Running head: Analysis of Knowledge Construction in Discussion Forum

An Introduction to Analysis of Science Knowledge Construction in an Asynchronous Discussion Forum

Chia Kok Pin

National Institute of Education

chia_kok_pin@moe.edu.sg

An Introduction to Analysis of Science Knowledge Construction in an Asynchronous Discussion Forum

Abstract

This paper will introduce two methodologies known as Knowledge Construction – Message Mapping (KCMM) and Knowledge Construction – Message Graph (KCMG) for analyzing knowledge-construction as well as mis-construction occurring in an online asynchronous discussion forum that potentially could advance understanding of these processes. The ubiquitous adoption of online asynchronous discussion forum in the field of Computer Supported Collaborative Learning (CSCL) has far outpaced the understanding of how this dynamic and collaborative learning tool should best be used to promote independent and higher-order learning. The adoption of an asynchronous discussion forum provides opportunities for an in-depth analysis of students' transcripts to understand the peer's interaction and knowledge construction in learning. This article will introduce an instrument for tracing the communication patterns and the knowledge construction as well as mis-construction processes of students working in groups, discussing subject-related content using an innovative approach to map the messages of students' postings. It is hoped that this approach will foster in-depth understanding as well as refining a categorical system to indicate the level of attainment for knowledge attained, through the use of this proposed instrument. This will enhance educational practitioners and researchers to describe on-line interaction with a more systematic approach and adopt a measurement methodology more effectively than anecdotally.

An Introduction to Analysis of Science Knowledge Construction in an Asynchronous Discussion Forum

Introduction

There had been extensive discussion in the field of educational research about the advantages of using technology to create a shared space among learning participants. As such, it is important to consider the dynamics of online forum discussions and how it facilitates student's cognitive and meta-cognitive development. In addition, there is a pressing need to understand how facilitators made use of discussion forum to design an electronic learning community for their students. The adoption of an asynchronous discussion forum provides opportunities for an in-depth analysis of students' transcripts to understand the development of knowledge construction in content related subject. Asynchronous discussion forum is one of the many forms of CSCL where learners communicate with one another via an online text-based learning environment over an extended period of time. Students are supposed to engage with one another in an argumentative discourse with the goal to acquire knowledge. For instance, students in groups are assigned to jointly analyze a written problem case with the help of theoretical concepts in order to learn to apply and argue with these concepts. Students may compose complex problem analysis and post them to a discussion forum where their learning partners may read these messages and reply to the contribution with critiques, questions, refinements, etc. During this type of discourse, learners collaboratively produce a text in order to put forward their point of view. The rationale for analyzing the electronic transcripts is that in this kind of data, cognitive processes of learning are being represented to a certain degree (Weinberger & Fischer, 2006). This is

in contrast to synchronous discussion forum where students have less time to search for information, to provide extended information and to evaluate the posted information thoroughly due to high psychological pressure to respond as fast as possible because of time constraint. On the other hand, learners are able to interact with one another via asynchronous discussion forum, at different times via text messages. Thus, these students will have more time to sort out their thought processes, reflect and search for additional information. As such, there is a need for analysis tools that review the process of knowledge development within these online asynchronous discussions. Chi (1997) pointed out that due to a multitude of reasons, there was an increasing need in educational research to collect and analyze qualitative data that were complex in nature, as opposed to quantitative data. The need for the collection of such data pointed to the trend towards studying complex activities in practice or in the context in which they occurred

