Interaction of Instructors and Students In a Science Class Based on Learning by Design

Yu-sun Gwon & Kazuhisa Miwa
Graduate School of Human Informatics, Graduate School of Information Science, Nagoya University, Japan
Email: {gwon, miwa} @cog.human.nagoya-u.ac.jp

The present study focused on hands-on activities in a university class, named Engineering Experiments of Material Science, at Nagoya University, Japan. Six undergraduate students, one professor and two teaching assistants (TAs) participated. The class consisted of 10 sessions during 16 weeks, from April to July 2003. One session continued for around 4~5 hours. The task in the class was to design a bathtub based on understanding of physical phenomena such as the RH degassing process and the continuous casting process in a reactor. The reason why we investigated this class is that it was a good case exemplifying Learning by Design (Hmelo et al., 2000; Kolodner et al., 2002) based on the inquiry approach.

In this paper, we analyze only the discussion phase from the 1st to 3rd sessions, where students propose their ideas and a teacher or TAs support them in deciding experimental themes. Further phases for the actual experiment from the 4th to 10th sessions are not dealt with here. Data were collected through reports by students and videotaped discussions on proposals of ideas. To investigate processes of on-time interaction, we categorized utterances of the participants in discussions. Four categories were identified: (1) P: proposing an idea, (2) R: responding to questions, (3) F: leading other participants to elaborate their ideas and pointing out poor aspects of ideas, and (4) E: explaining theoretical background knowledge related to students' idea. To investigate outputs obtained as the results of interaction, we analyze transference of the students' ideas based on their report presentation from the 2nd to 4th sessions.

In the analysis of processes of on-time interaction, the results showed that instructors and students reciprocally played each role, such as students as active proposers, a teacher as a provider of facilitation and theoretical explanation to students' ideas, and TAs as mediation between students and teacher. These results also indicated that the quality of interaction was sophisticated from superficial transacts to operational transacts, that is, the students elaborated their proposals and responses from unsatisfactory ideas without rational reasons to ones including the related data and concrete methods, whereas the teacher adjusted his facilitation and explanation to the students' cognitive states. In the analysis of idea transference as output of interaction, the result showed that the students' ideas were integrated and elaborated to become the critical themes of experiments. These results indicated that implicit interactions within the students as well as explicit interaction between instructors and students had learning effects, that is, students changed their ideas while observing discussions on other students' ideas. Constructivism in educational methods to make students study on their own through trial and error processes has been proposed as a substitute for didactic lecture, which has been predominant as a traditional education style. However, various limitations of constructivism have also been pointed out: e.g., students could not sufficiently study critical concepts through spontaneous activities. This study confirms that reciprocal interaction, such as facilitation and explanation by instructors matching cognitive states of students, allows students to promote understanding on the task and spontaneous exploration in science class.

References

Hmelo, C. E., Holton, D. L., & Kolodner, J. L. (2000). Designing to Learn about Complex Systems. *The Journal of Learning Sciences*, 9(3).

Kolodner, J. L., Gray, J.T., & Fasse, B.B. (2002). Promoting Transfer through Case-Based Reasoning: Rituals and Practices in Learning by Design Calssrooms. *Cognitive Science Quarterly, 1.*