The Design of Open Learner Model to Improve Interaction of Peer Assessment in Learning

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Abstract - Peer assessment has been reported as an effective collaborative learning approach. However, it is very difficult to encourage students to engage in reviewing activities. This study puts forward an open learner model approach that helps students’ peer interaction in the context of online peer assessment. A framework is proposed which structures and represents the information of peer interaction including Issue, Position, Argument and Feedback. These characteristics aim to support students to recognize and target problem areas. Once targeted, on the one hand, the system can suggest strategies to help students collaborate more effectively with their peers, maximizing students’ learning performance. On the other hand, students can access peers’ learner models and look for feedback on their work in a group. The result will provide strategies and suggestions to encourage peer interaction in the context of online peer assessment effectively.

Keywords: Peer Interaction, Open Learner Model

1 Introduction

There are many approaches to organize online peer assessment. However, we find it is very difficult to encourage students to engage in reviewing activities. In our previous study, we had developed and implemented a two-round online peer assessment system to support students’ learning in programming course [1, 2]. Some students complained that the feedback was not helpful or even inefficacy, such as, “Good, you are right” or “Excellent!”. The study of Lin et al. also reported that most students only sent simple feedback [3]. In the circumstances, learning performance is not satisfying. The goal of online peer assessment is not just for assessment by students themselves according to the rubrics, but also for enhancing students’ learning through collaborative learning activities. From Vygotskian perspective [4], learning is a kind of social activity in which peer interaction plays an important role. Thus, making students have more peer interaction should be one way to enhance learning performance in the context of online peer assessment.

Students need appropriate guides to be engaged in peer interaction. Tutors can provide encouragement and guide students in time through observing students’ behavior and learning performance in the classroom environment. In online learning environment, the online system could play a teacher role (as a tutor agent) and guide students’ peer interaction based on learner models which record students’ learning history and learning process. The study proposes a framework to design open learner models, which aims to structure and represent the information of peer interaction in the context of online peer assessment.

2 Review of related studies

Most approaches of peer assessment ask students to post comments on peers’ work in a summative way in one-round, including giving a final grade and posting comments [5]. In this case, there is less interaction among peers.

In fact, peer assessment is a kind of collaborative learning, where peer interaction should play an important role in improving students’ learning. Here, peer interaction means one student communicate with another around issues or topics in a group. However, putting students in a group does not guarantee them to engage in peer interaction. They may come across difficulties, such as less feedback, or even the peer missing. Thus, peer interaction should be organized properly by tutors. Especially, in a context where the teacher has less control than in a face-to-face setting, the teacher role is necessary. In online learning, the system can play as a teacher agent to provide guidance based on the students’ learning.

Then, how to record students’ learning by the online system? The learner model (or student model) is a kind of mechanism that records and diagnoses students’ learning, including learning performance, knowledge level, misconceptions etc.[6, 7]. When the learner model is open to students, it is named as open learner model. An open learner model is one with specific provisions for the learner to have one or more views of the information in the model [8]. It has been reported that open learner model should help students improve individual reflection. Moreover, there are also studies that explore learner models used in collaborative learning, which enable students interact with the peer agent to improve students’ learning [9].

Since the learner model is a kind of mechanism to record students’ learning, then how to record and support the peer interaction? Peer interaction is a complex cognitive process of human being. It is difficult to obtain precisely qualitative and quantitative analyses towards the discussion activity. One reason is the discussion activity is unstructured. Therefore, it is necessary to propose a framework to construct the interaction and facilitate the computer to record the
information. We find that the IBIS framework is suitable for this goal.

The Issue-Based Information System (IBIS) is proposed by Werner Kunz and Horst W. J. Rittel in order to organize the process of policy decision through discussion in CSCW environment (Computer Supported Cooperative Work) [10]. IBIS offers a framework to record information in a discussion process. It consists of a network of essentially three types of nodes: issue, position, argument. The issue is the organizational “atoms” of IBIS. The position is the response to issue(s) taken by somebody. The argument means somebody support or oppose positions.

There have been examples of IBIS type of information systems used in collaborative learning for students’ online group work. For instance, Karacapilidis et al. adopted IBIS framework as an argumentation tool when students participated in solving course exercises online [11]. The study of Liu and Tsai showed an analysis of peer interaction patterns based on IBIS in learning programming course [12]. Their study showed that IBIS was a suitable way for analyzing the students’ discourse in online group learning in programming course.