De Wever, Schellen, Valcke and Van Keer (2006) presented their findings that research in the field of CSCL utilized a wide variety of methodologies. Quantitative studies focus on measures, such as frequency of postings, which includes the number of threads per forum, the number of postings per thread, or the number of facilitator postings per thread. On the contrary, qualitative analysis also known as content analysis has generally been qualitative and delves into issues of critical thinking, problem solving and knowledge construction. Content analysis in CSCL has great potential in the field of educational research but minimal research exists in this field due to the massive amount of time required to perform such analysis (Hara, Bonk, & Angeli, 2008). This paper will introduce a methodology based on content analysis, which is a technique to analyze transcripts of asynchronous discussion groups in formal education settings. It

has to be noted that although this technique is popular in the field of qualitative educational research, standards are yet to be established by academic researches and this issue is compounded by the lack of a reliable instrument. The study conducted by Pena-Schaff and Nicholls (2004) revealed that students engaged in a knowledge construction process that was characterized by elaboration, clarification and interpretation produced more reflective monologues than dialogical interaction. Waters and Gasson (2007) presented a model that viewed learning as the passive transmission of knowledge from experts to novices, as didactic and inadequate. Learning is now viewed by educational reformist, as an active process of social construction, which is situated within the cultural norms of a specific community of practice. It is imperative that educators cannot simply trans-locate traditional teaching to a remote electronically mediated arena, but need to provide online environments in which reflective, interactive, and participative learning is possible. Martinez, Dimitriadis, Rubia, Gomez and Fuente (2003) stressed that studying and evaluating real experiences that promoted active and collaborative learning as a crucial field in CSCL. Major issues that remained unsolved deal with the merging of qualitative and quantitative methods and data, especially in educational settings that involved both physical and computer-supported collaboration. Fahy (2002) maintained that despite some helpful discoveries, however, overall progress in understanding the processes at work in online interaction had not been remarkable. Some researchers, in proposing changes to research methods, had noted consistent inefficiencies and inadequacies in the methodologies utilized and approaches commonly undertaken in transcript research.

Significance of paper

This paper will attempt to introduce a methodology to map the different stages of knowledge construction as well as mis-construction in asynchronous discussion forums, with emphasis on how students transact with one another in this dynamic process. The process of solving the task can be achieved with the contribution to and using one another's perspective (Schrire, 2005). Learning institutes, whose aim is to design useful learning environments and experiences, have to be aware of how learning proceeds in an online community. In addition, there is also a need to understand the preparation of students in engaging with the unstructured and unbounded problems that they will face in their future professional workplace (Hong & Lee, 2008). This will imply that students will have more opportunities to solve open-ended, unstructured problems that are best resolved through joint knowledge building process among their peers. Hmelo-Silver (2003) had the view that with increasing use of online asynchronous discussion forum, educators should assess the quality of interactions and learning that took place in this e-learning environment. Documenting and understanding collaborative knowledge construction are critical for research in asynchronous discussion forum taking place in an e-learning environment. Thus, the goal of this paper is to introduce a methodology for documenting the types of knowledge that are constructed or mis-constructed, as well as its processes during the asynchronous discussion forum.

Existing methods of analyzing asynchronous discussion forum

There exist a plethora of methods used by researchers in the content analysis of asynchronous discussion forum. Martinez et al. (2003) made use of a well-known shared workspace system based on web interface known as the BSCW (Basic Support

for Co-operative Work) for asynchronous document sharing and threaded discussions. BSCW provided the capability to log every action performed on the shared workspace, providing data that were used as a source of the analysis. Other tools, like e-mail for communication and simulators for the assignments are also used during the process. Schrire (2005) analysis of discussion forum, involved performing interaction pattern mapping through examination of the explicit and implicit interaction between messages. Each message in the forum was assigned a number corresponding to the chronological sequence of posting. The threading of the forum messages was then graphically depicted, facilitating categorization of threads according to pattern of interaction, such as instructor-centered, synergistic, developing synergism or scattered. In addition, relevant threads were selected for analysis of the latent cognitive content. The purpose was to determine the levels of different aspects of cognition in each conference. Hara et al. (2008) performed analysis through the conference activity graphs on a weekly basis in order to uncover unique patterns of interaction among the students. The authors were interested to find whether interaction among the discussion forum participants were "starter-centered", "scattered interaction" or "explicit interaction". Pena-Schaff and Nicholls (2004) used a message mapping sequence to identify the patterns of discourse, based on student's participation in the discussion forum. A categorical system was initially applied to the data and then modified to provide more detailed categories and indicators. Examples of categories identified were statements of clarification, interpretation, conflict, assertion, judgment and reflection appeared to be most directly related to the process of knowledge construction.

