A Learning Support System by Reflection and Knowledge Collaboration in a Software Engineering Project Course and Its Preliminary Evaluation

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Abstract
Software development is knowledge-intensive and collaborative. Problem solving processes are performed iteratively during software development. This paper proposes a learning process model that is based on reflection and knowledge collaboration for problem solving in a software engineering education. This paper also describes an overview of a support system and a preliminary result from its application.

1. Introduction
Software development is knowledge-intensive and collaborative. Problem solving processes are performed iteratively during software development. Each developer possesses only a specific part of the knowledge and expertise required for software development. They develop software and collect various types of information simultaneously. Some even consult experts. Ye emphasized importance of knowledge collaboration in software engineering [2]. He provided the following three types of support facilities for a social platform: finding sample programs, browsing the archives of previous discussions, and posing questions to selected experts.

We tackle studies on a team-based software engineering project course. There it is important for learners to acquire knowledge and skills on software development. Sample programs, discussions with respect to past problem solving, and/or answers to questions will be important information for a learner’s problem solving. In addition, we believe reflection on his/her problem solving process and recording of the process enhance his/her understanding. Furthermore by sharing the information that was described as the result of reflection, it may be able to contribute to problem solving of other learners.

2. Concept
The learning process regarding problem solving we propose is consisted of the following four steps.

(1) Identification of a problem
When a learner or a learning group faces a problem, (s)he identifies the event and its background. Problems may come from inspection and/or testing, troubles in programming, and/or troubles in development environment building.

(2) Information gathering
A learner or a learning group collects information which is necessary for problem solving and considers cause of the problem. As the information source for problem solving, we suppose the supporting system we propose in this paper and/or external resources. We also suppose to collect information by means of communication with peers in the course and/or the teaching staff.

(3) Disposition of the problem
The learner deals with the problem to remove the cause, which was considered based on the information collected in the step (2).

(4) Reflection
When the problem is solved, the learner reviews the problem solving process and describes the lessons learned by the problem solving process.

We ask learners for describing items that correspond to the steps. We adopt “Shippaigaku” as a framework for describing the problem solving process. Shippaigaku is a discipline, which aims at learning from failure and prevents similar failures by sharing them [1]. Shippaigaku defines six attributes (event, background, progress, cause, disposition, and lessons) to describe a failure correctly and transfer the failure to others. In the learning process, we regard reflection as activities of describing all the above attributes in the course of problem solving learners face in the software development process. The problem solving information that will be stored through the abovementioned learning process is available for other learners. At this time we think learning effectiveness will not be obtained if a learner only refers to the information, i.e., (s)he will not acquire implicit knowledge. Therefore we provide a
function that referrers describe their lessons based on the information they referred.

3. The Learning Support System
We developed a support system that implemented a framework we proposed in the previous section. We explain some main functions for learners as follows.

(a) Registration of problem solving information
This function is one that a learner describes her/his problem solving process. (S)he describes attributes which were specified by Shippaigaku as well as title for ease of browsing. A learner is also required to register links to external resources, and/or artifacts that are related to the problem if necessary.

(b) Browsing of problem solving information
A user can browse detailed information of a problem. A user can also describe feedback information (score of usefulness and qualitative comments) to the concerned problem.

(c) Request for help
This is a function that a learner may use for asking help for other learners or the teaching staff when (s)he can’t find a way of resolution to a problem. In asking help for others, (s)he must inform contents of the problem. Therefore we require the learner to submit the problem itself, what (s)he investigated and/or did for solving the problem, cause (s)he guesses, and the artifacts that includes the problem. By the learner submitting such information, communication overhead will decrease. Other learners can give comments for the problem. When (s)he can solve her/his problem through the collaboration, (s)he is required to register the problem solving process into the system.

4. Preliminary Evaluation
We applied the system to an actual team-based software engineering project course in the 2006 academic year to validate the system. Twenty-eight learners participated in the course and six teams were organized. Each team was consisted of four or five learners. Each team completed the task given by the instructor. The developed system is intended to use in practice. Therefore quality assurance activities are planned: inspection for the artifacts which are created in the upstream phase and acceptance testing were conducted by the teaching staff and the instructor. We applied the system during Dec. 2006 through Jan. 2007. All groups were in the implementation through testing phase in the period. Table 1 shows the result of system usage.

Sixteen problem solving information was registered. Only five learners registered information. They were those who had high motivation for the course. Some of the rest learners told they were pushed for time. Other told they did not know what kind of information should be registered. The number of learners who utilized the function of “request for help” was only one. A teaching assistant replied to his question and he could solve his problem. He has registered his problem solving information.

Table 1: Application result of the system

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of registered information</td>
<td>16</td>
</tr>
<tr>
<td>Number of learners who registered the information</td>
<td>5</td>
</tr>
<tr>
<td>Average number of access for the registered information</td>
<td>19</td>
</tr>
<tr>
<td>Average evaluation score for the registered information</td>
<td>5.0</td>
</tr>
<tr>
<td>Number of help request</td>
<td>2</td>
</tr>
<tr>
<td>Number of learners who asked help</td>
<td>1</td>
</tr>
</tbody>
</table>

On the other hand, many learners asked for help in a face-to-face manner. To have accepted this method was our mistake. Certainly to receive support from others in a face-to-face manner is an efficient way. However even if (s)he solved her/his problem by support from others, (s)he may not learn anything. We have to improve this problem. We also found a quarter of the registered problems were not written their cause. We have to consider a mechanism which promotes to locate cause of the problem.

5. Conclusion
We have proposed a learning process that is based on reflection and knowledge collaboration for problem solving in a software engineering education. We have also described an overview of a support system. We applied the system to an actual project course. The results show that the number of learners who registered their problem solving information was small. They were those who had high motivation for the course. On the other hand, many asked help for their group members or the teaching staff in a face-to-face manner. Most of them did not register the problem solving information. We have to consider a mechanism they promote to reflect their problem.

Acknowledgements
This study is supported by the Grant-in Aid for No. (C) 18500701 from The Ministry of Education, Science, Sports and Culture of Japan.

Reference