

Developing an Interactive Video Game-Based Learning Environment

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Abstract—With advanced computer and network technologies of nowadays, learners could benefit from well-developed distance learning systems for obtaining vast learning content, as well as performing learning exercises at anytime anywhere. However, to attract learners and to keep them active would be difficult in those content-based learning systems. One possible solution is to include some motivator factors in the online learning activities. Gaming could be considered as sort of learning. It also features in attraction and motivation. Thus, more and more researches are interested in developing game-oriented learning models and related game-based learning systems to attract learners during such learning activities. In this paper, we would like to combine the video-based course materials and game elements with an integrated learning platform called “V-GBL” environment. Course designers could easily design GBL courses and learners could enjoy their learning activities in the serious adventure game world.

Index Terms—VGBL, SCORM, authoring tool, interactive video, curriculum design

I. INTRODUCTION

Due to the advanced computer and network technologies, games have more and more special functions or capacities to attract the players' attention. Some statistic data showed that, the total sales of games were around 18 billion dollars in the U.S. The revenues is about 9.5 billion dollars in 2007 and continually grew by 17 percent from 2003-2006.[1] This data reveals an undoubted fact, and that is, games are more and more

popular. Gaming behavior is one of the learning activities in human's learning mode. Gamers will learn something in gaming phase naturally. Game also has a special attraction for them to keep continue their gaming phase. They have to solve all things themselves in game world. So, they have to learn all techniques, rules and related knowledge in order to keep them alive. Many researchers are interested in this issue and they have point out that if we could put the learning content in game world appositely, it will be helpful for improving learner's learning efficiency. But there are some problems when developing such kinds of learning environment. The first problem is hardly to edit such kind of course content. The instructor has to know a lot of designing rule in order to edit such kind of course content. So, the instructor has to cooperate with environment designer to do the game course content design. The Second problem is how to provide the efficient game course data management. How to manage the game course file and related data transmission to reduce the server's loading is the most important thing that to make the system could run in stable status. The third problem is that most GBL systems did not provide effective course evaluation and assessment rule for learners to help them to do their learning activities as well. Due to this reason, we would like to propose the V-GBL environment and related tools which follow the SCORM standard to solve above problems. The V-GBL system could run on Multiple Gaming Platforms such like PC (Personal Computer) and PPC (Packet PC). According to the V-GBL system, we try

to achieve the following objectives. First, course editors could easily use the interactive video authoring tool to develop the interactive video course materials. The course editors could collect all related course films over the internet and they could easily utilize the interactive video authoring tool to design the similar game play situation with simple puzzle game mode by using option, text input box and 2D graphic drag-and-drop elements. At last, these contents could easily combine into game environment by adventure game map authoring tool. Second, learners could collaborate with other people to do their learning activities in adventure game world. Third, V-GBL learning system could estimate the learner's learning status and give the learner feedback to them according to the teacher's assessment rules setting in adventure game environment.

II. RELATED WORKS

Many researchers have focused on designing the framework, architecture and related standards to build up practicable distance learning systems. Such as Sharable Content Object Reference Model (SCORM) [2] and IMS Simple Sequence Specification [3] and so on. As a result, instructors are able to use these specifications for their learning materials. And these kinds of courses and learner's related information will be managed by Learning Management System (LMS). The responsibility of LMS system is to manage the learning course materials and learner's learning process. Most distance learning systems have been reached maturity and followed by these system architecture and standards. There are more and more researches are interested in thinking about how to redesign the learning system present style and to attract people in order to use them and enjoy them. They found that the gaming behavior is one of the learning activities in human's learning mode. Gamers will learn something in gaming phase naturally. Games also attract gamers to keep continuing the gaming phase for a long time. From the perspective of game play behaviors, Prensky, M. [4] illustrated why game elements could be attractive to player as below.

- Game provides some degree for enjoyment.
- Game has playing mode corresponding with game type.
- Game has an obvious and significant goal.
- Game has an interactive mode.
- Game provides the gaming feedback and the related result.
- Game designing could be suitable for player.
- Game has winning reward.
- Game has conflict, competition, challenge and opposition factors.
- Game has a pilot with problem solving.
- Game has a character of narrative.