Unit of Analysis

The unit of analysis will determine how the overall discussion is to be broken down into

manageable items for subsequent coding according to the analysis categories. The choice for the unit of analysis will determine the accuracy of the coding and the extent to which the data will reflect the true content of the original discourse. The unit of analysis determines the granularity in looking at the transcripts of the online discussion. The choice for the unit of analysis is dependent on the context based on the research question and should be well considered, because differences in the size of this unit will have a causal effect of coding decision and comparability of outcome between different models. To get a complete and meaningful picture of the collaborative process, this granularity needs to be decided and implemented appropriately. As was discussed in De Wever et al. (2006), the choice for the unit of analysis represented advantages and disadvantages, as well as problems of subjectivity and inconsistency. In the literature review of Schellens and Valcke (2006), the unit of analysis reflected, in an exhaustive and exclusive way, a specific construct. A variety of choices were discussed: a sentence, a paragraph, a theme and the illocutionary unit (the complete message). Each choice presented advantages and disadvantages. Opting for each individual sentence or paragraph as the unit of analysis resulted in an objective and reliable choice but research experiences indicated that this unit was too small to represent individual theoretical constructs. Opting for themes as the analysis unit helped to counter the latter disadvantage but presented problems in terms of the reliable identification of each individual theme, resulting in subjectivity and inconsistency. The best choice was to opt for each complete message as an individual unit of analysis. Firstly, this results in the objective identification of all units of analysis. Second, the number of observed units is under control and is easily managed for analysis purposes. A third advantage is that the researchers work with the unit, as it has been defined by the author of the message. In

addition, a fine-grained line-by-line coding allows the researchers to examine an entire corpus of discourse to identify important and representative cognitive and social processes that can be reported as frequency counts. Further qualitative analysis can be used to investigate larger phenomena that occur over greater units of time. The fine-grained analysis model can also be represented in ways that allows some of the chronological sequencing and tool used to become salient (Hmelo, 2003).

Lampert and Ervin-Tripp (1993) and Chi (1997) proposed a dynamic approach to unitization. Since there is a trade-off between the grain size and the amount of information derived from the data, the dynamic approach to unitization implies that data may be coded more than once, each time according to a different grain size, depending on the purpose and the research question that a specific “pass” through the data is related to. The same idea on dynamism in unitization, was also shared by Schellens and Valcke (2006) where entire message was split up into two or three messages when the first and second part of the message needs to be coded and categorized differently. Hara et al. (2008) also concurred that any message could conceivably contain several ideas, the base "unit" of the analysis was not a message, but a paragraph. It was assumed that each paragraph in a submission was a new idea unit since college-level students should be able to break down the messages into paragraphs. Thus, when two continuous paragraphs dealt with the same idea, they were each counted as a separate idea unit. And when one paragraph contained two ideas, it was counted as two separate units. The granularity of segmentation is highly dependent on the research questions that are supposed to be investigated. After experimenting with several types of units, it was decided that a message-level unit, corresponding to what one participant posted into the thread of the discussion forum on one occasion, was the most appropriate to attain our

goals. Since messages were clearly demarcated in the transcript, multiple coders could reliably identify when a coding decision was required. The message as the unit was advantageous as the length and content of the message was decided upon by its authors, rather than by coders. As each complete message was chosen as the unit of analysis for the coding, the coders were obliged – in a number of cases – to split up an entire posting into two or three messages as recommended by the model of Veerman and Veldhuis-Diermanse (2001). This was the case when, for example, the first part of a message was coded as level 1 understanding and the second part of message was a misconception. In a number of cases, the message clearly contained two completely different contributions (De Wever, Van Keer, Schellens, & Valcke, 2006). In addition, a complete message provided coders with sufficient information to infer underlying cognitive processes.

