

Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Game-Learning for Primary Education

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Abstract: - For general teachers, in order to product digital teaching games more in line with the teaching theory and principles, the *Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Modular Scenario Design of Game-Learning for Primary Education* is proposed. This designed RPG learning games are based on the structure of primary curriculum courses according to the Vertical Curricular Organization method. By the completed modular digital games, in addition to be easy for changing the module game units, the information of individual system user such as the learning situations, the degree of understanding, the accuracy of problem solving can be storage into the RFID tag. Through the RFID system and the game central servers, the information of individual user can be exchanged between different computers. Users can connect to the learning-game system any where any time for the continued learning. In addition, the continuous assessment for teachers or directors can be enhanced. Furthermore, the primary students can learn advanced courses themselves by playing the advanced scenarios of the game-learning even without the assistant of teachers. The verification and experiment results show that the teaching performance is obviously outstanding.

Key-Words: Education Theory, RFID, Game-Learning, Modular Scenario Design, Vertical Curricular Organization

1 Introduction

Today, considering the tide of education and the interest of students, different entertainment and multimedia are integrated into e-learning. Many scholars have pointed out that digital games can enhance learning motivation [4]. Comparing with traditional classroom teaching, learning games can enhance and promote the interest in primary education.

Due to being interested in playing games, players may develop their abilities to solve the problems or stages of mission [1]. In other words, players have the motion to find and learn the method for obtaining the solution of the mission [2, 3]. Therefore, education theory based computer games are suggested to be the learning media or middleware to promote the interest in primary education [8].

Until now, most of the learning games provide the functions or Q&A types of learning for players. These games cannot provide further teaching content or any advance class for players to learn the content or knowledge unlearned. Based on Q&A, the learning games should be strict and inflexible with the teaching content. The players may lose interest in learning with conservative way which is just transformed paper content into digital content. In

other words, many researches or games only integrated the education content into the digital learning games just for browse or narration review. It also means that the advance learning potential of students may be hindered since the games are only for education content review without guidance learning design of advance courses. Based on the curriculum vertical organization principles which include: learning (1) from simple to complex; (2) from familiar with to not familiar with; (3) from concrete to abstract; (4) from whole to part; (5) from the past to now; (6) precondition study first; (7) concept association method, the game-learning that doesn't use the Q&A type of learning is proposed [8].

In addition to the design type of games, the way to create and maintain the learning game, and differentiate individual user for educational continuous assessment are also an important issue. Since the game-learning should provide not only courses review but also advanced courses guidance, the game designer has to adaptively divide the teaching content into several sub-sets of teaching content. However, generally speaking, a teacher who understands the education theory and procedure may not have the ability to create a digital learning game with animation or multimedia. In other words, to create a game with

animation or multimedia for education learning corresponded to education theory is difficult [8]. Therefore, in this paper, the *Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Game-Learning for Primary Education* is proposed. The proposed design scheme based on research in [8] in this paper includes modular creating procedure based on the education theory. Each section of the whole education course can be designed as a game branch or scenario of the whole learning game.

However, during the learning, the continuous assessment for individual student is important. Based on the security and unique, the learning should not be counterfeited or completed by other people that may cause the estimation of individual student wrong. Considering the management and continuous assessment corresponding to individual student, RFID technology is included in this paper.

Radio Frequency identification (RFID) is the popular wireless induction system [5-7]. RFID consist of Tag, Reader, Antenna [5-7]. Each RFID tag with a unique ID (UID) which records the on demand information can be used as the individual identification. When an independent RFID tag approaches the RFID antenna, the induction between RFID tag and antenna happens. The RFID antenna reads the information and content recorded in the tag. Then the information is translated into the computational data by the RFID reader. Figure 1 presents the concept of RFID operation.



Figure 1. The concept of RFID operation.

Due to the portable RFID tag and untouched data transmission, many local or small area wireless applications for track and trace based on RFID systems were proposed. Today, RFID technology is embedded into many applications of student ID cards. In other words, based on the existed student RFID ID-card, the proposed system can cost down and separate individual learner with effective continuous assessment. Moreover, the RFID can provide security [6] for each user.

According to the proposed *Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Game-Learning for Primary Education*, the main contributions are:

- 1) Based on *Education Theory and Vertical Curricular Organization Based with Individual*

RFID Integrated Game-Learning for Primary Education and research in [18], game-learning designers can follow a standardized and modular scenario or branch creation procedure of game-learning based on the education theory.

