Improving Young Learners’ Scientific Understanding in CSCL Environments

Hyo-Jeong So, National Institute of Education,, Nanyang Technological University, hyojeong.so@nie.edu.sg

Abstract. The purpose of the present study was to improve young learners’ scientific understanding in CSCL environments. The study consisted of two phases: Phase I for fostering a collaborative learning culture, and Phase II for using Knowledge Forum as a CSCL tool. Primary 3 students in one Singapore school participated in this study. Findings suggested that while students were motivated to learn in CSCL environments, they had difficulties monitoring and sharing knowledge for their own understanding. Additionally, a great deal of teacher guidance was needed to encourage student participation in collaborative knowledge building processes. Overall, this study may imply that students at this early stage of schooling need more structured guidance to improve their understanding in CSCL environments.

Introduction

The main purpose of the project in the present paper was to build a culture of classroom practices that are grounded in collaborative learning and knowledge building, which is known as the Knowledge Building Community model (Scardamalia & Bereiter, 1994). Knowledge Building is based on the concepts of communal constructivism (Meehan, Holmes, & Tangney, 2001) and situated learning (Lave & Wenger, 1991) whereby communities of learners construct a communal knowledge base through interaction, inquiry, discussion and reflection. For knowledge to be constructed by the community of learners, a *culture* needs to be enacted in which learners interact with each other in collaborative ways. With the culture of knowledge building in place, the additional interactive dimension of technology systems, e.g., Knowledge Forum (KF), a computer-supported collaborative learning (CSCL) environment, can then be incorporated to further enhance the discussion, sharing, reflections on and retention of that communal knowledge pool (Bielaczyc & Collins, 2006). The emphasis of the project was placed on employing collaborative inquiry-centered pedagogy, instead of traditional didactic pedagogy deeply rooted in many classrooms, in order to foster a collaborative knowledge building culture. After the process of collaborative culture building, Knowledge Forum was employed as a medium to facilitate the process of scientific knowledge building among students. This paper reports on early findings of the three-year plan of fostering and building CSCL environments at one primary school in Singapore.

Theoretical framework

Basically, the main theoretical framework is to help students learn how to collaboratively work with others, how to inquire knowledge, and how to reflect on their thinking process in CSCL environments. Specifically, this study is based on Knowledge Building, “defined as the production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions and part of broader cultural efforts.”(Scardamalia & Bereiter, 2003). In the classroom, Knowledge Building is usually initiated by a theme of inquiry relevant to a topic. Ideas and questions that the students have about the theme are then articulated and posted in a discussion forum as notes. Knowledge forum then acts as a communal database where the ideas are seeded and improved. As the participants engage themselves in the various means of advancing, they challenge each other’s ideas through building new notes or revising existing notes. This phase is essentially a social process mediated by knowledge-building discourse that focuses on sharing new knowledge, synthesizing new knowledge with prior knowledge, detecting gaps in understanding, co-construction of theory and so on. Eventually, it leads to the growth of the database which reflects the progress of the community as a whole.

Research Methodology

Participants of this study included Primary 3 students in a Singapore school. The majority of the students come from homes with low to middle SES. Among various subject areas, this study focused on Science lessons. Using a design experiment (Brown, 1992) as a methodological approach, the research team designed lesson plans and lab activities with the Science teachers. The intervention strategies employed collaborative learning and knowledge building activities involving heterogeneous groups of pupils of varying ability levels in the classroom prior to the introduction of Knowledge Forum as a learning tool. Mixed methodology was employed to provide multifaceted perspectives of the research questions. Qualitative data included classroom observations, student artifacts (e.g., think cards, worksheets, KF postings, etc), and interviews with selected students. Quantitative data on the rate of learning achievement was collected based on the mastery of instructional objectives as stated in the school curriculum.

Research findings of Phase I and II are presented in the present paper. The main purpose of Phase I was to foster a collaborative learning culture in classrooms. It should be noted that that since our aim was to build up a collaborative knowledge building culture prior to the introduction of a Knowledge Forum as a collaborative learning tool, all the activities in Phase I were carried out without any online activities and technology components. Basically, students participated in learning activities that were designed around the principles of Knowledge Building (Hewitt & Scardamalia, 1998) in the following order:

1. *Trigger activity and Idea Generation* – the knowledge building pursuit starts with a trigger activity to encourage students to generate ideas and questions on the theme or topic, and to write down these ideas and questions on specially designed think cards;
2. *Idea Connection* – the teacher then guides the students into the process of searching for classifications to connect the ideas generated on the think cards, and these classifications are visually constructed using a knowledge web of think cards;
3. *Direct Teaching* – this is the part where the authoritative voice of the teacher is heard, providing the initial impetus and framework for the students to start searching for information to create their individual and communal knowledge base;
4. *Laboratory activities* – these are experiments, either within a laboratory or outdoor setting, designed to help students in their search for information and knowledge;
5. *Reflections on laboratory activities* – these reflections are scaffolded by questions on reflection sheets to help students think about what they have learnt, how this new knowledge has helped them in answering their initial questions about the theme or topic of study, and what new perspectives of knowledge has been built from the laboratory activities;
6. *Individual and communal pull-together* – this is the activity, initiated by the teacher, that guides the students into looking at the knowledge that each individual has built from the preceding activities and to draw the individual strands into a group and communal pool of knowledge built up on the theme or topic for study.