Methodologies

This methodology was modeled after Frey, Sass and Arman (2006) and Hmelo-Silver (2003), where students' original electronic transcripts of the discussion forum were mapped. It has to be noted that although this technique is popular in the field of qualitative educational research, academic researchers have yet to establish standards and this issue is compounded by the lack of a reliable instrument. It is the ambition of this paper to introduce an innovative methodology, for understanding authentic knowledge construction as well as mis-construction among group of students participating in asynchronous discussion forum. This methodology uses an over-layering approach of messages posted by students, to the level of content conceptual understanding. Postings are analyzed with a content analysis tool to identify statements according to the level of conceptual knowledge attained. Since this study is concerned

with analysis and categorization of student's online transcript, it primarily relies on content analysis methodology. By using both quantitative and qualitative measures, it is hoped that this will be a catalyst for a more comprehensive study of online discussion than is typically found in most of the research literature on CSCL. Although online content analysis methodologies are still in the stage of infancy development, they appeared to capture the richness of the student interactions (Hara et al., 2008). The next section will present the step-by-step process for this case study:

1) The students are to be grouped in four or five based on their class register number. The reason for this system of grouping is for ease of administration work as well as eliminating any biasness in the findings due to students forming cliques in their groupings. In line with constructivist principles, the discussion theme is based on real-life authentic situation.

2) A trigger for this asynchronous discussion forum is recommended. As this paper promotes self-directed learning among students, the reason for the physical phenomenon observed by the students in the trigger activity is not made known to the students. However, these students have been exposed to a short introduction to the content prior to their period of research.

3) The students are expected to perform extensive research through medium such as relevant books and online resources in the attempt to correctly answer the question posed by the teacher in the first posting of the asynchronous discussion forum.

4) Students, in their groups, are informed of the dates where the asynchronous discussion forum in the learning management system of the school will take place. This asynchronous discussion forum is held for a period of 1 to 2 weeks. The teacher should make an attempt to intervene every day, through logging in to the students' virtual space

for discussion. It is imperative that the teacher does not give concrete content feedback, but rather structural feedback (scaffolding).

6) After the asynchronous discussion period is over, the original electronic transcripts are then analyzed using the KCMM. The next few sections will explain, in detail, the methods and models adopted for an in-depth analysis of the electronic transcripts.

Method of Analysis: Knowledge Construction – Message Map (KCMM)

This paper will introduce a content analysis approach, which is qualitative in nature, and explore issues such as the extent of knowledge construction or mis-construction. In view of the increasing use of asynchronous discussion forum in learning and teaching, there is a need for an analysis tool that reviews the process of knowledge construction within these online discussions. Through the detailed examination of transcripts, both theoretical and practical insights into the learning context of the students and its outcomes can be easily elicited (Gunawardena, Lowe, & Anderson, 1997). This research will analyze qualitative data through classifying individual learners' statements. Researchers using this approach have used a diverse range of approaches for classifying individual students' statements, ranging from classifying cognitive strategies used by individual student to classifying moves such as giving or receiving help as well as the content of students' talk. However, this paper will introduce the methodology of classifying the individuals' electronic statements from the asynchronous discussion forum to the levels of scientific knowledge attained. It is hoped that this will provide information about individual's performance within each group, and the extent of knowledge construction or mis-construction. To aid understanding, a visual representation of the levels of scientific understanding is achieved through the use of the

