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Argumentative Knowledge Construction Process in Social Collaborative Learning Environment towards Students' Higher Order Thinking Skills

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ABSTRACT

Nowadays, "thinking about thinking" skills is essential in 21st century education. Preliminary studies demonstrated that students' thinking skills will produce significant results when it is done in collaboration with colleagues. Working in a collaborative environment typically involves processes of evidence and argumentation. Argumentation refers to a claim supported by convincing evidence of extensive and comprehensive understanding of various aspects of an issue. In social collaborative argumentation, knowledge is constructed and shared among peers and the property of a single individual. The challenge is to ensure that argumentative knowledge construction process in social collaborative learning environment improves students' thinking skills. The aim of this paper is to analyze the process involved in argumentative knowledge construction and identifying the process in social collaborative learning environment that contributes towards higher order thinking skills among students. Seventeen students from the Computer Science program participated in the study were randomly divided into 3 groups of four and 1 group of five. This study used mixed method research design concerning the pre-experimental research design that involved type one-group pre-test and post-test design. Data was obtained from performance test and log data files from the social collaborative learning environment. Results showed that argumentative knowledge construction process in social collaborative learning environment could lead students towards higher order thinking skills.

Keywords: Argumentative knowledge construction, CSCL, higher order thinking skills, social collaborative learning environment

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INTRODUCTION

In collaborative learning, constructing knowledge at higher level is essential for students' learning because it ensures students acquire knowledge through the elaboration of learning material by constructing arguments (Stegmann, Weinberger, Fischer, 2007). Weinberger and Fischer (2006) claimed that argumentative knowledge construction (AKC) is based on the assumption that learners participate in a particular activity and the frequency of these discourse activities is related to the attainment of knowledge. To nurture student thinking skills to the higher level, a crucial part of critical thinking is to identify, construct, and evaluate arguments. In addition, many studies report positive benefits of using technology for collaborative learning that enhanced social interaction and mutual construction of knowledge (Kanuka & Anderson, 1998; Islas, 2004; Harasim, 2012). It is also believed that students learn well when they actively construct their own understanding through social interaction with their peers (Sthapornnanon et al., 2009).

Participating in online discussions usually give learners the opportunity to engage in argumentative debate and develop knowledge through argumentation. However, previous researches have shown that students' knowledge construction in online learning remains low. (Fisher, 2003; Hong & Lee, 2008; Kiuhara, Graham, & Hawken, 2009; Cookson, 2009; Yee et al., 2011; Durairaj & Umar, 2014). Although interaction has been found to be of high density it tends to focus on social regulations (Janssen, Erkens, Kirschner, & Kanselaar, 2010) or issues being discussed (i.e. off-topics). These can be caused by several influencing factors such as the use of communication mode, the lack of structure of the collaborative tasks or activities and dearth of interactions among peers.

In order to overcome the aforementioned influencing factors, an appropriate social collaborative learning environment (SCLE) needs to be proposed to enhance students' level of AKC. Computer-supported collaborative learning (CSCL) is one of the most promising innovations to improve teaching and learning. Even though CSCL and the use of networked technology has become a popular trend in research and design of learning environments (De Corte, Verschaffel, Entwistle, & van Merrienboer, 2003), empirical research has shown that there is no guarantee that networked collaboration contributes to improved knowledge (Jarvela & Hakkinen, 2002; Leinonen, Järvelä, & Lipponen, 2003). Siemens (2005) and Downes (2007) suggested the connectivism theory, where social learning is incorporated with social media technologies. They believed that, in the emergence world of social media, learning is not an internal or individualistic activity. To a certain degree, learners prefer to collect information through Wikipedia, Twitter, Facebook, RSS, and other similar platforms (El Helou, Salzmann, & Gillet, 2010). A main principle of connectivism is that of the ability to learn is more critical than what is currently known (Siemens, 2005).

As well, the responsibility of a teacher is not just to define, generate, or assign content, but more on helping learners shaping the learning paths and make connections with existing and new knowledge resources (El Helou et al., 2010; Anderson & Dron, 2011). Therefore, it is understood that social learning theories, especially connectivism, provide insights on the roles of educators in this social networked environment.