- 2) Each game-learning user can be identified. The information and playing progress can be recorded individually. In other words, the individual continuous assessment of game-learning player can be enhanced. In addition, since the learning progress is digital and can be stored in database, the teacher or director can observe the ability and potential of individual student,

- 3) Different and independent game units or sections are created according to the proposed creation procedure and can be integrated into one larger game platform. Furthermore, due to the utilizing of RFID, the information of each game player can be drawn out and recorded into the individual RFID ID-card. In other words, after each individual playing or learning, the designed game can be initialized for the next player. The cost of the learning game maintenance can be reduced.

- 4) The learning game is easy for use. Even a primary student with finite IT knowledge can play the learning game. In addition, according to the designed way and the principle of vertical curricular organization, the interest in playing of each player can be enhanced and kept. The player can change and influence unobtrusively and imperceptibly in further learning. The player or student who has the potentiality can be found.

The remainder of this paper is organized as follows. In Section 2, the proposed standardized and modular game-learning procedure of *Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Game-Learning for Primary Education* corresponding to the education contents and courses is introduced. Section 3 presents the integration of game-learning system and RFID. The real verifications and implementations are shown in Section 4. At last, the conclusion is given in Section 5.

2 *Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Game-Learning for Primary Education*

Since the game-learning has many advantages [8], to adaptively design the game-learning, the mission or solution of each designed game branch or scenario should be corresponding to the objective of education content. In [8], the game designer should follow five parts corresponding to education theory:

1. Demarcate students' initial ability.
2. Teaching content or material.
3. Real teaching action or activity

4. Evaluation.
5. Reward.

Figure 2 presents the procedure and structure of designing the learning game corresponding to educational teaching procedure. *Act* indicates the education content translated into the content or story of the game. Some procedures of educational teaching procedure overlap the same step of game design procedure.

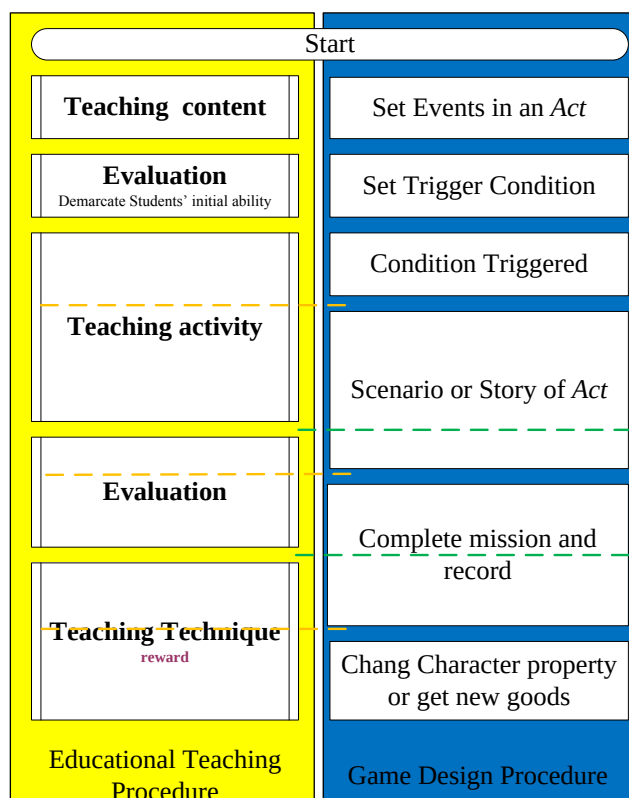


Figure 2. Design flow and structure corresponding to educational teaching procedure

In each act, several events can be constructed and the trigger conditions will be set first. The events in the game-learning are based on the materials of educational teaching content. For example, the event can be a game-document or game-object which indicates or represent the educational teaching content such as a paint or mathematical function. The trigger conditions can be designed depending on the players' level, ability. In other words, the trigger conditions are the same as the educational demarcation of students' initial ability before starting teaching. Game players should make the main characters which represent themselves fit in with the trigger condition. Then, the events, *Act*, or partition of the game story can be started. In other words, each partial game can be a sub-mission of training for the player's character the same as the training for students. In addition, if a player wants to complete the mission (partial-game or partial story), some on demand conditions of the mission should be achieved which is the same as the evaluation of teaching. Hence, every partial-game can not only trains but also evaluates the character in the e-learning game mission.

Based on the vertical curriculum organization and game playing process, each partial game or *Act* should be corresponding to the principles which are which include: learning (1) from simple to complex; (2) from familiar with to not familiar with; (3) from concrete to abstract; (4) from whole to part; (5) from the past to now; (6) precondition study first; (7) concept association method. Thus, players could progress the game step by step without frustration and depression. Furthermore, the potentiality of individual player or learner can be brought out. Figure 3 shows the integration of vertical curriculum organization principles and game designing.