diagram shown in Figure 1. This diagram consists of a triangle segmented into several sections. A lozenge, labeled "Question" located within the section reserved for questioning, represents the main question raised by the teacher in this discussion forum. The segments above the question section represent increasing level of scientific knowledge attained for a particular discussion forum, while segments below the question section represent the types of knowledge mis-constructed by the students. The number of levels designated for representing conceptual understanding achieved by the students, is decided by the researcher and is not restricted to the number as indicated on Figure 1. This representation will henceforth be known as Knowledge Construction-Message Mapping (KCMM) and it serves two purposes. First, the KCMM is able to present the coded data to the audience, just as one depicts quantitative data graphically or in tabular form. Second, the depiction of such representation might allow researchers to detect some patterns with reference to knowledge construction in asynchronous discussion forum (Chi, 1997), through the analysis of the structure and content of interactions by the creation of these message maps which displays graphically the interrelationships among the messages (Gunawardena et al., 1997). In addition, the KCMM represented in Figure 1 is able to provide a visual representation of the reasoning pattern and overall structure or flow of the group discourse as well as how individual contributes to this overall structure or flow. Furthermore, this form of representation facilitates systematic comparisons across different groups or discussions. The KCMM, through its pyramid structure, is able to trace the student's pattern of understanding as learning potentially involves different levels of understanding. Learning taking place in different subjects and disciplines follows different routes of argumentation and this could be shown easily with the help of the KCMM. Reasoning

made among learners may not be complete or totally correct and from this differentiation in levels of understanding, it is possible to move from a qualitative to a quantitative approach from the use of KCMM to compare different groups in knowledge construction and mis-construction.

A simple example will be illustrated to show the effectiveness of the KCMM in mapping out the knowledge construction as well as the knowledge mis-construction process. Referring to Figure 1, the cognitive processes in understanding a science topic (Why air-conditioner is situated at the top part of the room) by 2 students are shown. The first student initial message (1A) indicated that he had understood that the cooled air at the top had higher density than the warm air below (Level 1 understanding). The same student second message (1B) was then mapped to level 2 understanding where he wrote that the cooler air would sink and forced the warmer air upwards. Lastly, this student posted (1C) that the warm air would be cooled and be denser than the air below it and the process repeats with convectional current being set up (Level 3 understanding). This student has shown an increase in understanding of this topic as his messages are tagged from Level 1 to Level 3 understanding, with the use of solid arrows. Conversely, the second student first message (2A) indicated that he had understood that the cooled air at the top had higher density than the warm air below (Level 1 understanding). However, this same student second message (2B) was mis-constructed (or possessed mis-conception) as he wrote that the cooled air at the top conducts the coolness to the warm air below and this is represented using a dotted arrow. It is the job of the researchers or raters to infer from the messages created from the original transcripts and tag them correctly to the map. Therefore, the KCMM is able to present the cognitive levels and processes of the various group members in a visually

simplified diagram. The interrelationships among the different messages by different members are also visually displayed and patterns that exemplified cognitive processes can be elicited and researched upon.