Merill, et al [5] mentioned that game have four necessary properties as follows:

- Learners are not forced to play game.
- Learners could have fun in the gaming phase.

- Games have clear and definite goal and playing rules.
- Games have competition and challenge essential factors.

In addition, Bramucci [6] stated the basic learning behavior and learning mode with game play environment. He indicated that the game should provide the enjoyment to attract the player's attention. Keri Facer [7] claimed that a game could be a continuous activity or a simulation in real life. Games have some characters, for instance, the enjoyment and the independence. All of these characters were quite different from traditional instructional activities. For this reason, to utilize the interaction provided in game will strengthen the learning motivation and problem solving ability of the learner. Many scholars have the same standpoints that to utilize the computer game development mode will lead to a better learning effect. Brownfield and Vik [8] proposed that the game play could increase the learner's reading, listening, speaking and writing ability. Wood and Stewart [9] proposed that game could increase the learner's logic thinking ability. Therefore, Ravenscroft's [10] research has focused on that the elements in physics which could be utilized in the game play environment. According to this research, the authors found that to utilize the concept of the game play learning. Kennedy, R. S. et al. [11] proposed that "Game play is a form of presentation in order to do the learning assessment", the learner has to solve the problems in the gaming mode in order to achieve the objective of the game. Ang Chee Siang and Radha Krishna Rao [12] proposed the concepts of game teaching mode, learning and mental philosophy, and game design techniques. In mental philosophy, they mentioned some learning theories, such as the behavioral learning theory, operant conditioning, cognitive learning theory and motivation theory. In the game design techniques, they explained and discussed some important elements which game designer have to take care, for example, the learner's learning condition in the realistic gaming environment, the linking of learner's thinking and learning status, and the learner's varied mood. We could found some direction and related GBL learning model in order to integrate them when developing our proposed the V-GBL environment.

III. V-GBL ENVIRONMENT

3.1 V-GBL Environment Architecture

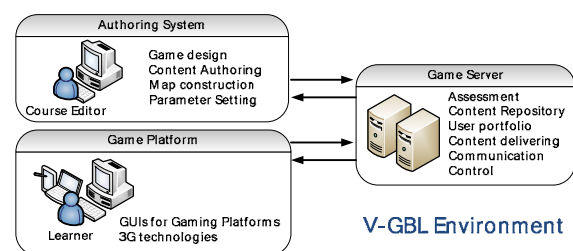


Figure 1. V-GBL environment

Figure 1 shows an overview of various learning platforms in V-GBL environment. In this V-GBL environment, it could provide the service to the various platforms (like the PC, Pocket PC) in client, Learners or course editors could utilize wireless or normal network to get connected with the V-GBL system environment and enjoy their learning activities or editing operations. The V-GBL system could cooperate with LMS in order to get the related course materials, course information and learners' learning portfolio according to the learners' learning status. As illustrated in Figure 2, the sub system of server will be described as follows:

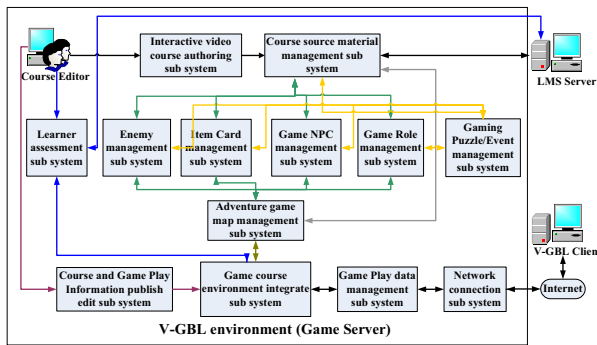


Figure 2. V-GBL system flow (Server)

- Interactive video course authoring sub system: It's responsible for course authoring interface, related editing functionalities and to produce the interactive video course content files.
- Course source material management sub system: It's responsible for integrating the game elements which processed by Enemy management sub system, Item Card management sub system, Game Role management sub system and game play Puzzle/Event management sub system and interactive video course materials with SCORM standard which processed by Interactive video course authoring sub system and integrating them in one game course content package. At last, this game course content package could send back to the LMS side in order to manage.
- Learning assessment sub system: It's responsible for producing the course assessment rule to course editor in order to fit them into the adventure game content.
- Adventure game map management sub system: It's responsible for integrating the related game elements into adventure game content and managing the game runtime loading.
- Game course environment integrated sub system: It's responsible for integrating the adventure game content and related assessment rule.
- Course and game information publish sub system: It's responsible for publishing the related information about the related game or course news.
- Game play data management sub system: It's responsible for processing the related game course package and data sending management.

