

Incorporating Farming Feature into MEGA World for Improving Learning Motivation

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Abstract: *Although educational games have been proved to be useful to get students motivated in doing learning activities, one of the most attractive game feature – farming – has rarely taken into consideration while designing and assessing an educational game. In this research, we design and develop the farming feature, also known as player versus environment (PvE) subsystem, for an educational game platform MEGA World (Multiplayer Educational Game for All). We discuss the operation workflow that the PvE subsystem communicates with MEGA World main system and design correspondent mechanic and required modules to assist students' learning. The subsystem has two game modes and the students can use the knowledge or skills they have learned in the course to fight with the monsters and earn the rewards. We expect this subsystem can improve students' learning motivation and performance. In order to verify our expectation, we design a semester-long experiment that involves four groups of undergraduate students.*

Keywords: Learning Performance, Learning Motivation, Educational Game, Gameplay, Player versus Environment

1. Introduction

Prensky and Berry (2001) claim that students or learners in 21st century have more different ways to learn than the students before. The students live in a media-rich environment where they can learn different knowledges from innovative and interactive ways such as games (Chang & Kinshuk, 2010). There are a lot of research have revealed that educational game is an effective way to improve student's learning performance and motivation. In 2018, Barr (2018) uses qualitative interview data to find the undergraduate students' attitude about using commercial video games to develop useful skills and competencies. Their research result shows that the students have in overall positive perception toward the use of video games to assist learning and believe the way can develop their communication skill. Furthermore, Wouters, Van Nimwegen, , Van Oostendorp and Van Der Spek (2013) find out that using digital game to assist learning activities can improve students' learning motivation and make them be more active on doing problem-oriented learning activities.

There are a lot of different types of games. Gros (2007) list seven game genres which are agreed broadly. These genres include (1) action game that is a kind of response-based games; (2) adventure game that allows players to progress though levels by solving problems in the virtual world; (3) fighting game in which players can fight against with non-player characters (NPCs) or other players; (4) role-playing game allows players to play a role of fictional character to explore the virtual world; (5) simulation game in which players have to achieve pre-specified goals though the game modelled after natural or man-made systems or phenomena; (6) sports game that is based on different kinds of sports; and (7) strategy game in which players adopt an appropriate strategy to achieve the goal in the recreate historical scenes or fictional scenarios.

In those game genres, role-playing game's educational potential has been proved and is worth to pay attention on it. Podjačevs and Skorobogatova (2017) indicate that using role-playing in learning is one of the most efficient methods to learn the foreign language. It not only can help leaning the foreign language but also develop player's mental personality. The game-play in role-playing game is aligned with developing skills of decision-making, cooperation, problem-solving, and social interactions (Chang & Lin, 2014).

According to the evidence above, we can understand that using role-playing game to assist learning activities is an effective way to improve students learning performance and motivation. Therefore, this research chooses a role-playing game called MEGA World (Multiplayer Educational Game for All) as the research platform which developed by Chang and Kinshuk (2010). The goal of this research is to design and develop the player versus environment subsystem which provides farming feature for MEGA World and expect to find out how this feature affect student's learning performance and motivation.

The rest of the paper is organized as follows: Section 2 talks the educational game elements and the MEGA World this research is built on. Section 3 explains the workflow between the MEGA World and the PvE subsystem while Section 4 reveals the prototype of the PvE subsystem. An evaluation plan for verifying the two hypotheses this research has is described in Section 5. At the end, Section 6 briefly makes a summary and discusses the limitation.

2. Research Background

2.1 Educational Game

The educational game is the game which designed for educational purpose. The goal of educational game is helping players to understand certain subjects or practice certain professional skills. In 1996, Hogle indicates that there are four major advantages of using educational games which aim to assist learning activities.

The first advantage is that the curious because interactivity and the fantasy of game story in the game can enhance players' interest and learning motivation. The second one is improving memory retention; for instance, simulation games can have better effect on memory retention compared to the traditional learning activities. The third advantage is providing chances to practice and immediate feedback – that is, players can practice their professional skills repeatedly and receive the immediate feedback from the game; therefore, players can assess their learning outcomes and improve their skills or knowledge.