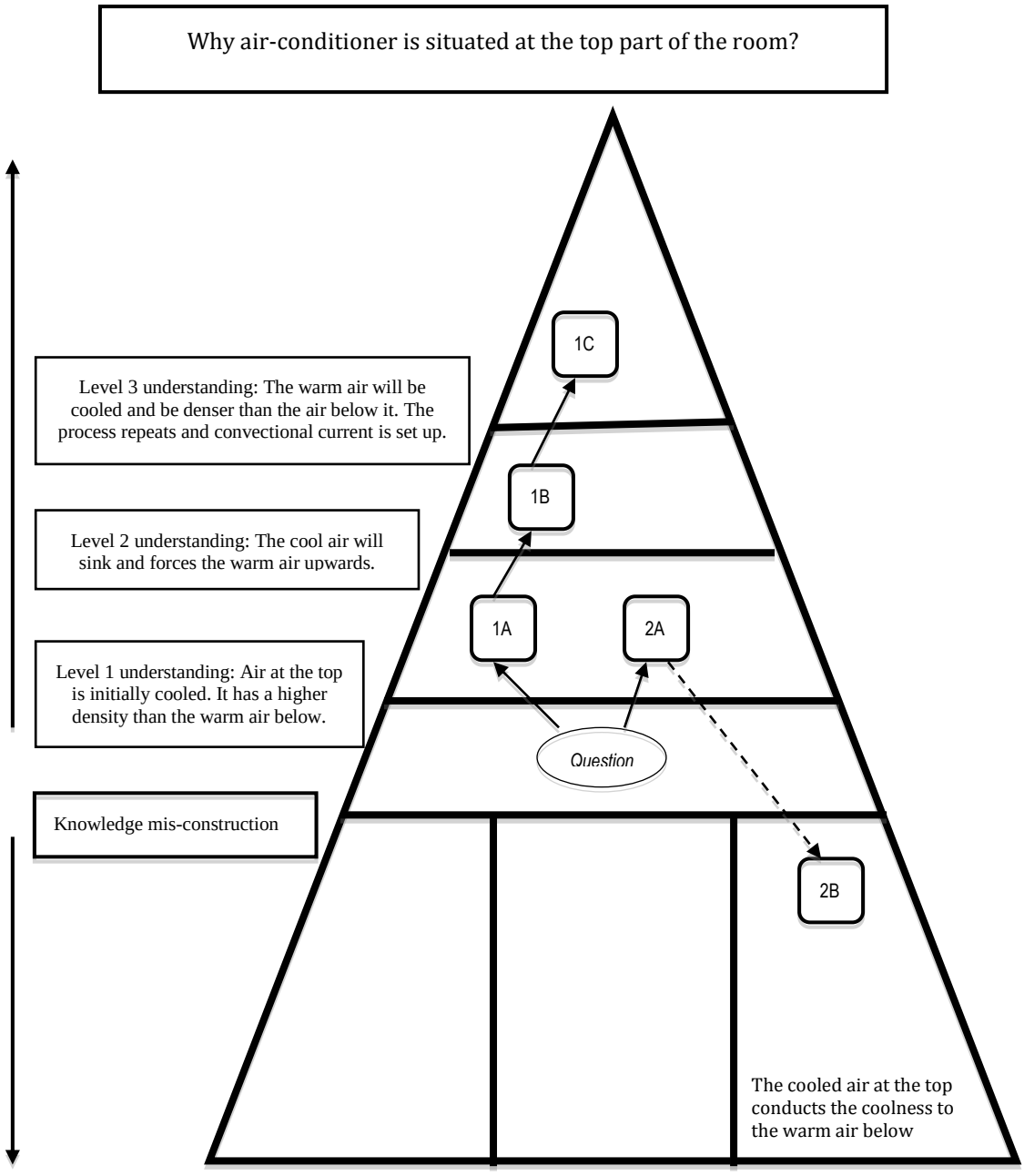

Figure 1: Knowledge Construction – Message Map (KCMM)

Method of Analysis: Knowledge Construction – Message Graph (KCMG)

The graphical representation for the number of postings as well as the level of scientific knowledge attained for every member of the team is shown in Figure 2 below. The positive y-axis represents the level of understanding attained by individual member of the group, while the negative y-axis represents the number of misconceptions posted by the individual student. The x-axis represents the number of meaningful postings made by the individual student. This representation will henceforth be known as Knowledge Construction - Message Graph (KCMG). The purpose of the KCMG is to allow the ease of tracking individual conceptual cognitive development between knowledge construction and mis-construction. It can be observed from the graph that Student 1, represented by dotted line, increased his conceptual understanding from Level 1 (L1) to Level 3 (L3) as he posted his first message to the third message. Student 2 first message was correctly constructed at L1. However, his second message was mis-constructed and was represented as a misconception in the graph as the dash line is plotted below the origin line. It has to be noted that all the students' postings originated from the zero message as this represents a shift from nil conceptual knowledge to either knowledge constructions or mis-constructions.