- Network connection sub system: It's responsible for selecting the corresponding connection network and coordinating with client side.

As illustrated in Figure 3, the sub system of client will be described as follows:

- Game course environment integrates sub system: It's responsible for doing the game course content package unzip and presenting them in adventure game environment.
- Game Play data management sub system: It's responsible for processing the related game course package which from the server side and data sending management.
- Game environment GUI sub system: It's responsible for providing the game environment interface which designed by course editor.
- Network connection sub system: It's responsible for selecting the connection mode and coordinating with server side.

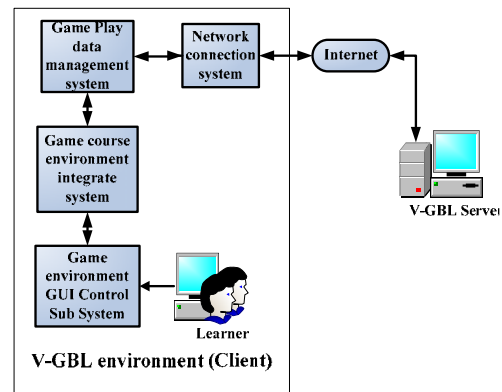


Figure 3. V-GBL system flow (Client)

3.2 V-GBL Adventure Game Content Design

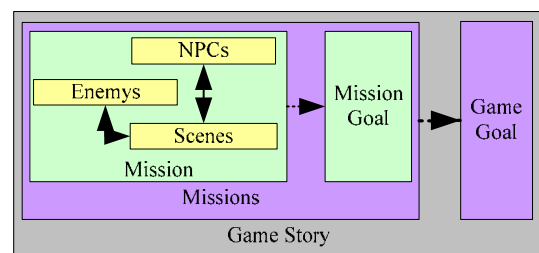


Figure 4. Basic elements of Adventure game

The adventure game style has the advantage which could be easily to embed and to provide the problem-based learning environment which combined with situated learning strategy in order to attract learners to enjoy their learning activities. Figure 4 shows the basic elements of the adventure game. In this game style, gamers should finish all game missions which follow the directions of game story. In game play phase, players have to follow scenes of game story and to interact with NPCs (Non Player Character) in particular scene in order to get useful hints and related information to help them to finish duties of current scene in order to help them get

into the next scene. So, when designing the game content, we could consider the problem-based learning strategy and to put it in designing the game story and its workflow. We also could consider the situated learning strategy and to put it in designing game scenes and its workflow of particular mission.

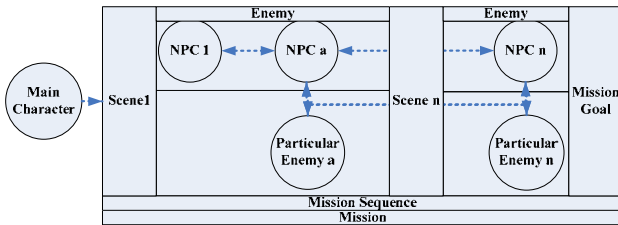


Figure 5. V-GBL game mission workflow

Figure 5 shows the V-GBL game mission workflow. The game mission will be divided into two parts. They are main mission and sub mission. Basic elements of main mission are NPCs, enemies and interaction scenes. Related interactions of them will be followed by story sequence which is made by course editor or game map auto generator. Basic elements of sub mission will be the same as main mission. The sub mission will be triggered by the particular NPC in main mission. The combination of sub missions and main missions could produce more complex game story in order to attract learners and to let them pay more attention and to take long period time on doing their gaming activities.

