The Study and Modification of Open Source Game-Based Learning Engines with the Development of Game-Based Learning Prototypes for Higher Education

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1) Introduction

Research findings on future trends of e-Learning by both local and international educational technologists show that content of e-Learning should promote learner participation and provide them with control over their own learning. Game-based learning is one such mode of learning which makes learning fun by employing the concept of edutainment. At present, MMORPG (Massive Multiplayer Online Role-playing Game) games are tremendously popular and the main feature of these games is a virtual world setting in which multiple players can join simultaneously to exchange knowledge and experience. This feature is considered well suited to the construction of games promoting learning. It is anticipated that players (learners) who learn through game-based learning can gain understanding of the contents while simultaneously developing various learning skills, including intercommunication skills (Cuban, 1986; Prensky, 2001).

The Information Technology Service Center, Chiang Mai University has been interested in developing game prototypes and a game engine with a focus on modification of open source engines to make it user-friendly. The study resulted in both a game-based learning/open source system that is appropriate for use by beginning game developers as well as for on-line MMORPG English language learning games for university students. The pilot test found that the contents of the game match the topics stated in the course syllabus. Players (learners) are able to understand the content of the game with ease and find the game interesting and fun making the learning experience both educational and entertaining.

2) Objectives

1) To study and further develop the open source game-based learning engine
2) To develop a game-based learning prototype for university learning
3) To set guidelines for game developers for on-line games creation through the use of open source engines for game developers.

3) Concepts related to game-based Learning

The design of game-based learning was based on the following conceptual frameworks (Malone, 1981; Thanomporn Laohajaratsang, 2000):

- **Major characteristics of game-based learning.** When designing game-based learning, the developers have to take major characteristics of game-based learning into thorough consideration including goals, rules, competition, challenge, fantasy, safety, and entertainment.

- **Theories related to the design of game-based learning.** The designers of game-based learning need to apply the design principles different from those employed when designing other types of e-Learning. One of the most prominent theories related to the design of game-based learning is the Motivational Theory proposed by

Malone which involves challenge, curiosity, fantasy, and control.

4) Research Procedures

4.1.) Study and select popular open source engines used for game-based learning development and compare their strong and weak points, then choose the most appropriate engine for game-based learning.

4.2) Further develop the open source game-based learning engine chosen. The focus is to develop an engine that makes the creation of games easier for game developers by adding a user-friendly library that consists of the following:

- Use of the mouse to control actions in the games
- Control of game characters with control buttons
- Creation of a power bar in the game and the transfer of power
- Text or number display
- Creation of tools for the games such as a menu, scroll bar, check box
- Tools for debugging the program
- Application of visuals and sounds for use in the game

4.3) Design the storyboards involving the themes that will be used as the game scenarios. The themes that have been selected must be present in the dialogues and interactions between the players or characters and NPC (Non Player Character) to get prizes or items that the characters need.

4.4) Design the games that can be used through the Internet.

4.5) Design graphics for the games, namely maps, scenes, player characters and non player characters as well as monsters.

4.6) Write a set of commands and develop a game-based learning prototype to get the story moving, set game rules and conditions according to the storyboards that have been designed.

4.7) Test and make adjustments based on feedback from a sample group of no fewer than 50 subjects to analyze the suitability and the effectiveness of the application of the game as university level English learning media.

5) Results of the Study

1) The study to select an open source system for game based learning and a list of engines to further develop the engine was part of the project to study game-based leaning engines and to develop a game-based learning prototype for university education. From the study, the Irrlicht engine was chosen as the most appropriate for the purpose.The Irrlicht engine is an open source graphics engine that is popular among professional game developers worldwide. It comprises a set of commands that helps manage computer resources in creating 3-D games. A survey showed that 83.78% of programming languages used in developing games is C++, which the Irrlicht engine uses (See Table 1 below). Moreover, among all the surveyed engines, the Irrlicht engine can best support game developers in several ways (See Table 2 below). Therefore, when compared to other open source game engines used at present, the Irrlicht engine is considered most appropriate for developing MMORPG games and 3-D games. It can also be used with other 3-D game engines.