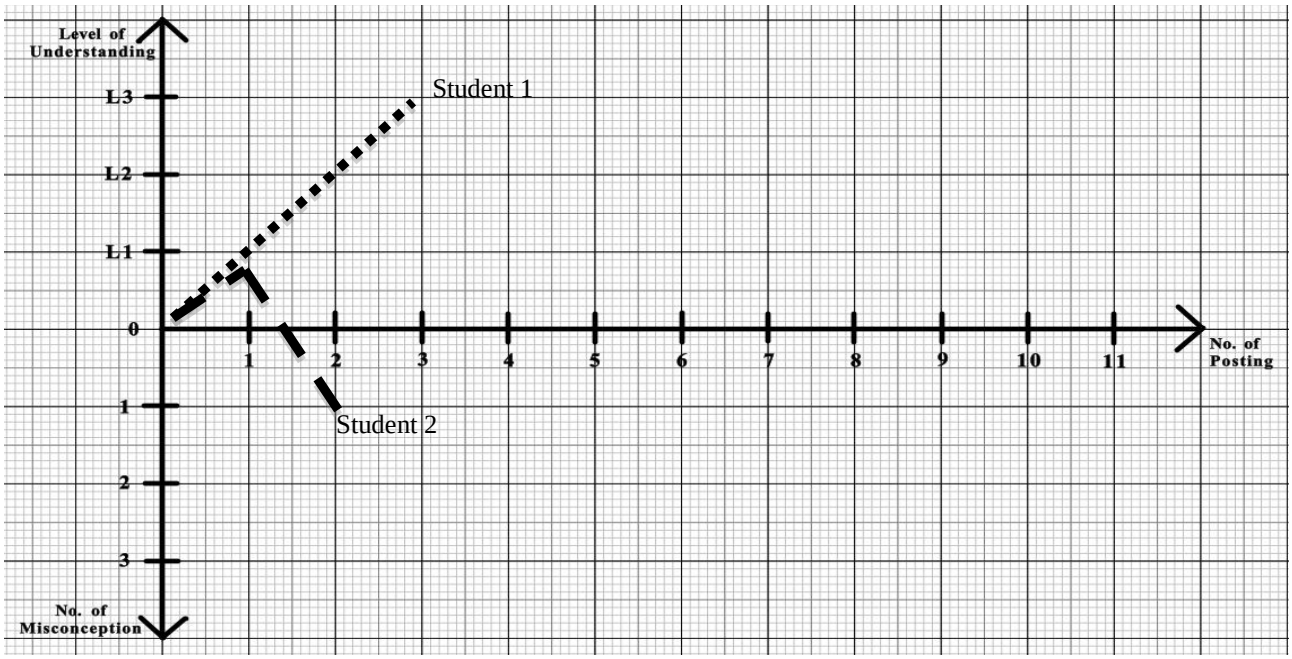

Figure 1: Knowledge Construction – Message Graph (KCMG)

Analysis and comparison

Quantitative analysis from the electronic transcripts, which is qualitative in nature, can be easily achieved and the number of knowledge constructed as well as mis-constructed, and other parameters can be compared among different groups. An example is shown in Table 1 overleaf where the number of messages, which is constructed (represented by solid arrows) and mis-constructed (represented by dotted arrows), is shown alongside with their percentages against the total number of messages posted for easy analysis and comparison. It is also worth noting that the misconceptions posted by the students could be archived and remediation processes should be in place to address the issue of removing these misconceptions from the minds of these students.

Group	No. of Knowledge construction Messages	No. of Knowledge Mis-construction Messages	Total No. of Messages	% of messages with constructed knowledge	% of messages with mis-constructed knowledge
1					
2					
3					
4					
5					

Table 1: Analysis and comparison between groups for knowledge construction / mis-construction

