ProBoPortable: Does the Cellular Phone Software Promote Emergent Division of Labor in Project-Based Learning?

Toshio Mochizuki, Center for R&D of Higher Education, The University of Tokyo,
7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan, tmochi@mochi-lab.net
Hiroshi Kato, National Institute of Multimedia Education,
2-12 Wakaba, Mihama-ku, Chiba, 261-0014, Japan, hiroshi@kato.com
Kazaru Yaegashi, College of Business Administration, Ritsumeikan University,
1-1-1 Noji Higashi, Kusatsu, Shiga, 525-8577, Japan, mail@kazaru.jp
Toshihisa Nishimori, Center for R&D of Higher Education, The University of Tokyo,
7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan, nisimori@utmeet.jp
Yusuke Nagamori, Graduate School of Comprehensive Human Sciences, University of Tsukuba,
1-1-1 Tennodai, Tsukuba, Ibaraki, 305-8577, Japan, mail@nagamori.jp
Shinobu Fujita, Spiceworks Corporation,
19-13 Aizumicho, Shinjuku-ku, Tokyo, 160-0005, Japan, fujita@spiceworks.co.jp

Abstract: This paper describes the design and evaluation of a cellular phone application called "ProBoPortable", which displays information regarding the task status and division of labor in a project-based learning (PBL). The authors have developed a cellular phone application that cooperates with a Web-based groupware to enhance the learners' reorganization of learning activity in PBL. The research conducted in an undergraduate course revealed that ProBoPortable can enhance awareness regarding the status of learners' collaborations in PBL.

Introduction

In recent years, the project-based learning (PBL) is being extensively used as a major educational method in higher education (Gijbels, et al., 2005). PBL is a type of learning activity in which learners study along with other learners whilst working toward a common goal and collaborating on tasks as a group. Throughout the PBL, the learners rarely share the same task parallel with that of other learners. They prefer to divide a certain part of the task into smaller tasks and allocate each task to individual group members.

Even in cases where the rules for division of labor are institutionalized by a teacher or an organization, people sometimes cross the borders of the division and coordinate their tasks across the borders with other people as the occasion may demand. For instance, if the task monitor gives the task performer some instructions when the monitor notices the task performer's errors, it implies that the monitor becomes involved in performing the task. Thus, division of labor is reorganized in a more or less ad-lib and ad hoc manner in order to progress the task uninterrupted and error free. Kato et al. (2004) termed such a cross-over of division of labor as "emergent division of labor (EDL)." They argued that EDL should provide rich opportunities for learning wherein scaffolding takes place naturally, and EDL is subject to occur in open environment where the learners can see what they do each other.

However, in Japanese universities, undergraduate students get very little time to interact with each other on campus; for example, they can meet only in the classroom, while eating lunch, etc. Therefore, the authors have developed a web-based groupware for PBL called "ProBo" (formerly "Project Board"), in order to enhance the learners' recognition of their EDL in both classrooms and distributed environments. ProBo has been designed to visualize and allocate tasks among the learners in a group. The practical evaluation revealed that ProBo promoted the learners to monitor their personal learning activity but the other members' activities in the group. (Nishimori, et al., 2005).

Design and Development of ProBoPortable

In order to enhance the awareness among the learners for the EDL, the authors designed and developed a cellular phone application called "ProBoPortable," which is based on ProBo. ProBoPortable was designed to work as wallpaper on the learner's cellular phone screen in order to keep them updated as regards to the progress of their project and stimulate the division of labor as soon as the requirement or inevitability arises. In accordance with the requirements of the EDL, the authors selected the necessary information to confirm and reorganize the division of labor, such as the number of tasks to be completed by each learner, the progress of each task, etc. (see Table 1).

ProBoPortable describes the learners who have to complete their tasks as warehouse keepers (see Figure 1). If a learner performs a task, the corresponding box shifts slightly. The other learners can observe this change when they activate their cellular phones. When two or more learners collaborate to perform a task, the corresponding box in each of their positions moves. When the learner(s) completes the task, the corresponding box drops down and the amount of money increases; all the learners can observe the completion of the task. In accordance with the requirements of the EDL, ProBoPortable indicates whether each learner has confirmed his/her status of the PBL via ProBo or ProBoPortable. Thus, the learners are expected to observe the status of the other members on a daily basis, perform their tasks, and reorganize their division of labor as and when required.

Table 1: Relationship between Visualized Information on ProBoPortable and ProBo.

| Information	Index	Target	Expression
Member(s)	Each member	Warehouse keepers and their facial colors	Each of the members is color-coded
Number of Tasks	Number of boxes	Box(es)	If a new task is added on ProBo, a new box is added from above
Progress of each task	Shift length	Box corresponding to the task	If a learner carries forward a task, the corresponding box shifts slightly
Approaching the time limit for the task	Color (normal or red)	Corresponding box	If the deadline approaches, the color of the corresponding box changes to red
Progress of the project	Background color (normal or red)	Backgrounds of all the members of the project	If the progress of the project shows a lower value than the benchmark, the color changes to red.
	Money	Amount of money	If the task is completed, the amount increases
Whether or not each learner has confirmed the status	Background color (of relevant learner(s))	Relevant learner(s)	If the learner has not confirmed the status of EDL via ProBo/ProBoPortable, his background color changes to black
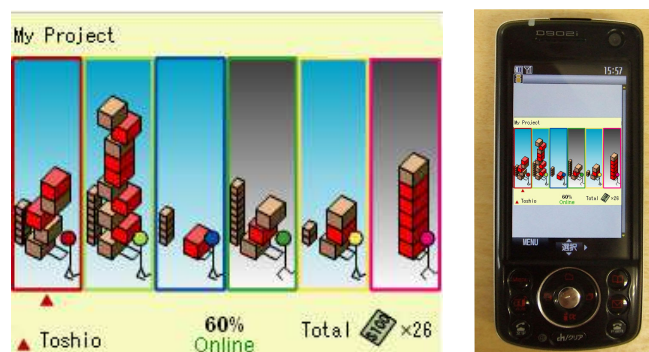
Figure 1. ProBoPortable Interface (displayed on the cellular phone screen)