Table 1: Comparison of programming languages used in developing games by the number of usage

Application or programming language for development	Number of usage	Percentage
C#	22	8.49
C / Visual C++	217	83.78
Java	15	5.79
Delphi / Visual Delphi	22	8.49
Pascal	16	6.18
Basic	10	3.86
Visual Basic 6	10	3.86
Visual Basic.NET	13	5.02

Table 2: Comparison of open source game engines by supporting capabilities

Supporting Capabilities	Open Source Game Engines							
	ORGE	**Irrlicht**	**Nevrax LIbrary**	**Revolu-tion 3D**	**HAAF**	**CDX**	**Crytal Space**	**Nebula Device**
Level of developers								
Beginner		*x*		*x*	*x*	*x*		
Intermediate		*x*	*x*	*x*		*x*	*x*	*x*
Professional	*x*		*x*				*x*	*x*
2D Graphic Support								
Building game character support	*x*	*x*	*x*	*x*	*x*	*x*	*x*	
MMORPG support		*x*	*x*			*x*		*x*
Supporting Capabilities	**Open Source Game Engines**							
	ORGE	**Irrlicht**	**Nevrax LIbrary**	**Revolu-tion 3D**	**HAAF**	**CDX**	**Crytal Space**	**Nebula Device**
3D Graphic Support								
Terrain(background graphic) building support	*x*	*x*	*x*		*x*	*x*	*x*	*x*
Terrain building tools	*x*	*x*					*x*	*x*
3D graphic import support		*x*		*x*				*x*
Graphic user interface tools		*x*	*x*	*x*				*x*
Modification Support								
Use of the mouse to control actions in the games	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
Creation of a power bar in the game and the transfer of power	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
Text or number display	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
Creation of tools for the games such as a menu, scroll bar, check box	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*
Tools for debugging the program		*x*				*x*	*x*	
Application of visuals and sounds for use in the game	*x*	*x*	*x*	*x*	*x*	*x*	*x*	*x*

The further development of open source software for game-based learning has resulted in a library of tools (source code) that can be used to develop the game following the set requirements. The trial showed that the set of tools was effective in developing the game-based learning prototype.

3) The content used in the game development is a university level English course. The content chosen (Pre-intermediate & Intermediate Reading) is suited for use in MMORPG games. (See the Appendix 1 for the details of the Content) The game is a combination of academic content and game situations which makes it both entertaining and educational to the learners who had to take the following steps:

- Analyze the situations in the game, answer the Quest questions and destroy the enemies in the game to increase their power level in various areas
- Learn the Reading skills (Pre-intermediate & Intermediate levels) and pass the test in each sub-module.
- pass the test in each sub-module.

Figure 1: The Game-Based Learning Prototype "Eternal Story"

4) The game developed allows concurrent multi-players within the same virtual world on a large scale computer network (here = the Internet). For this reason, the development of this type of game requires the following components:

- Game-Server: receives and compiles requests from Game-Clients such as requests for the information of the characters in the database, and shows the results to the Game-Client.
- Database: stores important information within the game such as character information.

The development of the above system requires the following:

1) A Game-Server system using Microsoft Direct X version 8. The software has basic functions that can be used in developing a MMORPG Game-Server effectively, namely the function that enables concurrent compilation of Game-Client's requests from multiple machines, and the function that enables the sending of compilation results to multiple Game-Clients on different machines at the same time.

2) A Database system using MySQL version 5 that works effectively with C++ language program. There is also MySQL++ software that is especially designed for C++. MySQL is the database system that is widely used on various websites and other programs in use today, making it easy to connect with other game components. For instance, a game membership application website can be created using one of the languages such as PHP, using the same database as that of the Game-Server. In addition, MySQL is capable of handling over 100,000 records which is suitable for the development of MMORPG games. It is also capable to handling a large amount of information coming in at the same time.

3) Graphic Design of maps, scenes, non-player characters and monsters has to be appropriate in terms of file size-that is, the file size must not be too large and the features of each character must not be too detailed as this will affect the information transfer between Server and Client.

4) The job of creating the set of commands and of game development is divided into various parts and different teams are in charge

of the development of different parts as follows:

- The Client part comprises various parts namely:

- The game's main structure that is used in receiving and sending information to and from the Server

  - The control of the characters in the game

  - The visual and audio features of the game

  - The controls in the game such as the menu and control keys

5) The test is conducted by use of questionnaires on 3 groups of subjects namely:

The results can be concluded as follows:

The questionnaire results show that the content contained in the game matches the content requirements specified in the course syllabus while the game storyline is easy to follow. The game itself is interesting, making the learning process entertaining as well as educational.

One additional suggestion is that the game should provide clear instructions for learners who are not game players. Although experienced game-playing students have no difficulty understanding the game system, the students that do not have much exposure have problems in following the story line to a certain extent.

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7) Appendix

Appendix A: Details of Contents

The content used in the game development is a university level English course. The topics of the contents are listed as follows:

1.1) References

1.2) Topic

1.3) Main idea

1.4) Skimming

1.5) Scanning

1.6) Context clues

1.7) Word analysis

1.8) Organization of text

1.9) Supporting details

1.10) Using dictionary

1.11) Making inference

1.12) Identifying fact and opinion

1.13) Transition words