However, the question is how to ascertain that AKC process in SCLE really reflects students' thinking skills? In this study, we are focusing on Java Programming subject since a programming course can inculcate critical thinking, logical reasoning and problem solving skills (i.e. part of higher order thinking skills; HOTS) to students which they can later apply to their particular disciplines and their daily life.

The purpose of this research is to first, analyzing students' levels of thinking skills using pre-and post-performance test. It is important to know how AKC processes in SCLE correlate and contributes to students' HOTS.

METHODS

Research Design

This research used the pre-experimental design approach, to be exact the one-group pre-test and post-test design.

Participants

A total of seventeen (17) undergraduate students enrolled in a Java Programming subject, from the Computer Science course were involved in this study. They were randomly formed into 3 groups of four and 1 group of five.

Procedure

Phase 1. The researcher developed the instruments needed in conducting this research study and later performs the pilot testing in order to measure the validity and reliability for each instrument developed.

Phase 2. The development of SCLE is in response towards students' HOTS and their AKC. The developed environment will apply the 3A Interaction Model design pioneered by El Helou et al., (2010) and Weinberger and Fischer (2006) framework dimension principles (see Figure 1).

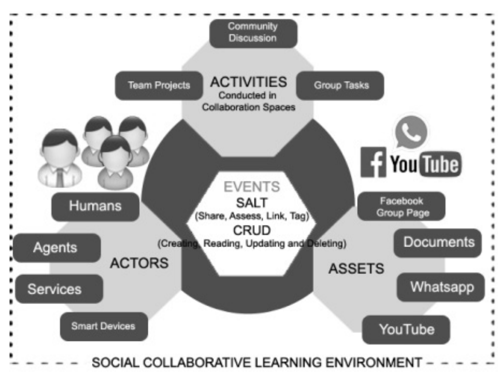

Figure 1. The design of SCLE adapting the 3A Interaction Model (El Helou et al., 2010)

Phase 3. The actual study begins with a pre-performance test. Afterward, every two weeks, starting from Week 2 until Week 10, students will be given five different tasks in SCLE based on topics by the instructor for formative assessment in 5 different weeks and later will discuss in SCLE. Each task will reflect the content of topic learnt for that week. The discussion will initiate by the instructor as to trigger deeper interaction and argument among students as well as nurturing their thinking skills towards higher levels. Students also are provided with the example of questions prompt as to encourage them to ask questions and commenting on their peers' status (for peer feedback activity). After that, once completed with the social collaborative discussion and learning tasks, students will be given a post-performance test on Java Programming subject on discussed topic as to evaluate their performance.

Phase 4. To analyze, the AKC process through social interaction data in online discussion finally evaluated qualitatively through content analysis technique (with deductive approach) and later converted quantitatively (i.e. descriptive statistics: frequency, percentage). The correlation between the content analysis of AKC process and performance test is discovered using the Pearson correlation matrix.

Instruments

Two research instruments were used in this study i.e. SCLE and performance test.

1. **Learning tasks in SCLE.** Learning tasks in SCLE is given by the instructor based on topics. Students are encouraged to discuss with their peers throughout the five weeks of study (see Table 1). The researcher played her role; monitored and observed instructor and the student's participation in the discussion. Student discussion was coded accordingly using content analysis technique as shown in Table 2. This research used 'meaning' as the unit of analysis.

Table 1
Sample of learning tasks in SCLE (based on Figure 1)

Week	SCLE (Assets)	Tasks (Activities)	Actors
2	YouTube, Facebook group	Videos and discussion	
4	E-learning, Facebook group	Group project and discussion	Instructor
6	YouTube, Facebook group	Videos and discussion	&
8	WhatsApp	Discussion	Students
10	E-learning, Facebook group	Group project and discussion	

Table 2
Coding scheme with categories in participation, epistemic, argumentative and social dimensions (adapted from Weinberger & Fischer, 2006)

Code	Category	Description
PAR1	Quantity of participation	Entering a CSCL environment and contributing to online discourse.
PAR2	Heterogeneity of participation	(Un-)Equal participation of learners in the same group