The last advantage is improving their higher order skills. The game design of educational game aligns with the cognitive structure of human beings. Players solve problems and make their own choices in the game repeatedly which means players need to integrate what they have learned to deal with the situation they encounter in the game. Therefore, the knowledge can repeatedly be remembered into players' memory.

2.2 Educational Game Elements

The advantages of educational game are mostly based on the engagement of players. Alexiou and Schippers (2018) identify three components of educational game which can engage players' cognition and emotion, including the game system (game rules and game mechanics), narrative (theme, story, characters) and aesthetics (audiovisual elements, fidelity, aesthetic choices). In order to fully use the advantages of educational game, a well-design and attractive educational game is required. Alexiou and Schippers (2018) also mentions there are four main elements which majorly determine the engagement of the player in designing the educational game, including goals, rewards, challenge, and feedback.

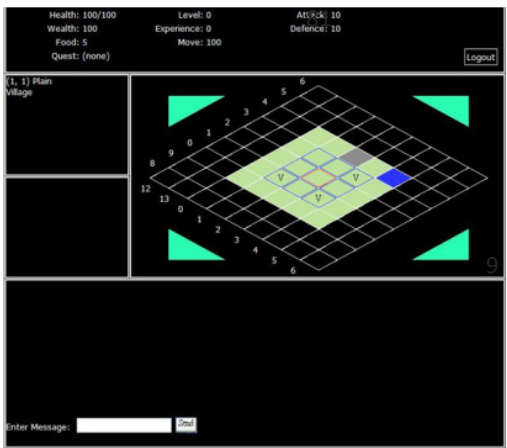
Locke, Shaw, Saari and Latham (1981) also present that the digital game use a series of objectives and quests to achieve the goals that become larger as the game progresses. The clear, specific, and challenging goals can enhance players' persistence and performance. After players achieve the goals, they can earn the rewards. McKernan and the research team (2015) claim the players' effort, progress and performance generally related to the reward systems. The unpredictable rewards can have

more effects to players' engagement than steady and predictable rewards (Howard-Jones & Demetriou, 2009).

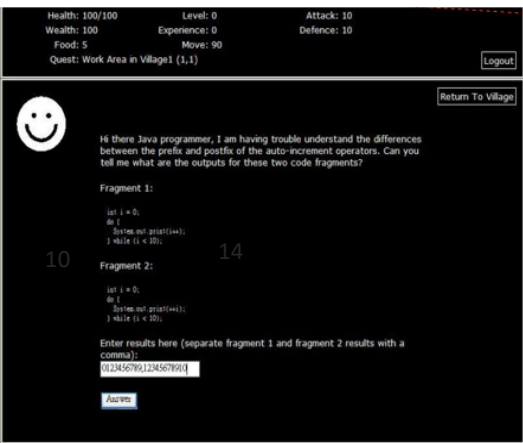
The third element is challenge. Csikszentmihalyi Mihaly and Csikszentmihalyi Isabella (1975) believe that if the given challenges are high but the players' skill level can still handle, the players will feel extreme absorption, enjoyment and achievement. Therefore, the relationship between challenges and skill level also determines the players' engagement. During the gameplay, players use the knowledge learned to solve the problem. The feedback mechanism can help the players to learn from the mistakes as well as enhancing the engagement and maintaining the cognitive engagement (Beserra, Nussbaum, & Grass, 2017; Gresalfi & Barnes, 2016).

2.3 Multiplayer Educational Game for All

MEGA World¹ (Multiplayer Educational Game for All) is a web-based multiplayer role-playing educational game which designed and developed by Chang and Kinshuk (2010). They develop the system and used it to help students to assess their Java programming skills as Figure 1 shows.



(a) Chessboard-like game world



(b) A Java programming quest

Figure 1. The original MEGA World (v1.0) in 2010.



