence on meaningful interaction that enables critical reflection as to own comments at the same time. This study was designed to have five elements (interpretation-analysis -evaluation-inference-explanation) for critical thinking as to claim or objection of learners to derive a practical capability of critical thinking taken into account and prepared in each level At the same time, it was available for leaners to identify why certain opinion or objection were derived with an opened structure that learners could see comments made by others. Learners have responded via satisfaction survey that this distinctive type of experiment to read own comments and ones made by others at the same time made it possible to figure out specific connection between claim and grounds, promoting an acquisition of domain knowledge.

However, the study result estimating satisfaction was not significantly different. Regardless of support for normal argumentation for many of learners or support for critical thinking, it turned out that learners were satisfied with lowered difficulty in writing with provision of guide line. In addition, learners given a critical thinking strategy have pointed out that there were inconsistent flow of development for the opinion and a poor understanding in case that other learners made irrelevant comments. Quality of collaborative outcome did not show statistically significant difference between groups given support of normal logic and ones given support for critical thinking. Assumptions regarding quality enhancement of collaborative outcome were based on the presumption that argumentation followed by critical thinking promote significant interaction, leading to increase quality of collaborative outcome derived such interaction. Therefore, statistically insignificant result in terms of the quality difference of collaborative outcome was related to either insufficient interaction or non-derivation of collaborative outcome from web-based interaction. As a result of this study, it was confirmed that promoting critical thinking during argumentation enhances reflection of learners and expand horizon of domain knowledge. This signifies a need for learners to experience critical thinking rather than a mere activity with proper support as for argumentation

activity geared toward learning. In addition, provision of such support brings positive effect for learning and lowers difficulty for learners who are not familiar with argumentation activities, motivating them to lead activities. However, excessive segmentation of levels can lower satisfaction of learners, preventing a smooth argumentation, so it is needed to create measures to support critical thinking while not interrupting a smooth argumentation procedure for learners at the same time.

In addition, considering the fact that critical thinking is needed to identify opinion from others, to give out valid grounds, and to dispute, critical thinking is regarded as a prerequisite element for highly qualified argumentation, which can be promoted via argumentation and be led to learning at the same time.

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