Evaluation of ProBoPortable in an Undergraduate Course

The research was conducted in an undergraduate course taught by one of the authors as an adjunct lecturer at a university in Japan. The research took place between June 5 and July 10, 2006, during which each section met six times. The common objective of each group was to conduct a presentation on the current situation and the prospects of one of the various topics associated with information communication technology. Each group had to conduct a survey on the assigned topic and make suggestions on the topic for future society. A total of 94 students participated in the course. The students were divided into 20 groups, each group comprising 4 to 6 individuals.

This research was formulated using the split-class design (Carver, 2006) to evaluate the software being used in the classroom with respect to the context of the course taught in the classroom. At the beginning of the evaluation, the authors announced that students taking the class could participate in this evaluation. Based on the group structure and the preferred topics, the authors selected 11 students from those who applied for their cooperation in the research. ProBoPortable was installed in each of these 11 students' cellular phones, which they had been using from before. ProBoPortable worked and appeared in the background color of their cellular phone throughout the four-week period starting from June 12. They also used ProBo with other students.

The authors analyzed the operation log of all the students operating ProBo and ProBoPortable from June 12 when they started using the ProBoPortable through July 10. In addition, the questionnaire was administrated after the final class; this contained self-evaluation of PBL regarding the awareness of division of labor during group work.

Results: Does ProBoPortable Promote Awareness among Learners for EDL?

In order to accurately confirm the effect of ProBoPortable, the Mann-Whitney U-test was administered to examine the differences between students who used ProBoPortable ($n = 11$, hereafter referred to as "Experimental Group") and those who did not ($n = 83$, hereafter referred to as "Control Group"), with regard to the students' self-evaluation of their PBL on a 5-point Likert scale (1: strongly disagree – 5: strongly agree).

According to the test results, significant differences were observed in items as "I was aware of the progress of each task undertaken by the other members" (Experimental Group ave.= 4.55, Control Group ave.= 3.17, $U = 138.0$, $p < .001$), "I think that the other group members were also aware of the progress of my tasks" (Experimental Group ave.= 3.72, Control Group ave.= 2.75, $U = 172.5$, $p < .01$), and "I have adjusted the pace of my task according to the others' pace, which I monitored" (Experimental Group ave.= 3.45, Control Group ave.= 2.43, $U = 233.0$, $p < .01$). These results indicated that the ProBoPortable was effective in not only understanding others' task status but also confirming whether or not the others were aware of one's progress in the task, and to flexibly adjust one's own task as necessary by a continuous monitoring of others' status as well as one's own.

On analyzing the operation log (the number of people accessing each function per day) of ProBo, significant differences were observed between Experimental Group and Control Group with regard to the access of the ToDo list, which structures the PBL tasks, (the Experimental Group averaged 0.175 times, Control Group averaged 0.101 times, $U = 273.5$, $p < .05$) and the Scheduler, which confirms the prospects of PBL (Experimental Group averaged 0.357 times, Control Group averaged 0.142 times, $U = 311.0$, $p < .05$). The group using the ProBoPortable also exhibited higher points with regard to the number of accesses to the profile of a task (Experimental Group averaged 1.11 times, Control Group averaged 0.86 times) and the number of times to a task was modified (Experimental Group averaged 0.12 times, Control Group averaged 0.08 times), although no significant statistical difference was observed. Therefore, the results suggest that ProBoPortable promoted the self-review of the entire PBL task structure.

Furthermore, significant differences or trends were observed with regard to items such as "From time to time, I wanted to talk with other member(s) outside the classroom to negotiate the protocol for further project proceedings" (Experimental Group ave. = 4.09, Control Group ave.= 3.39, $U = 250.0$, $p < .05$) and "I frequently contacted other group member(s) outside the classroom in connection with the group activities" (Experimental Group ave.= 2.73, Control Group ave.= 2.02, $U = 274.0$, $p < .10$). It suggests that ProBoPortable presents opportunities to generate learning activities and mutual adjustment outside the classroom.

These results demonstrate that the mutual confirmation of the task status by using ProBoPortable stimulates the relative evaluation of one's own task status and encourages one to perform ones own tasks.

References

Carver S.M. (2006). Assessing for Deep Understanding. In R. K. Sawyer (Ed.) *The Cambridge Handbook of the Learning Sciences* (pp. 205-223), New York: Cambridge University Press.

Gijbels, D., Dochy, F., Van den Bossche, P. & Segers, M. (2005). Effects of Problem-based Learning: A Meta Analysis from the Angle of Assessment. *Review of Educational Research*, 75(1), 27-61.

Kato, H., Mochizuki, T., Funaoi, H. & Suzuki, H. (2004). A Principle for CSCL Design: Emergent Division of Labor, Proceedings of ED-MEDIA 2004 conference (Lugano, Switzerland, June 2004), pp.2652-2659.

Nishimori, T., Kato, H., Mochizuki, T., Yaegashi, K., Hisamatsu, S. & Ozawa, S. (2005). Development and Trial of Project-Based Learning Support System in Higher Education. *Japan Journal of Educational Technology*, 29(3), 289-297 (in Japanese)

Acknowledgments