Next, the purpose of Phase II was to improve student understanding of science principles and concepts in a CSCL environment where Knowledge Forum was employed as a technological tool. Instead of using think cards, students used Knowledge Forum to share their ideas. Students worked collaboratively with 4-5 group members.

Results

Rather than discussing data in a separate manner, findings from data analyses were integrated to provide a clear picture of what happened in the early stage of the implementation. At the end of the term, a test consisting of 13 items from knowledge building units (Magnets and Materials) and 17 items from non-knowledge building units (Living things & Non-living things) was administered to measure student understanding. A statistical analysis showed that there was no significant difference on test scores between knowledge building units (M=57.83, SD=22.14) and non-knowledge building units (M=60.72, SD=15.85). While it may be thought that employing collaborative knowledge-building activities could reduce performance on traditional types of assessments, this result can be interpreted that there was no negative effect on traditional measures. The analysis of observations indicated that students were motivated by trigger activities and Knowledge Forum. Students perceived that starting a lesson with a trigger activity and idea generation was quite different from typical lessons where teachers directly introduce lesson topics from textbooks. In the focus group interviews, students mentioned that they enjoyed working with friends during Science lessons as they could learn from their friends' ideas.

While it was encouraging to discover the students' increased motivation in CSCL environments, several issues were identified as problematic. One of the biggest problems was lack of idea improvement. The analysis of think cards and KF postings revealed that the initial ideas of many students were rarely improved. Although lab activities and reflection times were employed to encourage students to improve their ideas over time, student ideas generally consisted of isolated facts with little explanations. This result might be related to lack of resources for idea improvement. The analysis of the data from the focus group interviews revealed that many students had limited access to resources other than the Science textbook. This was especially true of the students from low SES families, of which there was a majority in the school. Many of these children do not have home access to computers and the Internet. They also did not search for additional information from books available in the school library. As for the small number of children who had home access to computers and the Internet, their web surfing largely consisted of games rather than Science-related searches. Additionally, the analysis of the observation data revealed a lack of collaborative learning. Although the students carried out their knowledge building activities in collaborative learning groups, there was little evidence of collaboration in the learning process among the group members. Activities in science labs and computer labs were conducted collaboratively, but the learning process was individual rather than collaborative. Specifically, little KF postings were connected to other postings and few students posted questions to other groups.

Conclusion

Building a CSCL environment is a difficult endeavor, especially in classrooms where students have little exposure to collaborative learning approaches. Our results showed that while it is critical for students to monitor and build knowledge for their own understanding, they had difficulties developing such skills. Although attempts were made to improve young students' science learning through scaffoldings such as think cards, reflection sheets and Knowledge Forum, results revealed that students in this study needed more specific scaffolding strategies. Additionally, results of the present study are consistent with previous studies that found a great deal of teacher guidance is needed to encourage student participation in collaborative knowledge building processes (Caswell & Bielaczyc, 2001; Hewitt, 2001). For instance, teachers need to help students see the value of building knowledge for their own understanding, instead of completing tasks given by a teacher (Hewitt, 2001). Overall, this study may imply that students at this early stage of schooling need more structured guidance toward reflective inquiry learning in CSCL environments.

References

Bielaczyc, K., & Collins, A. (2006). Implementation paths: Supporting the trajectory teachers traverse in implementing technology-based learning environments in classroom practice. *Educational Technology, 46*(3), 8-14.

Brown, A. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions. *The Journal of Learning Sciences, 2*, 141-178.

Caswell, B., & Bielaczyc, K. (2001). Knowledge forum: Altering the relationship between students and scientific knowledge. *Education, Communication & Information, 1*(3), 281-305.

Hewitt, J. (2001). From a focus on tasks to a focus on understanding: The cultural transformation of a Toronto classroom. In T. Koschmann, R. Hall & M. Miyake (Eds.), *CSCL2: Carrying forward the conversation* (pp. 11-41). Mahwah, NJ: Erlbaum.

Hewitt, J., & Scardamalia, M. (1998). Design principles for distributed Knowledge Building processes. *Educational Psychology Review, 10*(1), 76-96.

Johnson, D. W., & Johnson, R. T. (1999). *Learning together and alone : cooperative, competitive, and individualistic learning* (5th ed.). Boston: Allyn and Bacon.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Meehan, S., Holmes, B., & Tangney, B. (2001). Who wants to be a teacher? An exploration of the theory of communal constructivism at the chalk face. *Teacher Development, 5*(2), 177-190.

Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communites. *The Journal of Learning Sciences, 3*(3), 265-283.

Scardamalia, M., & Bereiter, C. (2003). Knowledge Building. In J. W. Guthrie (Ed.), *Encyclopedia of Education* (pp. 1370-1373). New York: Mcamillan Reference.