CONCLUSION

It is crucial to understand how to support collaborative knowledge construction in asynchronous discussion forum settings due to prevalence of asynchronous approaches to online learning. This paper shows that content analysis of asynchronous discussion forum is both possible and feasible through the focus on both qualitative and quantitative data, with various ways to examine and evaluate the interaction of participants as knowledge is being constructed. Using our customized innovative analysis tools known as KCMM and KCMG, we are able to successfully analyzed students' electronic transcripts and to verify characteristics of an asynchronous

discussion forum that was previewed in the earlier sections. These processes meet our goals to develop a useable and replicable approach for content analysis of asynchronous discussion forum. It is a dangerous notion for educators to assume that students will naturally attained the correct scientific conceptual understanding once they participated in discussion forum or other forms of CSCL activities without close monitoring by facilitators. Thus, educators should be mindful of reviewing the summary of the findings by the students, through raising the awareness of the misconceptions written by the students and delivering the correct scientific understanding. It is the hope of the authors that further research on knowledge construction as well as mis-construction in asynchronous discussion forum be undertaken, as this paper draws from a multitude of research findings on the potential of using online asynchronous discussion forum to discuss course-related content.

References

Chi, M. T. C. (1997). Quantifying qualitative analyses of verbal data: a practical guide. Journal of the Learning Sciences, 6(3), 271–315.

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyze transcripts of online asynchronous discussion groups: A review. Computers & Education, 46(1), 6–28.

De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2007). Applying multilevel modeling to content analysis data: Methodological issues in the study of role assignment in asynchronous discussion groups. Learning and Instruction, 17(2007), 436-447.

Fahy, P.J. (2002). Assessing critical thinking processes in a computer conference. Center for Distance Education. [Verified 12 Feb. 2009]. http://auspace.athabascau.ca:8080/dspace/handle/2149/1220.

Frey, B.A., Sass, M.S., & Arman, S.W. (2006). Mapping MLIS asynchronous discussions. International Journal of Instructional Technology & Distance Learning, 3(1), ISSN 1550–6908.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. Journal of Educational Computing Research, 17, 397–431.

Hara, N., Bonk, C.J., & Angeli, C. (2008). Content analysis of online discussion in an applied educational psychology. Center for Research on Learning and Technology, 28(2), 115–152.

Hmelo-Silver, C.E. (2003). Analyzing collaborative knowledge construction: Multiple methods for integrated understanding. Computers & Education (2003), 41(2003), 397-420.

Hong, K.S., & Lee, J.A.C. (2008). Postgraduate students' knowledge construction during asynchronous computer conferences in a blended learning environment: A Malaysian experience. Australasian Journal of Educational Technology, 24(1), 91-107.

Lampert, M. D., & Ervin-Tripp, S. M. (1993). Structured coding for the study of language and social interaction. In J.A. Edwards & M. D. Lampert (Eds.), Talking data: Transcription and coding in discourse research. Hillsdale, NJ: Lawrence Erlbaum.

Martinez, A., Dimitriadis, Y., Rubia, B., Gomez, P., & Fuente, P.D.L. (2003). Combining qualitative evaluation and social network analysis for the study of classroom social interactions. Computers & Educations, 41(2003), 353-368.

Pena-Schaff, J.B., & Nicholls, C. (2004). Analyzing student interactions and meaning constructions in computer bulletin board discussions. Computers & Education, 42(2004), 243-265.

Schellens, T. & Valcke, M. (2006). Fostering knowledge construction in university students through asynchronous discussion groups. Computers & Education, 46(2006), 349–370.

Schrire, S. (2005). Knowledge-building in asynchronous discussion groups: going beyond quantitative analysis. Computers & Education, 46(1), 49–70.

Waters, J., & Gasson, S. (2007). Distributed knowledge construction in an online community of inquiry. Proceedings of the 40th Hawaii International Conferences on System Sciences 2007.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. Computers & Education, 46(2006), 71–95.

Veerman, A., & Veldhuis-Diermanse, E. (2001). Collaborative learning through computer-mediated communication in academic education. In P.Dillenbourg, A Eurelings & K. Hakkarainen (Eds), European perspectives on computer-supported collaborative learning. Proceedings of the first European Conference on CSCL. Maastricht: McLuhan Institute, University of Maastricht. [Verified 12 Feb 2009]. http://www.ll.unimas.nl/euro-cscl/Papers/166.doc.