Figure 2. MEGA World v2.1.

¹ <https://megaworld.game-server.ca/>

Teachers can design several learning activities from different learning objectives in the game, and the students can control their avatars to explore the chessboard-like game world and assess their professional skills or knowledge through complete those learning activities (Kuo, Chang, Kinshuk, & Liu, 2010). Teachers use the learning materials to create different types of quests, including greeting, item collection, delivery, sorting, treasure hunting and digging, calculation, fill-in-the-blank, short answer, multiple choices, true/false, and speaking-based conversation (Chang, Chen, Wu, & Yu, 2019), and assign to particular Non-Playing Characters (NPCs). Students meet the NPCs to receive the quests and complete the quests to stealth assess their learning outcome as well as earning the game rewards.

However, almost none of educational games includes MEGA World taking the farming feature which is one of the attractive game features in role-playing games into the game design. Therefore, this research aims to design and develop the player versus environment (PvE) subsystem for the latest version of MEGA World which shows in Figure 2.

3. Workflow between MEGA World and PvE Subsystem

The PvE subsystem is an expanded module of MEGA World which is mainly based on PHP, JavaScript and AJAX (Asynchronous JavaScript And XML). During the development, we cannot modify the MEGA World main system except the necessary connection between two systems.

When a student moves his/her avatar around the game world, MEGA World sends the player's location information in a package in JSON (JavaScript Object Notation) format to the PvE subsystem. The data passed in JSON format can be interpreted and looked like Figure 3a. The PvE subsystem then checks the database to see whether there is any monsters at that location. If there are monsters at that location, there will be 40 percent chance for the student to encounter the monsters. If the PvE subsystem is triggered, the subsystem sends the monsters' information in a JSON-based data package (see Figure 3b) back to MEGA World.

```
{
  "MapTypeName": "city",
  "MapID": "16",
  "X": "1",
  "Y": "1",
  "ProfessionID": "2",
  "ProfessionLevel": 10,
  "AverageQuestLevel": 10
}
```

(a) The "Find Monster" query

```
{
  "BattleType": "Normal",
  "Monsternumber": 3,
  "Monster": [
    {
      "Monsterid": "1",
      "MonsterName": "Slime",
      "MonsterRace": "Demon",
      "MonsterLV": 2,
      "MonsterHP": 12,
      "MonsterATK": 4,
      "MonsterDEF": 4,
      "MonsterDEX": 4,
      "MonsterGold": 44,
      "MonsterEXP": 18,
      "ImageID": "1537867333",
      "ImageFileType": "png",
      "AttackType": [
        {
          "AttackTypeName": "magic_attack",
          "CD": "2",
          "FileType": "gif"
        }
      ]
    }
  ],
  {
    "Monsterid": "1",
    "MonsterName": "Slime",

```

(b) The "Monster" found

Figure 3. JSON-based data package sent from/to between main game and the PvE subsystem.

In order to prevent the data package from the interception and modified by the end user or any hacker, the PvE subsystem will also send a CRC (Cyclic Redundancy Check) code together with monster information. The code is generated by encrypting the data package with public-key cryptography. The subsystem will adopt SHA1 algorithm to get the hash code of the data package before apply public-key cryptography.

Once MEGA World receives the monster information and the CRC code, it will redirect student's browser to the PvE battlefield and forward the monster information, CRC code, student's information in JSON string and a hash value of the student's information got through SHA1 algorithm.

The PvE battlefield will decrypt the CRC code and get the hash value for the received monster information with SHA1 to compare two the two hash values to check whether or not the monster information has been modified by others. Also, the battlefield will do the same thing for the received player's information to check whether or not the player's information has been modified.