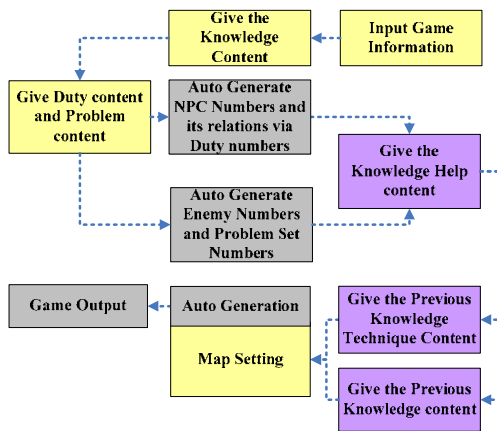


Figure 6.(a) V-GBL game content design workflow

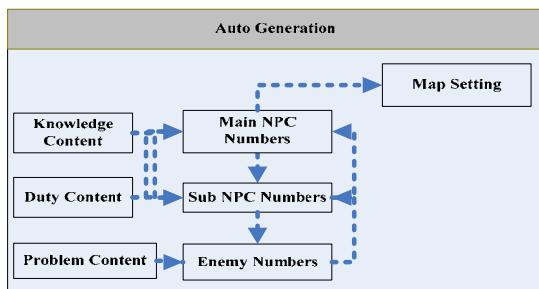


Figure 6.(b) Properties and related Setting of Game Map which produced by auto generator

Figure 6(a) and Figure 6(b) show the V-GBL game content design workflow. While designing the course content, instructors have to point out and try to give the

related course knowledge content. Then they could continue to give related course content and assessment questions. And the game map auto generator could create game NPC/missions and related puzzles event by using these materials. In middle editing phase, the course editor could give or ignore the knowledge help content, prior knowledge technique content and prior knowledge content. These contents could be transformed into the helpful content to provide the basic knowledge of manipulations and hints to keep alive in the game world. At last, related game map data will be generated by the game map auto generator and output the game package files.

Figure 7 shows the guilder of V-GBL game content authoring tool. The course editor only has to give related assessment content and learning content and puts these contents to the basic game elements by drag and drop mode. The guilder will make them into related basic game elements of NPCs, enemies and interaction scenes. When finishing the game course editing phase, it could generate the sharable game course content package which is based on SCORM standard automatically. Figure 8 shows the whole related dataset of game course content package.

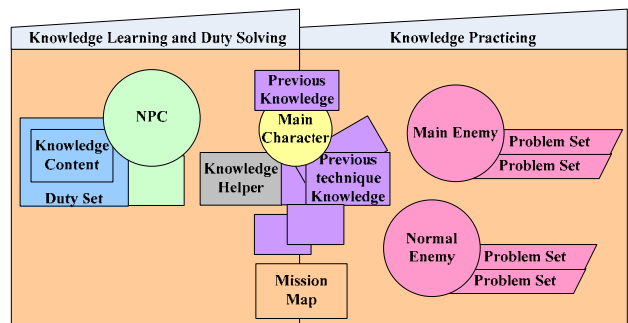


Figure 7. The guilder of V-GBL game content authoring tool

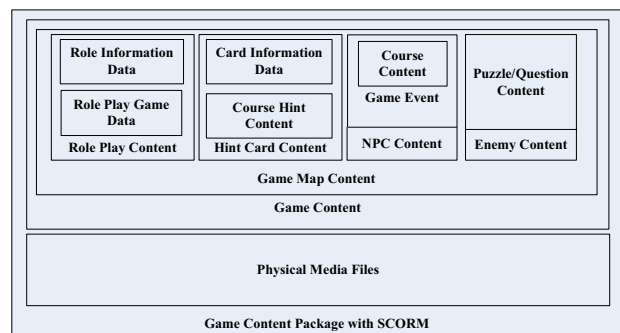


Figure 8. V-GBL course content package with SCORM standard

3.3 The Concept of V-GBL Environment

In the V-GBL system environment, learners could cooperate with other learners to adventure in this game environment. About the quantity of numbers, we limited the max numbers of cooperation learners to 4, to reduce the game server's loading. Learners have to solve some problems by interacting with mission or NPC which is based on interactive video scene in order to keep continued in the adventure video game world. When playing game, learners could get into enemy battle phase and try

to affect and defect enemies' attributes by completing the puzzles. When finishing this battle phase, learners could get rewards and experience which could increase the role's abilities.

