

Enabling Collaborative Learning with an Educational MMORPG

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Abstract--In order to provide interesting theoretical education of software engineering, this paper presents a collaborative learning environment on the base of a multiplayer online game platform. A matching mechanism is designed to facilitate the collaboration among students with complementary knowledge. The implemented educational game can be used as a supplementary tool for traditional classroom teaching.

I. INTRODUCTION

Nowadays the enormous demand for high-quality software systems and professional developers pose great challenges to software engineering education [5,9]. The concepts, theories and methods of software engineering have been greatly developed through the common efforts of academic researchers and industrial practitioners. In order to provide effective training for software developers, software engineering education is given from both theoretical and practical aspects [12]. Although practical training can be given efficiently with simulated projects in universities or real projects in companies, theoretical education is mainly provided through traditional classroom teaching. Abstract and boring theoretical knowledge dampens the enthusiasm of students. Moreover, teachers cannot offer enough guidance and assistance to students due to their limited time and energy.

In recent years, collaborative learning theory and educational games attract more attentions of researchers [4]. Collaborative learning theory encourages collaboration among learners. Individuals can acquire new knowledge or reconstruct existing knowledge by participating in the teaching process and learning from each other during social interaction. A shared space and online communication tools need to be provided for collaborative learners. As educational tools, games can add entertainment elements to tedious learning contents. Students keep good motivation and engagement in educational games. Furthermore, Massively Multiplayer Online Role-Playing Game (MMORPG) has inherent channels of communication and collaborative tools for players [1,7]. It can be used to support effective collaboration among learners (players) for the educational purpose.

In order to provide interesting theoretical education of software engineering, this paper presents a collaborative learning environment based on a multiplayer online game platform. The basic knowledge of software engineering is transformed into questions in the game. Students have to answer these questions if they want to win the game. The most interesting part is that learning collaborators with complementary knowledge can be recommended by a collaboration recommender to the appropriate learners. During the process of playing games, the performance of students is evaluated according to their answers in the game. The

evaluation can be used to recommend ideal learning partners to students. The knowledge of software engineering can be improved in a collaborative learning environment on the base of the educational game. The rest of this paper is organized as following: In the second section, collaborative learning theory and its connection with multiplayer online games are introduced briefly as the research background of the designed collaborative learning environment. In the third section, the architecture of the educational game is explained in detail. The learning collaborator recommendation mechanism is described in the fourth section. Finally, the conclusion and future work is given in the last section.

II. BACKGROUND

Collaborative learning defines learning as a social process of constructing knowledge [8,11]. Learning is seemed as a collaborative process and depends on communities of practices. Collaboration provides an opportunity for more effective learning when learning happens in a social context [10]. Individuals acquire new knowledge or reconstruct existing knowledge through social interaction. The individual with different knowledge and experiences for a certain topic can exchange ideas with others and form a new understanding for the topic. The learning perspective of students is transited during the learning process. Students are encouraged to participate in the teaching process.

Collaborative learning requires students to create strong relationship with other peers. The communication of learners is necessary in collaborative learning. The support tools or platform are needed when people are distributed in different time and space [13]. As the development of Internet and computer science, Computer Supported Collaborative Learning (CSCL) can provide a share workspace, online communication tools and learning materials for collaborative learners [2,3]. MMORPGs can be used to promote collaborative learning when the educational contents are included in the game. Collaborative learning theory can be used to guide the design of educational games in order to support effective collaboration in the game [6].

III. THE ARCHITECTURE OF EDUCATIONAL GAME

The knowledge of software engineering can be achieved by students through sharing and collaboration in a learner-centered way. A new collaborative learning environment is designed as an educational MMORPG, which is called World of Wisdom (WoW) [14]. The knowledge of software engineering is transformed into questions and challenges in the game. Students have to answer these questions if they want

to win the game. The game will be a useful supplement to traditional classroom teaching. It can promote collaboration among students. The most interesting part is that potential learning collaborators with complementary knowledge can be recommended by a collaboration recommender to the appropriate learners. Students are evaluated according to their performance in the game. The evaluation results can be used to match learning partners. Students can improve their knowledge by communicating with their learning collaborators.