When the battle between the student and monster(s) is over, the PvE battlefield will send the battle result information once again in JSON format (see Figure 4) as well as a CRC code back to MEGA World. Similarly, the CRC code is generated based on the hash value of the data package with SHA1 algorithm and public-key cryptography.

```
{
  "PlayerID":412,
  "RemainHP":250,
  "RemainMana":50,
  "RewardGold":300,
  "RewardEXP":60,
  "Items":[
    {
      "item_guid":"2e08a600aa5a2cd7259a5c965287af43",
      "item_amount":1
    },
    {
      "item_guid":"41292110bad3cc10d510400b41196a7f",
      "item_amount":1
    }
  ],
  "DropItems":[
    {
      "item_id":"201120001",
      "item_amount":1
    },
    {
      "item_id":"201120001",
      "item_amount":1
    }
  ]
}
```

Figure 4. JSON-based data package of the battle result sent from PvE subsystem.

4. Prototype of the PvE Subsystem

There are five areas in the gaming field as Figure 5a shows, including information area, display area, health bar, game play area and action area. The information area is on the top of the gaming field which shows the student's information include attacking power, defending power, and dexterity. The display area shows the background image and the monsters' image and information like monsters' name, health and cool down time for next attack as well as all the attacking animations. To help the student to identify his/her avatar's remaining health, there is a health bar below to the display area. The health bar decreases when the avatar is hit by monsters. The student will do the most of operations at the game play area, including choosing different attack types of attacks, answering assessment questions and

using the items in his or her bag. The action area contains three different action options include attack, use item and escape.

There are two game modes in the PvE subsystem: regular fighting mode and assessment question mode. At the beginning of the game, the game play area shows the items the student has and he or she needs to choose three different types of armors to protect his or her avatar and three different levels of weapons to trigger the three different levels of attacks. After the student has chosen the equipment, the game starts.

In the normal fighting mode, game play area shows three attack options: easy attack, normal attack and hard attack, each one represents one weapon that the student just chose. There are damages and accuracy for an attack option and the higher attack level option will have lower accuracy. Figure 5b shows the prototype of the gaming field. The student can choose one of the monsters shown in the display area as the target by clicking on the image of the monster and then choose an attack option to trigger the attack. The display area will show the animation for the attack that the student chose if the attack is successful taken.



(a) basic layout



(b) prototype

Figure 5. The layout and prototype of gaming field in the regular fighting mode

On the other hand, the game play area also shows three different attack options in the assessment question mode. Figure 6 shows that the game play area has the assessment question whose difficulty is depending on the level of the attack option the student chose. The student needs to answer the question in a limited time correctly to trigger the attack, and the attack will absolutely hit the monster – which means 100% accuracy rate for correct answer in the assessment question mode.

The student can use an item in the bag before choosing the attack option by clicking the “use item” option in the action area to see all of the items he or she has in the game play area. After the student chooses the item he or she wants to use, he or she can go back to the attack options by clicking the “attack” option in the action area. If the student encounters the monsters that are too strong or the student wants to skip the fight, he or she can choose “escape” option in the action area that has the successful rate of escaping shown on it.

After the student chooses to attack or escape (but the escape action is failed), the round ends and the cool down timers for attacking that the monsters have decrease. When a monster’s cool down timer becomes zero, the monster attacks the student’s avatar to cause damages and reset its cool down timer. The game ends when the student’s health points become zero or all the monsters are defeated. The

student can earn the award items, gold and experience points if he or she wins the battle. On the other hand, there will be gold deduction if the student loses the battle.