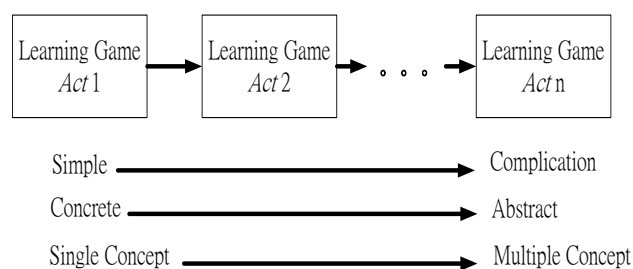


Figure 3. The integration of vertical curriculum organization principles and game designing

When a player starts the proposed learning game, the domain or category of the game should be manually selected first. Then, according to the level of the player's character, only the suitable games or stories can be triggered. The e-learning game evaluates the player according to the past records. If the on demand conditions of mission completion cannot be satisfied, it means that the player fails to finish or incomplete the current mission. Otherwise, there will be some rewards for the player such as character level upgrade, new or finite items obtaining, etc. At the same time, the current information and continuous assessment can be updated.

Corresponding to the game playing flow, after a student chooses a course which similar to a player select the game category, this student should be evaluated first that the course is suitable or not. Only when the player or student fits the on demand requirements can start the game.

The teaching events will be given to the student step by step according to education theory: 1) give rise to student's motivation. Then, 2) the student will be given a goal of this course similar to the on demand mission completion conditions of the game. 3) A student will be trained, taught, and examined. 4) Only when the student passes the examination which is similar to the player satisfying the mission conditions of the game, the student can be identified as one who possesses the knowledge of this course. Then, students could keep learning by this way again. Figure 4 shows the playing flow correspondent to each teaching flow which is defined in the education theory. In other words, each *Act* of learning game designed according to the proposed procedure in this paper follows the education theory.

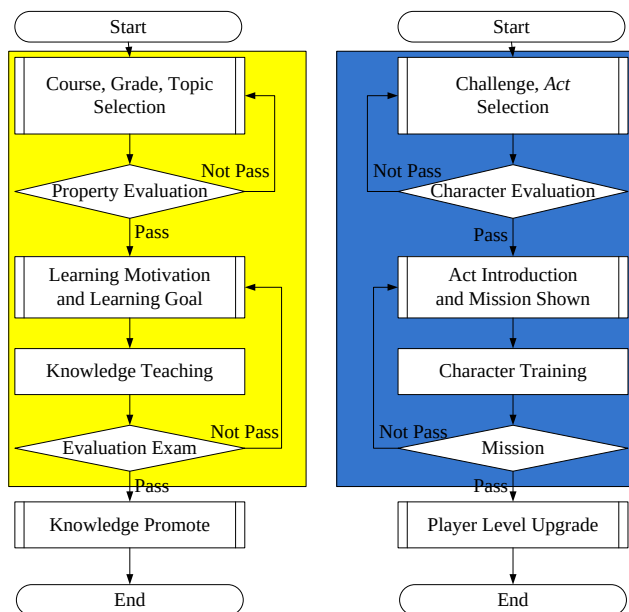


Figure 4. Playing flow corresponding to teaching flow

3 Integration of game-learning system and RFID

Since the RFID systems today are popular and ripe for distinguishing individual target [5-7], the unique characteristic or identification of RFID can be the solution for the continuous assessment of individual system user. When an independent RFID tag approaches the RFID antenna, the induction between RFID tag and antenna happens. The information and content recorded in the tag is transmitted to the RFID antenna and translated into the computational data. Following up the data translation, the tag recognition can be completed and related applications are provided.

Based on RFID, when the user wants to start the proposed learning games, the user has to provide the RFID card (RFID tag) for identification. All the information of the individual user is recorded in the database and RFID tag. After recognizing the RFID user (whether password needed or not), the learning characteristics and parameters of the user recorded in the RFID tag can be transmitted to the learning game server. The user information management can set the information and parameters from RFID tag into the individual RPG game. Furthermore, the current information and characteristics of individual user can be managed by the user information management procedure. The learning game server is the platform for executing the designed education game. In this paper, since different Acts can be integrated as one RPG game, the designed RPG game can be executed as an application or procedure. In other words, different users accessing to the game server can obtain the same and initialized RPG game procedure. Figure 5 shows the structure of the proposed *Education Theory and Vertical Curricular*

Organization Based with Individual RFID Integrated Game-Learning.