In terms of creating the V-GBL learning game environment, there are composed of five parts.

- Game Lobby
- Comic Room
- Adventure Room
- Hint Card Store
- Learning Status Searching Room

In the game lobby, learners could make discussing about the game course with other learners in this area. Figure 9 shows relations between comic room, adventure room, hint card store and learning status searching room. In the comic room, they could learn the prior knowledge and operating skill of the course section by way of comic-based interactive video course content. The comic-based interactive video course provides an easy way to read and review the prior knowledge. After finishing the learning phase from particular course section, they could get the course section key. Then they could use the section key to get into adventure room and to select the related gaming environment and complete game course missions. When they start playing the game, they will meet some related NPCs and try to interact with them in order to trigger and to solve all game puzzles or tasks of related game missions. In some particular situations (Ex: In enemy battle phase), they could use the hint cards bought from the item card store to increase their survival rate in the enemy battle phase. After finishing the battle phase, learners could get some specific rewards (Ex: experience, gold and the reputation) to increase their roles abilities. After the game missions finished, they could leave the adventure room to the item card store and buy extra hint cards to help the learner in next gaming phase. In the learning status searching room, learners could search particular learner's learning and gaming status by using the keyword search function.

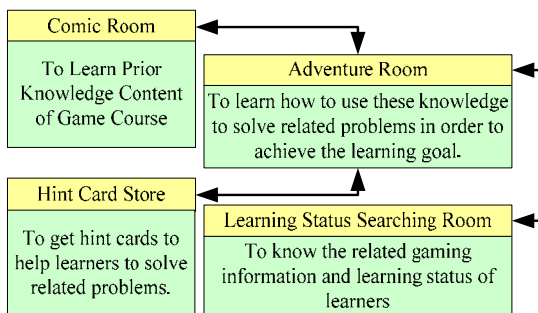


Figure 9. Relations between related rooms in V-GBL system

3.4 The Implementation of V-GBL Environment

Figure 10 (a) shows the interface of game lobby. Learners could use message box to talk to others and select specific the game mission in this place. In the adventure learner list, the learner could see other learners in this area and to observe other learners' role status, item

cards information and a part of learning status. In Figure 10 (b), as clicking the status option, the detailed information about this role's ability would be shown, such as clicking on the item option, the detailed information (Ex: item card name, its functionalities and descriptions of game course hint) of the item cards will be available.

