Web-based Multiplayer Online Role Playing Game (MORPG) for Assessing Students' Java Programming Knowledge and Skills

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Abstract

This paper discusses the current practices of assessing students' Java programming language concepts and skills by using educational multiplayer online role playing game. Some of the pitfalls of course design have been identified which need to be addressed to increase students' motivation and to reduce students' difficulties in grasping Java programming concepts. As a solution, a game based assessment and exercise design is proposed for Java programming which will keep students on the task, and provide motivation and challenges. The game is developed and built on web browsers with AJAX technology. The web-based game enables students to play it across different operating system platforms and AJAX makes it possible for the game to be able to provide students with rapid response and instant inter-player interactions.

Keywords: Online Game, Role Playing Game, Java, Programming Language, Multiplayer, Assessment

1. Introduction

21st century learners who grew up in a digital world playing digital games also learn differently. Computer games are what they are familiar with since childhood; they learn with ease if formal learning is also made more media rich and interactive.

With the availability of multiplayer gaming environments over the Internet, students learn to interact with people virtually, and collaborate and form communities more easily. So, introduction of multiplayer games in formal subject areas could also enhance social aspect of learning and provide interpersonal skills essential for 21st century learners.

In this research, we have developed a role-playing game for assessing students' Java programming knowledge and skills. The aim is to increase effectiveness of the learning process by making it fun and interesting for learners with game-based contents. Learners will learn how to do Java programming while they are engaged in a multiplayer role-playing game and interact with distant peers.

2. Rationale for Game Based Course Design for Java Programming

The qualities that make a game fun to play include challenge, fantasy, curiosity, and control [11]. Research suggests that a good game for learning should have challenge factor and should be fun to play for learners [5]. There are many different types of games, and two of them seem to be rather suitable for educational purposes [7]: adventure game and role-playing games [3]. Both adventure games and role-playing games provide challenges; the players need to clear the stages (in adventure games) or complete the quests (in role-playing games) in order to get promoted (in adventure games) or ascend the levels (in role-playing games).

Many multiplayer online role-playing games (MORPGs) that have emerged in past several years, for examples, World of Warcraft, Guild War, and Ever Quest. These MORPGs have significantly influenced the current generation [12]. A number of research efforts in designing games for educational purposes or applying game concepts in learning activities. For examples, Chang et al. [4] used the stage concept in games where the learners were allowed to learn and to have breaks among different learning topics; Olazar [10] used an online game for business education; and, Bueno et al. [2] taught sports to handicapped people by using games. There have been very few attempts of using MORPGs for teaching programming skills.

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3. Game Design Issues of Assessing Java Programming Skill

Five issues require consideration while designing the multiplayer online role-playing game for assessing students' Java programming knowledge and skills. First, for the game to be fun for the students, the avatar and the game world should look like a game rather than a learning environment. For rapid development, a web-based development environment is selected rather than a 3D development environment. A web-based multiplayer game requires rapid feedback and instant inter-player interaction. To achieve this, AJAX technology is found to be appropriate for developing web-based MORPG.

Second, the quest givers are Non-Player Characters (NPCs) and there are five quest types:
  (a) **Greeting quest**: This is the simplest quest type in RPG. This kind of quests asks the player's avatar to look for specific NPC.
  (b) **Delivery quest**: This is the most common quest type in RPG. In this kind of quests, the quest givers or receivers look for the quest item(s) from the player's avatar's bag(s) and take the quest item(s) away. They also give the avatar some sort of rewards, such as gold pieces and/or experience points.
  (c) **Multiple choice / true-false quest**: In a multiplayer role-playing game for assessing students' Java programming knowledge, this kind of quests can be used to assess the player's knowledge regarding specific concepts.
  (d) **Fill-in-the-blank quest**: This kind of quests can be used to assess the player's higher level cognitive knowledge and to discover whether the player knows specific concept and/or operation flow in-depth.
  (e) **Coding quest**: In a role-playing game for assessing students' Java programming skills, this kind of quests is similar to the delivery quest type, the only difference is that the player needs to type his/her Java code solution on a papyrus sheet according to the quest he/she took, and when he/she turns the quest item(s) in to the NPC, he/she needs to drag the papyrus sheet from his/her bag and give it to the NPC.

Third, the game should be able to update and expand its quests for assessing students' knowledge and skills in different topics and ways. The "expansion" methods that most of the commercial massively multiplayer online role playing games (MMORPGs) use nowadays can be taken into consideration for this purpose. The game can use expansion to add new quests with different difficulty levels and learning topics into the game world. Sometimes, in order to keep students' curiosity and motivation, new continents can be added through this way.

Fourth, Bartle [1] and Yee [13] categorized the players of multiplayer online role playing games into different individual/mixed types, e.g. Bartle's achievers (Diamonds), explorers (Spades), socialisers (Hearts) and killers (Clubs) types, and Yee's achievement, social, and immersion groups. Some players such as the Hearts type and the social group players use the communication functions in the game world, e.g. chat, whisper, emotion actions, and voice chat to interact with others. The Diamonds type and the achievement group players focus on completing every quests and tasks offered to them by the game. The Clubs type and the achievement group players also aim at defeating other player as their goals. The game should therefore provide communicative facilities, PvE (player vs. environment, including the game world, monsters, and NPCs) combat and interaction, and PvP (player vs. player) duel or arena.

Fifth, after the NPC receives the quest item (the source codes for solving specific problem - the quest) from the player's avatar, the NPC should be able to use the online judge system to mark the source code and also detect the possible plagiarism.