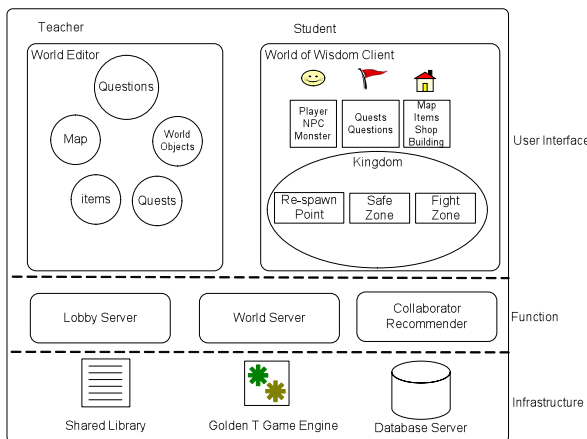


Fig. 1 The Architecture of World of Wisdom Game

The architecture of WoW, which is shown in Figure 1, consists of three levels: User Interface, Function and Infrastructure.

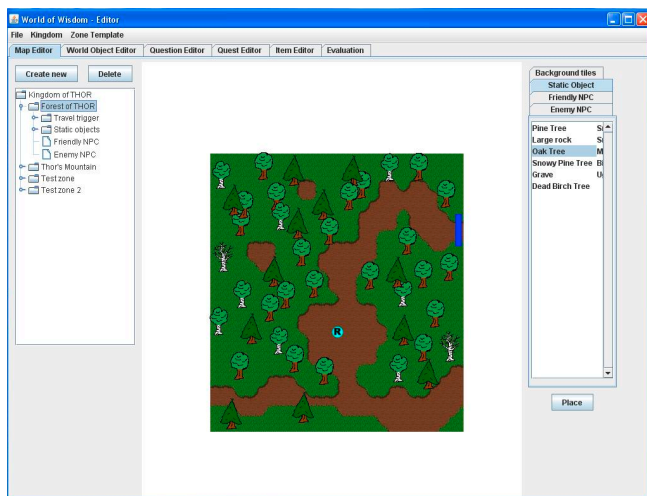


Fig. 2 World Editor for Teachers

User Interface, which is given in Figure 2 and Figure 3, includes World Editor for teachers and WoW client for students. Teachers can use the editor to create new game plots with map, items and world objects and new learning contents with quests and questions. In the clients for students, each kingdom represents a course. Students can choose different kingdoms to practice exercises of different courses. A kingdom consists of re-spawn point, safe zone and fight zone. There are maps, items, shops and buildings in a kingdom. Student players will receive quests from NPC in the game, go to the corresponding area, and fight with monsters by

answering questions. The questions are preset by teachers according to the knowledge of software engineering. During the process of game playing, players can communicate and collaborate with each other via text chat.

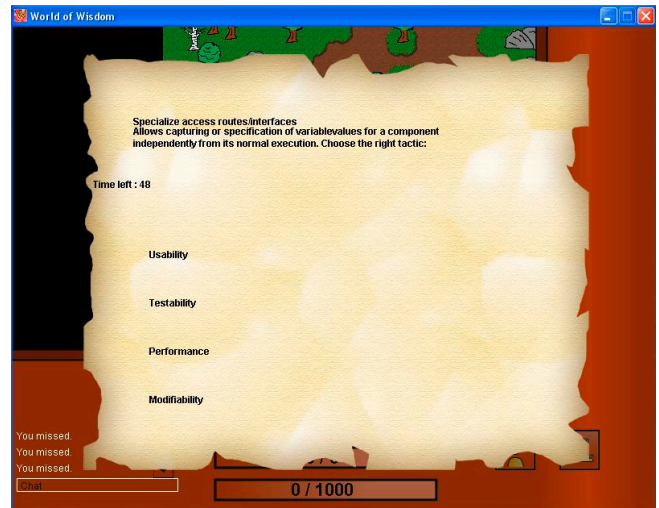


Fig. 3 World of Wisdom Client for Students

Function layer consists of lobby server, world server and collaborator recommender. Lobby server is responsible for user login and authentication management. The game plots and learning contents provided by teachers and game running data produced by students are managed by World Server. Collaborator Recommender recommends appropriate collaborators to learners in order to facilitate the establishment of collaborative relationships among learners.