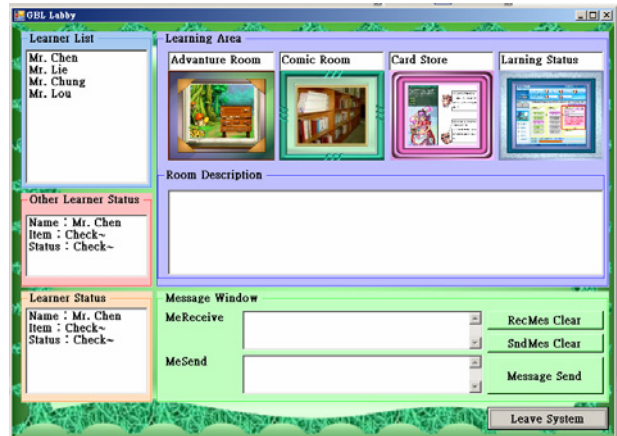


Figure 10(a). Game lobby interface

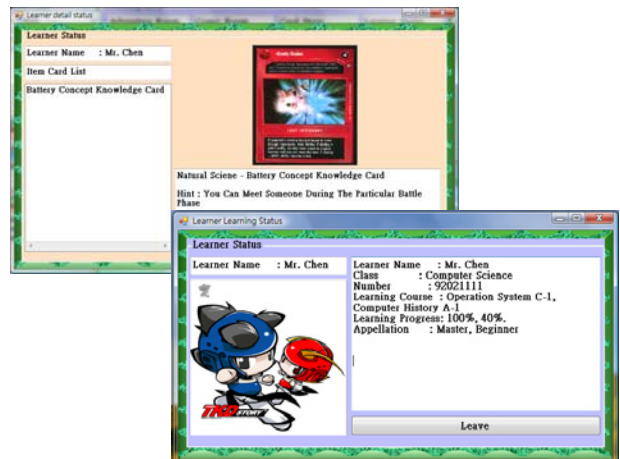


Figure 10(b). Hint card and role information interface

Figure 11 shows that the learner could select the particular course chapter and get start their learning activities in comic room. After finishing this prior knowledge learning phase, he could get into the adventure room to keep on his gaming activities. In adventure game room, he could initial the adventure game world made by course editor or to join other game worlds made by other learners. After finishing the Prior preparing phase, he could start to enjoy his gaming activities.

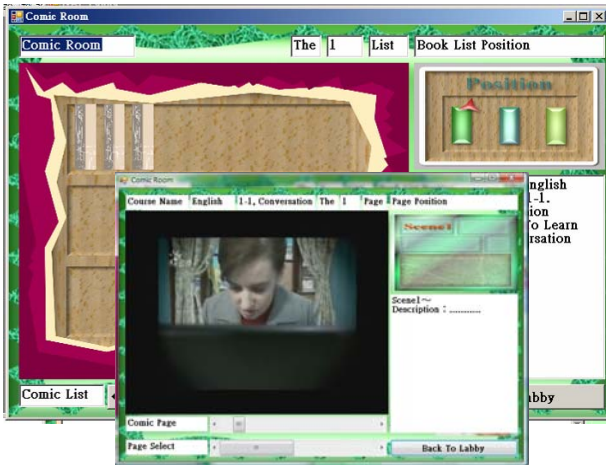


Figure 11. Prior knowledge area interface

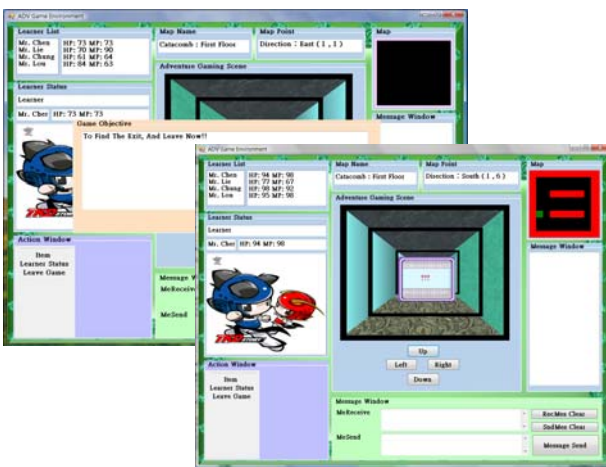


Figure 12. Adventure Game Environment

Figure 12 shows the workflow when team members get into the game world. They will see the game objective firstly according to the map area or other conditions. The team members should try to find the related NPCs or mission event trigger points and to solve all missions in the game world. Figure 13 shows the enemy battle phase in the game map. Meanwhile learners could see some quizzes behind the enemy. When the quizzed solved, the abilities of the particular enemy could be reduced. So, they could easily to win the battle phase in this turn. When they meet the mission event trigger point, they have to make decisions and to solve the related puzzle quiz during mission phase. We propose three types of puzzle quiz, and they are option, text input and 2D graphic drag-and-drop mode. Figure 14 shows that the team members try to select the answer, there will show the game course hint based on interactive video to remind the learners' prior knowledge learned. Of course, after referring to the hint video, the option might be changed due to the particular time point in order to generate the adaptive gaming quiz and let them pay attention on solving these puzzle quiz. When they finished these puzzle quiz, they could get some key items in order to continue this game. Finally, they will get rewards, such as the virtual money, role experience, and etc., after finishing the adventure gaming phase.