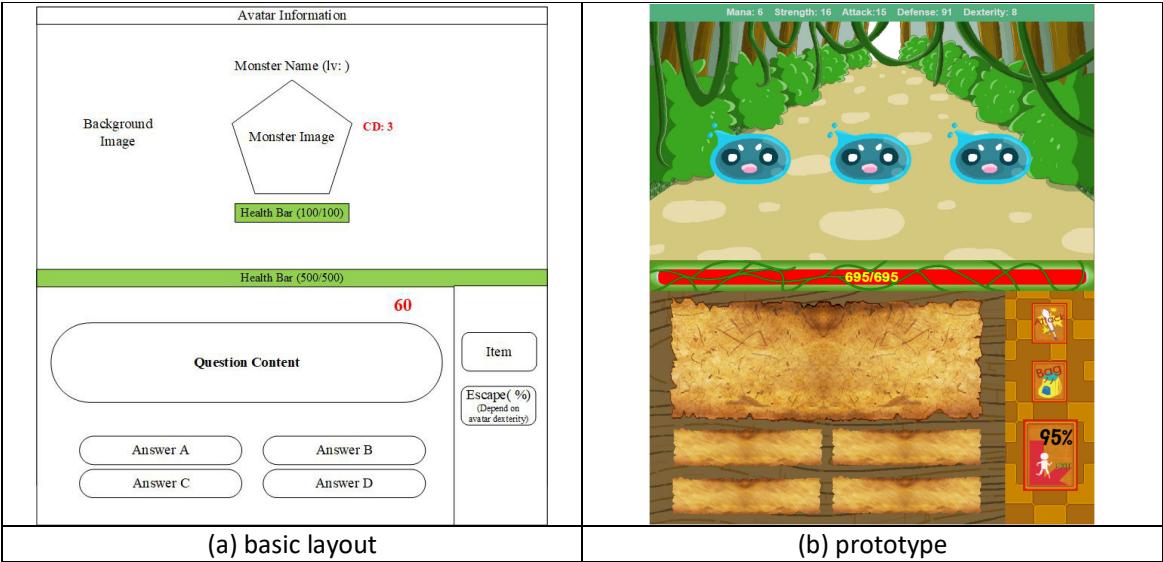


Figure 6. The layout and prototype of gaming field in the question assessment mode.

5. Evaluation Plan

In order to evaluate the effectiveness of the PvE subgame designed and developed in this research and verify the hypothesis “the farming feature in the educational role-playing game can enhance student’s performance and motivation,” this research plans to recruit undergraduate students who enroll Java programming course and separate them into four groups to conduct a full semester experiment. The first group is the control group which will not play any educational game; the second group will play MEGA World with the PvE subsystem that only uses the regular fighting mode; the third group will also play the game with the PvE subsystem that only uses the assessment question model; and the fourth group will play the game with the subsystem that uses both of the two game modes randomly.

At the beginning of the semester, the students will be asked to fill out a pre-questionnaire that is asking for their attitude in terms of playing games and their gaming experience as well as their learning motivation towards the course. During the semester, the students will need to play the game after the class to review the learning content each week. The course instructor will record the students’ progress in the game, including their avatar’s current level, experience points and gold at the end of each week. There will be several quizzes delivered to the students in the class from time to time in the semester and the instructor will also record their performances of every quiz, midterm exam and final exam.

At the end of the semester, the students will be asked to fill out a post-questionnaire that is asking their perceptions toward the use of educational game and their learning motivation towards the course. The research will use SPSS to verify the reliability and validity of the questionnaires and their collected data as well as use *t*-test to analyze and compare the collected data.

The expected results include the PvE subsystem that we design and develop can improve students’ learning motivation and performance. Moreover the mixed of regular fighting and question assessment mode can have the significant differences in terms of making students have more learning motivations and better learning performance. The research team also expect to see both of the gaming experience and students’ attitudes toward computer games won’t make any difference.

6. Conclusion

There are many evidences show that using educational game to assist learning is an innovative and effective way to improve the students’ learning performance and motivation. In this research, we propose an extend module of MEGA World called Player versus Environment (PvE) subsystem. This subsystem allows student to encounter and fight against with the monsters and earn the rewards by

defeating the monsters. The student can use the knowledge he or she has learnt from the class to defeat the monsters. In order to evaluate the system's effectiveness and verify the research hypotheses, the research designs a semester-long experiment with four groups of students who enroll the undergraduate level Java programming course. However, this research still has limitations. Since we expect to find out the relations between the PvE subsystem and students' learning motivation, we cannot force the students to play the game. The cooperation of the course instructor and the students are very crucial for this research.

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