4. The Game

In the one year research project (December 2008 to November 2009), a web-based multiplayer online role playing game has been developed using AJAX technology. Dozens of quests related to two learning topics, Operators and Execution Control, have been designed and installed into the game. The game's platform independent feature has been tested with various web-browsers, including Microsoft Internet Explorer, Mozilla Firefox and Opera.

After the player has signed in the game, s/he can see the game world and user interface as shown in Figure 1. The game world is constructed as a set of tiles, each of which has different attributes representing different geographical features (in the world map) and buildings (in the village map).
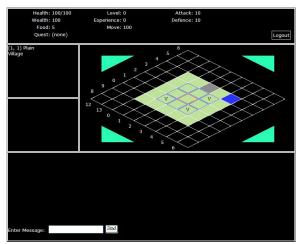
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Figure 1. The game world and user interface

In order to enhance the sense of exploration in the game, the game world is initially hidden from the players [8]. As the players move around the game world, the terrain features of nearby tiles are revealed. There may be other means within the game to uncover the tiles without physically traveling through the game world. For example, there may be some NPCs within the game that are willing to sell maps to the players.
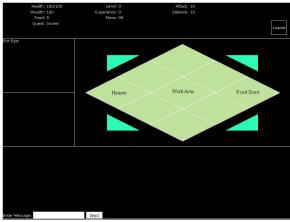

Figure 2. Village map

Certain tile types can expand into second level user interfaces. For example, a 'V' tile represents a village and will be activated to display a village map as Figure 2 shows. The player can choose various services from vendors and pick-up quests from NPCs in a village.

Figure 3. A player gets and solves the quest offered by the NPC at the Work Area in the village at (1, 1)

For example, at the Work Area in the village at (1, 1), a player gets a **fill-in-the-blank quest** which asks the player to write down a small Java program's output (Figure 3). After the player has completed the quest by returning the correct quest item (the correct output) back to the NPC, the NPC offers him/her 30 gold pieces and 20 experience points as reward (Figure 4).

Figure 4. The player received golds and experience points as reward of solving the quest

Besides the fill-in-the-blank quest, there are also **multiple choice quests**. Figure 5 shows the vendor offers the player a multiple choice quest asking him/her to identify the correct truth table for the logical AND (&&) operator.
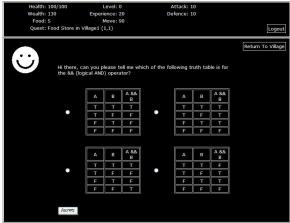
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Figure 5. The vendor NPC at the Food Store offers the player a multiple choice quest

The game also contains **greeting quests**, which are used to enable the players to travel in the game world as Figure 6 shows. After the player has solved the Java programming problem, the NPC may ask him/her to go to another place to get his/her reward for completing the quest, which may be another greeting quest.

Figure 6. A greeting quest asks the player traveling to another village in the game world

The last quest type in the game is the **coding quest**. As shown in Figure 7, the NPC gives the player a small piece of Java program and asks him/her to rewrite it with the ternary operator. Currently, the online judge system has yet not been integrated into the game. Therefore, the NPC tells the player that the rewritten code will be examined later and gives him/her the reward for completing the coding quest directly at that moment.
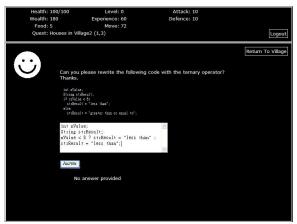
Figure 7. A coding quest that NPC asks the player rewrite a small Java program with the ternary operator

All the quests in the game have the level characteristic, which means that the player can only see the quests at his/her level. For instance, s/he can only see the level 1 quest if s/he is at level 1, based on current game configuration. The game has quest expansion function that teachers can use to add as many quests as they want at anytime without interfering the students' current playing activities in the game.

The game also has a text-based chat function. A player can talk to others who are at the same location. All players have a hidden characteristic, the reputation characteristic. The higher the reputation a player has, the longer distance s/he can communicate with others. Which means, the player, whose reputation is greater than 1, can see and communicate with other users who are at the different tiles.

Three issues have not yet been implemented in the game. First, the game does not have monster and boss for PvE combat. As shown in Figure 1, although a player has health, attack, and defense characteristics, s/he does not have to fight with a monster or a boss. Second, the game does not have PvP mode. Similar to PvE combat, the player cannot challenge and/or duel with others at the moment. Absence of this feature may leave Clubs type and the achievement group players feeling bored in the process of playing the game. Third, the online judge system [6][9] is not yet integrated into the game. Without the online judge system, the source code submitted by the player cannot be assessed in real time. Moreover, the possible plagiarism can also not be detected.

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5. Conclusions

In this paper a game based approach is proposed for assessing students' Java programming knowledge and skills. With the characteristics of multiplayer role-playing game, the students can have fun while doing their homework and exercises. A web-based multiplayer online role playing game has been developed for this purpose in a one-year research project.

The multiplayer online game offers the students a forum of exchanging idea and experiences. Moreover, due to the characteristics of multiple player online games, the students can look for a certain degree of help from peers and even use the game as a social network to exchange work experiences or seek solutions to problems after graduation.

As summarized in Section 4, there are three issues that have not yet been covered in this game. The most important issue is the integration of online judge system. We aim to look for possible collaboration with other researchers and research teams instead of building this component ourselves. In the meantime, we aim to formally evaluate the game in undergraduate level Java programming courses. Initial evaluation will take place within our school's Java for Programmers course and subsequent experiments will be conducted at other schools in different parts of the world, in order to analyze the possible influences from factors such as gender, culture, age, and country.

Acknowledgements

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