Table 2 *(continue)*

EPI1	Non-epistemic activities	Learners discussing off-topic/ digressing off-topic
EPI2	Construction of problem space	Learners relate case information to case information within the problem space with the aim to foster understanding of the problem
EPI3	Construction of conceptual space	Learners relate theoretical concepts with each other and explain theoretical principles to foster understanding of a theory
EPI4	Construction of adequate relations between conceptual and problem space	Applying the relevant theoretical concepts adequately to solve a problem. Learners relate theoretical concepts to case information. A number of concept-case-relations may need to be constructed to adequately solve a complex problem
EPI5	Construction of inadequate relations between conceptual and problem space	Applying theoretical concepts inadequately to the case problem. Learners may select the wrong concepts or may not apply the concepts according to the principles of the given theory.
EPI6	Construction of relations between prior knowledge and problem space	Applying concepts that stem from prior knowledge rather than the new theoretical concepts that are to be learned.
ARG1	Non-argumentative moves	Questions, coordinating moves, and meta-statements on argumentation
ARG2	Simple claim	Statements that advance a position without limitation of its validity or provision of grounds that warrant the claim
ARG3	Qualified claim	Claim without provision of grounds, but with limitation of the validity of the claim (with qualifier).
ARG4	Grounded claim	Claim without limitation of its validity, but with the provision of grounds that warrant the claim
ARG5	Grounded and qualified claim	Claim with grounds that warrant the claim and a limitation of its validity
ARG6	Argument	Statement put forward in favor of a specific proposition
ARG7	Counterargument	An argument opposing a preceding argument, favoring an opposite proposition
ARG8	Integration (reply)	Statement that aims to balance and to advance a preceding argument and counterargument
SOC1	Externalisation	Articulating thoughts to the group
SOC2	Elicitation	Questioning the learning partner or provoking a reaction from the learning partner
SOC3	Quick consensus building	Accepting the contributions of the learning partners in order to move on with the task
SOC4	Integration-oriented consensus building	Taking over, integrating and applying the perspectives of the learning partners
SOC5	Conflict-oriented consensus building	Disagreeing, modifying or replacing the perspectives of the learning partners

2. **Performance test.** Performance test consists of pre-and post-test and designed with the same structured questions. Pre-test were given before the class started and post-test was given to the students on the eleventh week, right before the class ended. The pre-and post-test questions was validated earlier by two experts and based on level by Anderson et al., (2001) rubrics. Table 3 shows examples of questions in the performance test.

Table 3
Examples of questions in the performance test

No	Sample question	Categories of question	Level of question
1	A Java class definition contains an object's ______________ and______________.	Remember	L
2	What is the difference between Associations and Aggregation?	Analyze	H
3	Write 3 overloading static method, named min that able to find the minimum value from parameters of different data types as invoked in the following program. public class Method Overloading { public static void main (String [] args) { System.out.println ("The minimum between 120 and 135 is " + min (120, 135)); System.out.println ("The minimum between 141.2 and 135.7 is " + min (141.2, 135.7)); System.out.println ("The minimum between 110.7, 107.3 and 115.3 is " + min (110.7, 107.3, 115.3)); } }	Create	H

*L= low level degree; H= high level degree

RESULTS AND DISCUSSIONS

In order to analyze the students' AKC process in SCLE, four dimensions (i.e. participation, epistemic, argumentation, social modes of co-construction) from Weinberger and Fischer (2006) is applied. Mainly, the types of argumentation in this study (i.e. argumentative dimension) are divided into two types: micro level (ARG1 – ARG5) and macro level (ARG6 – ARG8) using the process found in Toulmin model of argument. In addition, the argument dimension also differentiates between argumentative moves and non-argumentative moves. Figure 2 shows the results from four different groups of students based on the discussion in SCLE.