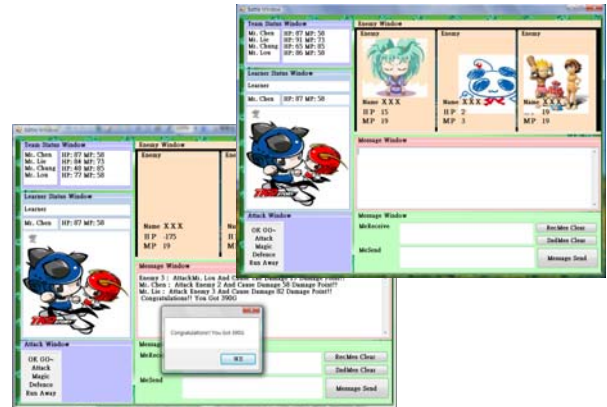


Figure 13. Enemy battle phase

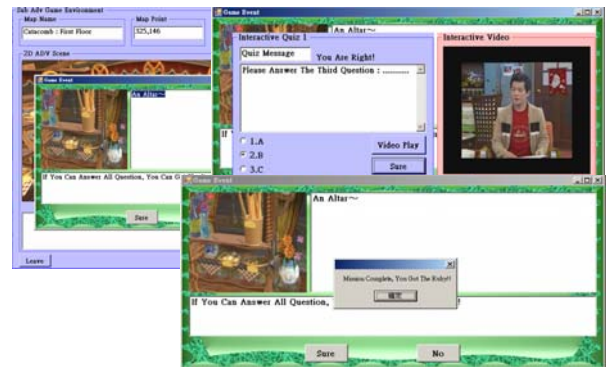


Figure 14. Game puzzle quiz interface

When the adventure gaming phase ended, the learners may get into the card store (see Figure 15(a)) to buy some hint cards for further sub missions, or to get another game course hint to pass the follow-up missions. Eventually the learner could search for personal or group learning result by performing a keyword-based search from the learning Status list form (see Figure 15(b)).

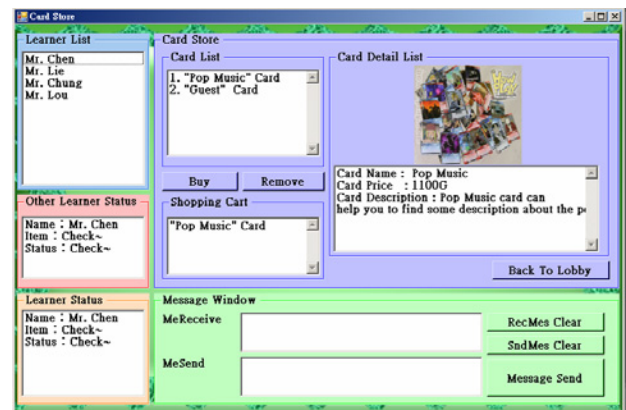


Figure 15(a). Card store interface

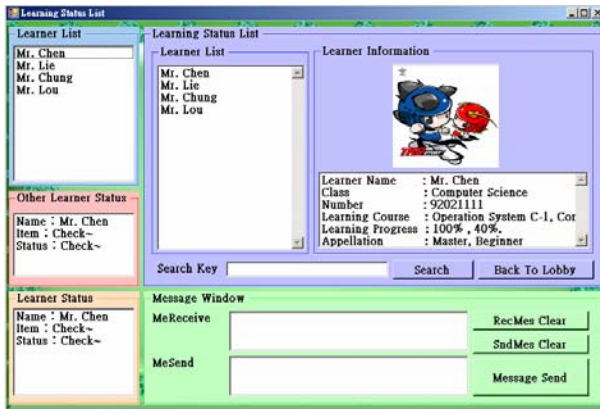


Figure 15(b). Learning status searching room

IV. CONCLUSION AND FUTURE WORKS

In this paper, we proposed an interactive Video Game-Based Learning environment. We have introduced the environment architecture, game course content package and related development workflow. Course editor could easily generate the V-GBL learning materials, such as interactive video course, game materials and game environment, by drag-and-drop operation with the authoring guilder and game map auto-generator. We also implemented the V-GBL system and gave an example to illustrate the system workflow. By using our proposed V-GBL system, learners could benefit from efficient learning activities, and the attractive learning content embedded with problem solving strategy. The utility rate of this learning system and learners' learning competency could be both improved. The future direction of our V-GBL environment aims at including multiple gaming sub systems to enrich the interactive models during the learning activities with various gaming behavior.

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