Infrastructure layer consists of shared library, Golden T Game Engine (GTGE) (<http://www.goldenstudios.or.id/products/GTGE/>) and database server. Shared library provides basic support for communication between applications and network connection. GTGE is an advanced cross-platform game programming library, which provides complete routines for developing 2D games. Database server is responsible for access and stores the data of user and game.

IV. COLLABORATOR RECOMMENDER

As the most interesting part of the architecture, Collaborator Recommender helps students to find their suitable learning partners. Effective collaboration among peers is a powerful way of learning. However, it is just a possibility of collaboration when students are being put together on the game platform. The collaboration cannot be guaranteed to happen spontaneously. How to find suitable collaborators among students is a challenging question in collaborative learning. Good results will be achieved when learners work with the right person. But it is inefficient for learners to find a suitable collaborator only through spontaneous interaction of players in the game.

The question of how to help learners find their potential collaborators can be expressed as how to recommend suitable collaborators according to the knowledge complementary degree among learners. In this paper, the suitable collaborators

can be found by evaluating the knowledge of students in the game. The knowledge of different students can be automatically matched by a recommendation algorithm.

Based on the performance evaluation of students, the most suitable collaborators can be recommended by computing the similarity of each pair of players on complementary knowledge. All the similarity values can be described in a matrix

$$\begin{matrix}
 & P_1 & P_2 & P_3 & \cdots & \cdots & P_n \\
 P_1 & \left[\begin{array}{cccccc}
 s_{11} & s_{12} & s_{13} & \cdots & \cdots & s_{1n} \\
 s_{21} & s_{22} & s_{23} & \cdots & \cdots & s_{2n} \\
 s_{31} & s_{32} & s_{33} & \cdots & \cdots & s_{3n} \\
 \vdots & \cdots & \cdots & \cdots & \cdots & \cdots \\
 \vdots & \cdots & \cdots & \cdots & \cdots & \cdots \\
 s_{n1} & s_{n2} & s_{n3} & \cdots & \cdots & s_{nn}
 \end{array} \right.
 \end{matrix}$$

s_{ij} represents the similarity of player P_i and P_j on the complementary knowledge.

Assumed that there are Q questions in the game, the scores of player P_i to answer these questions can be represented as a vector $V_i = [v_{i,1}, v_{i,2}, \dots, v_{i,Q}]$.

Then the similarity of player P_i and P_j can be calculated with the following formula:

$$s_{ij} = \cos(\theta_{V_i, V_j}) = \frac{V_i \cdot V_j}{\|V_i\| \times \|V_j\|} = \frac{\sum_{q=1}^Q v_{i,q} \times v_{j,q}}{\sqrt{\sum_{q=1}^Q (v_{i,q})^2} \times \sqrt{\sum_{q=1}^Q (v_{j,q})^2}} \quad (1)$$

The students with complementary knowledge can collaborate easily. So for a player P_i , the similarity vector $S_i = [s_{i1}, s_{i2}, \dots, s_{in}]$ should be sorted in descending order. And the first N players with minimum similarity are recommended as suitable candidates to the player P_i . Then player P_i can choose among these candidates to send invitation of collaboration. If a candidate accepts the invitation, they can begin with their collaborative learning through discussion. The vague concepts and theory of software engineering are clarified by discussion.

V. CONCLUSION AND FUTURE WORK

In this paper, a collaborative learning system is realized as a multiplayer online educational game. The theoretical software engineering education can be achieved by combining collaborative learning and educational game. The game platform endues fun and entertainment to the knowledge of software engineering. As a useful teaching aid for traditional classroom teaching, the proposed recommendation mechanism can promote collaboration among learners. How to evaluate the effectiveness of MMOEPGs for learning purpose will be our next research question. Students' learning outcomes will be quantitatively evaluated and measured with experiments in our future work.

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