Based on Table 2 we can clearly see the types of process involved in students' AKC through SCLE. The trends show that most of the types of AKC used by students are in argumentative dimension (ARG1 – ARG8) with ARG1 (13 times occurred) being the most dominant category followed by ARG5 (11 times occurred) for argumentative and social modes of co-construction (SOC1-

SOC5) with SOC2 (18 times occurred) are being the most dominant for social modes of co-construction. As we can see, the number of arguments and their types differ from one group to another. Still, an argumentative discourse was developed in each group. In the four groups, 22.73% of the arguments involved an epistemic dimension, 48.86% consists of argumentative dimension and 28.41% of social modes of co-construction dimension (see Table 4).

Truly, the counter claim or rebuttals become part of the arguments when the results attained different with the group's hypothesis, are uncertainly understood, or when the group's members have contrasting views (Katchevich & Mamlok-Naaman, 2013). Note that the discourse that develops between the group members is highly dependent on the inquiry question selected for inspection by the group (i.e. ARG1 and SOC2). Sometimes the answer to the research question is obviously clear and definitely no in-depth discussion develops between the group members and this is even more so with an argumentative discourse. Using Weinberger and Fischer (2006) framework, this study found that

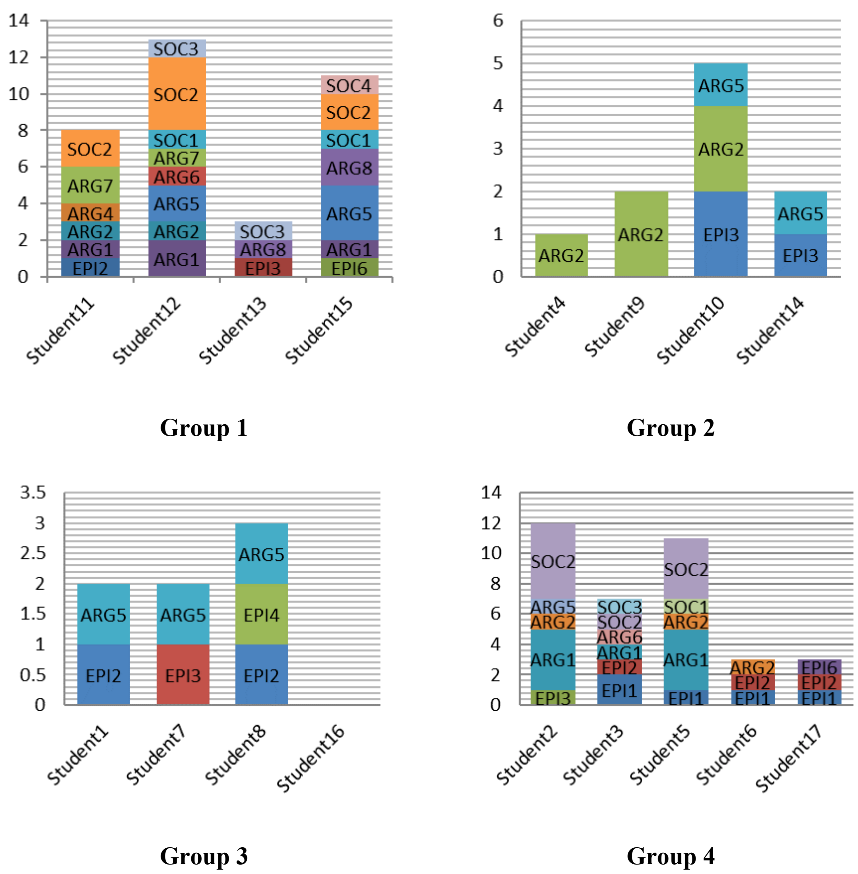

Figure 2. The quantity and types of process in students' discussion (student vs. group)

ARG dimension has being the dominant types of AKC process transmitted by each student, followed by SOC and EPI dimension. As well, PAR dimension from students' discussion shows that there is equal participation of students' engagement in SCLE.

Additionally, result from Table 5 indicates that there is a positive, moderate significant correlation between the AKC processes with the student's performance when learning (.408). This might be due to the students' benefiting from the process of AKC in the discussion sessions in which this action has contributed to the students' learning performance. Also, this suggests that AKC process in SCLE can lead students' performances towards HOTS as it supports students in their learning process through proper strategies that stimulate their thinking. The finding reveals that the use of SCLE design can promote students' interests to be engaged in an academic discussion.