So, IBIS is a suitable way to structure and analyze the process of discussion by the computer. The benefits of IBIS include:

(a) Help students be aware of the process of discussion
   Although IBIS is a simple structure, it helps students know the key stages in their discussion. This likes the open sentences that used in the Knowledge Forum (http://www.knowledgeforum.com/), which help scaffold the discussion. The structure of IBIS makes students realize how to engage in effective discussion.

(b) Help the information structured and saved
   In generally, the process of peer interaction is very complex and unstructured. If the information is unstructured, then, the log files of peer interaction saved in the database may be disorganized. And the significant effort is required to extract communicative relationships within the group. If the information is organized according to a kind of structure, it will facilitate the analysis by the computer.

(c) Help the information reused
   The following students can retrieve the issues from the database and browse the process of peer interaction. It is a good resource for students’ future study.

Our study extends the IBIS, putting forward Issue-Position-Argument-Feedback (IPAF) as the framework to structure the peer interaction in the design of open learner model. The open learner model (Technology) is the vehicle for providing support to improve peer interaction (Pedagogy).

3 Issue-Position-Argument-Feedback Framework

In our study, the peer interaction in the online peer assessment is structured of issue, position, arguments and feedback (See Figure 1).

3.1 Issue

Assigning students in a group with peer reviewing tasks does not guarantee that the students will engage in effective peer interaction. Perhaps, some peer groups seem to interact naturally, others struggle to maintain a balance of participation and encouragement. Thus, it is necessary that providing issues for students and the issues should be designed carefully.

Here, the issue means that a subject or problem that is discussed or argued about. In our design, the issues come from two ways. One is from the teacher, which is designed to stimulate students to consider the domain knowledge related to the assignment. Another is from students themselves. The students will have opportunities to post issues by themselves. If students post issues and this issue stimulate more interaction, then, the student will be awards. All the issues will be saved in a database for students’ future learning as issues repertory.

3.2 Position

The position means a point of view on a certain question or issue. Generally, there are three kinds of positions—agree, oppose, other. And students have opportunities to show their position if they do not like select “Agree” or “Oppose”.

3.3 Argument

The argument means a debate, or a statement put forth as proof or evidence. Because, the issues that students discussion are high related to their current assignments. Thus, students are encouraged to provide a statement or reason towards their assignments.

3.4 Feedback

In our design, every student has responsibility to post comments and rank on peers’ arguments. It is a compulsory task. The comments and rank students get is named as “feedback”. Since the issue is high related to their current assignments, and perhaps, the argument will provide a solution. Based on the feedback, students could know whose arguments are very useful for their assignments.

The rubrics for commenting on peers’ arguments are based on the study of Webb [13]. It consists of five criteria for ensuring that students provide effective help to their peers. These criteria include: “help is timely; help is relevant to the
student’s need; the correct amount of elaboration or detail is given; the help is understood; the student has an opportunity to apply the help in solving the problem (and uses it!)”. Based on the criteria, we put forward a rubric for commenting on peers’ arguments. The goal is to look whether the arguments are help for students’ assignments (Figure 2).

### 4 A Framework of Supporting Peer Interaction by Open Learner Models

When the learner model is open to students, we need consider what information should be presented to students. That is to say, how to externalize and visualize the learner model. The methods of externalizing of learner model are varied, such as a graphical externalization of a Bayesian network [14], a fuzzy logic method [15]. Among the methods, the skill meters remain the most common form of open learner model, which can illustrate knowledge level, difficulties, misconceptions. The study of Bull and Kay suggested an open learner model which consists of four parts: “how does the open learner model fit into the overall interaction and how was it evaluated? what is open? how is it presented? Who controls access? ” [16]

Based on previous studies, in our design, the open learner model consists of two parts: cognitive support and social support. It represents students’ knowledge, misconceptions and interaction with the system and peers (Table 1).

#### 4.1 Cognitive Support

The cognitive support aims to help students reflect their learning performance. It represents the domain knowledge of students themselves, including the students’ current learning performance and their learning progress.

#### 4.2 Social Support

The goal of social support is to help students reflect their interaction process. The information of students’ peer interaction is described by four aspects: issue, position, argument and feedback. Here, the supporting strategies designed are named as rules.

(a) Issues

There are two kinds of issues in the design. One is from tutors. Another is from students themselves. The strategies are listed below.

- Rules-related to Issues 1 (RI-1): show students concepts related to the issues.

Perhaps, some students do not understand the meaning of the issues. Thus, the system provides prompts about issues, including the explanation about the issues, some concepts related to the issues.