Table 6 reveals that about 11 students managed to increase the marks in their post performance test especially in high level (Hpost) question. Results show that 15% of increment occurred in performance test for both Lpost and Hpost. Likewise, students engaged in the AKC discussion

Table 4
Distributions of AKC process in students' group discussion

AKC Process	Group 1	Group 2	Group 3	Group 4	Total	Percentages	Overall percentages
EPI1	-	-	-	5	5	5.68%	
EPI2	1	-	2	3	6	6.82%	
EPI3	1	3	1	1	6	6.82%	
EPI4	-	-	1	-	1	1.14%	
EPI5	-	-	-	-	-	0.00%	
EPI6	1	-	-	1	2	2.27%	22.73%
ARG1	4	-	-	9	13	14.77% *	
ARG2	2	5	-	3	10	11.36%	
ARG3	-	-	-	-	0	0.00%	
ARG4	1	-	-	-	1	1.14%	
ARG5	5	2	3	1	11	12.50% *	
ARG6	1	-	-	1	2	2.27%	
ARG7	3	-	-	-	3	3.41%	
ARG8	3	-	-	-	3	3.41%	48.86% *
SOC1	2	-	-	1	3	3.41%	
SOC2	8	-	-	10	18	20.45% *	
SOC3	2	-	-	1	3	3.41%	
SOC4	1	-	-	-	1	1.14%	
SOC5	-	-	-	-	-	0.00%	28.41%
Frequencies/ Percentages	35	10	7	36	88	100.00%	100.00%

seems to have an improved performance in learning the subject, especially towards HOTS. With the total of 88 types of AKC process it can be seen that S2, S5, S12 and S15 had uttering more than 10 times of AKC process. Note that even others not using too many types of AKC process, yet they still benefiting from peers discussion and established understanding about learning the subject. One of the most important factors of the quality of student experiences and learning outcomes in an online program is the quality of interactions between the students and instructor. When instructor involvement is low, outcomes are not as positive as in a face-to-face course (Junk & Junk, 2011).

Table 5
Pearson correlation matrix

	Post-test score
AKC process	0.408**

**Correlation is significant at the 0.01 level (2-tailed)

Table 6
Distributions of AKC process and students' pre-and post-test scores

Group	Students	Total of AKC process involved	L_{pre}	L_{post}	H_{pre}	H_{post}	Performance in learning
	S11	8	4	5	2	1	-
1	S12	13	4	6	2	4	+
	S13	3	3	6	2	3	+
	S15	11	3	7	3	3	0
2	S4	1	4	7	2	4	+
	S9	2	4	6	3	3	0
	S10	5	5	6	3	3	0
	S14	2	6	6	2	3	+
	S1	2	5	7	1	4	+
3	S7	2	5	5	3	4	+
	S8	3	6	7	3	4	+
	S16	0	5	4	1	2	+
	S2	12	3	5	2	0	-
	S3	7	3	7	3	2	-
4	S5	11	5	6	2	4	+
	S6	3	5	6	1	4	+
	S17	3	5	7	2	3	+
Frequencies/ Percentages		88	75 42.13%	103 57.87%	37 42.05%	51 57.95%	11 of 17

* Lpre= low level pretest; Lpost= low level posttest; Hpre= high level pretest; Hpost= high level posttest; + = increment; - = decrement; 0 = maintain

The limitations of this study are: was addressed. First, the discipline being examined was limited to a computer-based subject called Java Programming. Studies on the AKC process in SCLE in other disciplines or subject areas may provide different results. Secondly, this study was carried out in real learning settings in which the instructor did not have control over the students' behavior. Thirdly, the current research involves less participation of instructor through the AKC process in SCLE. Finally, it is suggested that in future factors affecting higher engagement of AKC process in SCLE needs to be examined.

CONCLUSION

An apt setting for SCLE can result in nurturing students' HOTS and constructing their knowledge via argumentation. This study also showed that the processes of AKC in SCLE through the discussion will increase students' performance in learning. AKC with its emphasis on students' participation and engagement in the discussion contributes to academic achievement.

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