- Rules-related to Issues 2 (RI-2): give award to students who launch an issue.

Students should have opportunities to launch an issue. And, perhaps, these issues are what they are interested in.

(b) Position

- Rules-related to Position 1 (RP-1): provide a checklist for students to post their position.

The system will provide a checklist for students to show their positions, including agree, oppose and other.

(c) Argument

- Rules-related to Arguments 1 (RA-1): provide an example for students on how to argument.

Perhaps some students have difficulties to launch an argument to express their thought, thus, the system will provide examples for students to browse.

(d) Feedback

As mentioned above, in order to make students have effective feedback, students are asked to post comments and rank on peers’ arguments to assess whether they get benefits from students’ assignments.

- Rules-related to Feedback 1 (RF-1): provide rubrics to students to comment on their arguments.

It is to ensure that each student’s discussion is high related to their demands. We put forwards a rubric for students to comment on their arguments. The main point is to look whether the arguments is help for students assignments (Figure2).

### Table 1. The Design of Peer Interaction in Open Learner Model

<table>
<thead>
<tr>
<th>Open Learner Model</th>
<th>Peer Interaction</th>
<th>Cognitive support</th>
<th>Social support</th>
</tr>
</thead>
<tbody>
<tr>
<td>What</td>
<td>Why</td>
<td>Open</td>
<td>Bar chart</td>
</tr>
<tr>
<td>Test score</td>
<td>Show students current learning performance</td>
<td>Know their ZPD</td>
<td></td>
</tr>
<tr>
<td>Learning progress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Errors posted by peers</td>
<td>Show the learning status</td>
<td>Help to reflect their learning</td>
<td></td>
</tr>
<tr>
<td>Peers comments Marks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issues</td>
<td>Improve interaction and make reflection in the process of peer interaction 30% of the mark come from peers rating on the arguments, 70% of the mark come from the teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rules-related to Issues 1 (RI-1): show prompts for concepts related to the issues</td>
<td>Rating</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Rules-related to Issues 2 (RI-2): show the students progress on rewards by posting issues</td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Rules-related to Position 1 (RP-1): provide checklist for students to post their position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rules-related to Position 1 (RP-1): provide checklist for students to post their position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argumen t</td>
<td>Rules-related to Arguments 1 (RA-1): provide an example for students on how to argument</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback</td>
<td>Rules-related to Feedback 1 (RF-1): provide rubrics to students to comment on their arguments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the conceptual framework of open learner model, an example is shown below.
Assignment: “Please edit codes in C programming: show 20 Integers by Random Function between 0 to 100, and save them in an array. Print the Integer which is over 50 and sum up them.”

Issues: Whether the Loop statement can be used in this assignment? If it can, then which kind of Loop statement is more suitable for this assignment?

The user-interface of open learner model design is showed in Figure 3.

Figure 3. The User-Interface of Open Learner Model

5 Evaluation

The evaluation of open learner model includes the usability evaluation and the pedagogy evaluation. In our study the learner model is constructed from three aspects---contents, pedagogy and technology. Among the three aspects, the learning content is constant. Thus, the usability evaluation is to investigate whether the technology could support students to communicate with the contents through user interface. If it could, then the technology is designed appropriately.

After that, the study will investigate the pedagogy evaluation. The pedagogy evaluation means whether the Issue-Position-Argument-Feedback mechanism could support students to peer interaction. If it does not work well, then changes and modification maybe need. The details are listed in Table 2 and Table3.

Table 2. The Data Collecting Methods

<table>
<thead>
<tr>
<th>Methods</th>
<th>Participants</th>
<th>Usability Evaluation</th>
<th>Pedagogy Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey A (for teachers and students)</td>
<td>√</td>
<td></td>
<td></td>
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<tr>
<td>Survey B (for students)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Final Testing Scores</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>The Quality of Comments Each Student Post</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Quality of Arguments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levels of Involvement</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. The Pedagogy Evaluation

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>With Open learner model (Class A (IV1))</th>
<th>Without Open learner model (Class B (IV2))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class A (IV1)</td>
<td>Class B (IV2)</td>
</tr>
<tr>
<td></td>
<td>Survey B (for students) (V1)</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>Final Testing Scores (V2)</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>The Quality of Students Programming (V3)</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>The Quality of Comments Each Student Post (V4)</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>The Quality of Arguments (V5)</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>Levels of Involvement (V6)</td>
<td>√</td>
</tr>
</tbody>
</table>

The pedagogy evaluation aims to investigate the effectiveness of the open learner model designed in the context of online peer assessment. There are two independent variables, IV1 and IV2 (See Table 3).

The effectiveness will be assessed by six dependent variables---the results of survey B (V1), the students’ final testing scores (V2), the quality of students’ programming (V3) and the quality of comments each student post (V4), the quality of arguments (V5) and levels of involvement (V6). The last three variables will be analyzed from the individual level and group level. The aim is to have an investigation on the effectiveness of individual learning and group learning when using open learner model.

1) Survey of students
   Each question in the questionnaires is related to evaluate the design in the Table 1.

2) Final testing scores
   Each semester, when students finish the programming course, there will be a test in ECUST, which adopts the item banks by computer automatically. Each year, the students will be tested by the same item banks. It is a standardized test. Thus, there will be a compare among the students not only in this semester but also in the past year.

3) The quality of students’ programming
   The students’ assignments will be marked by the lecture. All the participants are taught by one lecture. Thus, the lecture can compare the quality of students’ programming. This compare can be from two aspects. On the one hand, it is the quality of each student’s programming, including the marks given by lecture and the errors students commit. On the other hand, the lecture can compare the whole group level through the average marks and the average errors students commit.

4) The quality of comments each student post
   It will be measured from two aspects. One is to count the number of comments each student post. The other is to inspect the contents in the comments. The aim is to explore whether students make a serious posting, since in the above design in Table 1, the social support is designed in order to encourage students engage in a serious posting activities.

5) The quality of arguments
   The quality of arguments will be measure by the teachers based on the rubrics as mentioned above (Figure2).

6) Levels of involvement
   The level of involvement will be measure by the following questions by interview.

   - Are students interested in the activity?
   - Are students attending to and reacting to what peers are doing?

   Levels of Involvement may vary depending on the student’s different learning performance.

6 Results and recommendations

In the usability evaluation, including 8 teachers and 54 students took part in filling the questionnaire online. Based on their comments and suggestions from questionnaire, the system was polished, revised and improved.

About 400 students have engaged in this study until this semester. Compared with the common classes, students in the experiment class shows high satisfaction with the learning
through the course feedback of questionnaires, high examine pass rate through the final testing (Table 4).

<table>
<thead>
<tr>
<th>Class</th>
<th>Average Score of Final Testing</th>
<th>Numbers of Students Taking Part in the Competition in Information Literacy</th>
<th>Score of Students' Evaluation about the Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A (IV1)</td>
<td>Sep. 2011: 64.1, Sep. 2012: 72.7</td>
<td>15 students (27 students)</td>
<td>93.33, 93.16, &gt;90, &lt;90</td>
</tr>
</tbody>
</table>

The peer interaction in online peer assessment in learning programming course makes students show more motivation taking part in the learning activities. In the experiment class, in total, the number of students is 15 and 27, who took part in the competition activities in information literacy organized by the Ministry of Education in China. However, the number of students is null in the common class. And it also found that students with high learning performance would dominate the process of peer interaction.

This study proposes a method of online peer assessment, which emphasizes the peer interaction. The following are key ideas in our design.

1. An experiment study of online peer assessment used in programming course

   In reviewing literature, the method of online peer assessment used in the big classroom in high education is few in Shanghai. Although all over the world, there are many research reported the peer assessment activities in learning, especially in learning programming course. Compared with that, few similarity research reports in the past ten years are involved in high education in Shanghai.

2. Reforming the assessment method of learning in programming course

   This method emphasizes “Assessment for learning” rather than “Assessment of learning”. It affects the students’ attitudes and behaviors. The student attitudes decide the direction of learning, and further stimulate and encourage them engaging in the innovation competition activities.

   Generally, the number of students in a classroom is more than one hundred in Chinese high education environment, such as in information literacy course, C programming language course etc. The main characteristic of teaching in such classrooms is the number of students. So we need a method to improve students’ learning in such classrooms. This study argues that improving students’ peer interaction can make students learn more interestingly. For instance, the number of students, in the experiment classroom, who takes part in the competition activities of information literacy, is more than the number of students in the common class. The students show high motivation in taking part in learning activities. (See Table 4)

   This study explores the open student model used in online peer assessment, to improve the peer interaction among students. In the pilot study, the method not only makes the student interest in learning programming, and further improves their learning performance. And at the same time, this inspires the students’ motivation to take part in the innovation learning activities.

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7 References