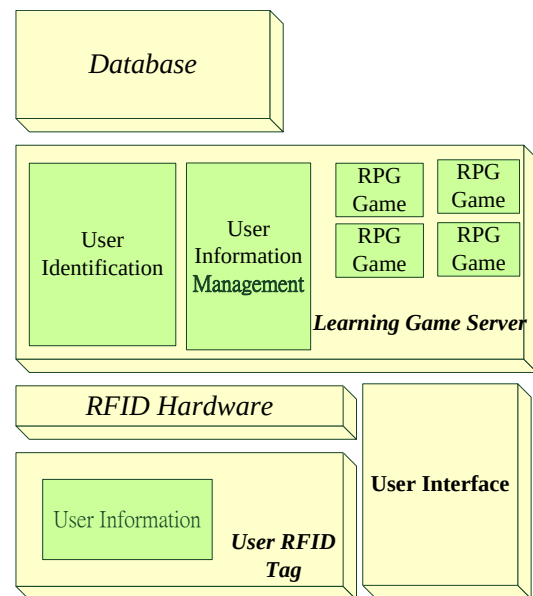


Figure 5. The Structure of the proposed system.

In addition, when the player finishes a mission or wants to quit the RPG learning game, the information, characteristics, and current rate of progress should be recorded. Therefore, every time the player stops using the RPG game, the current learning state of individual user should be recorded. Based on the design of the RPG game, there are two events that the system should trigger the user information management for data recording: 1) user finishes a mission; 2) user manually saves the game or quits the game. In the first, since the playing flow provides the choices for going on challenge, no matter user chooses yes or no, the learning game system automatically triggers the user information management. The current information of the player can be recorded. In other words, after a user finishes a mission, the information and characteristics of the player will be updated. In the second event, the game provides the selection list for saving and quitting, a player who selects either saving game or quitting game will trigger the user information management. Due to that the learning progress even without finish may cause the characteristics of the player different from the mission beginning, the information of each user has to be updated. Then, the user information management procedure updates the information to database and to the RFID tag of player. Figure 6 presents the flow of information updating.

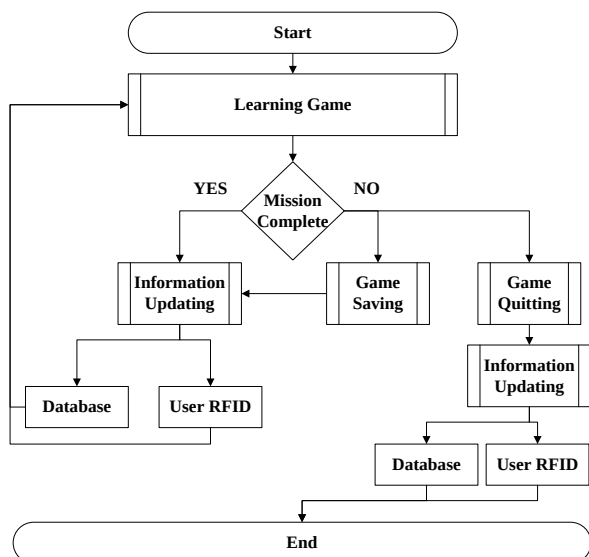


Figure 6 presents the flow of information updating.

4 The Real Verifications and Implementations

In this paper, a game designing tool, RPG maker XP, is selected to design the game which represents the teaching course in primary school. Four main activities: rectangle, parallelogram, triangle, and trapezoid, are implemented as the Acts (game missions) for primary students. Based on the vertical curriculum organization, the four learning games should be connected according to the priority. The first game unit is rectangle. The second is the parallelogram. Then, triangle is the third plot. And trapezoid is the last one. In this paper, all primary students for real verification doesn't have the basic knowledge of the teaching content. Only when a student's properties or characteristics are fitted in with the on demand condition, the next game mission with higher lever which indicates more complexity or more multiple concepts can be triggered. In other words, the properties of individual student may be the lowest requirement of the new Act (game mission). Thus, a student (game player) could play and learn the game step by step.

To enhance the convenience of RFID using, appropriate RFID systems and deployments is important. The frequency of RFID system used can be classified as LF (low frequency, 125~134KHz), HF (high frequency, 13.56 MHz), and UHF (ultra high frequency, 915MHz). Furthermore, there are different antenna sizes of the RFID systems. Due to the power and size of RFID antenna, the induction distance between antenna and tag changes. To serve for normal user and keep the security of RFID induction, the HF system with limited power for on demand induction distance can be a good solution. Figure 7 presents the RFID system used in this paper. The RFID reader and antenna are both embedded in the box with USB connection.



Figure 7. The RFID system; (a) RFID reader and antenna, (b) RFID tag

In the implemented game of the proposed *Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Game-Learning for Primary Education*, the student will play a virtual role for the game mission processing. Only the appearance of each virtual role between different users (player) in each RPG game is the same. Different game missions are playable corresponding to the abilities and characteristics of individual user. Figure 8 shows the shoot of the game. Every player will begin at the same entrance. Based on the evaluation results of individual user, the suitable game missions can be triggered.



Figure 8. The shoot of the game.

The experiment result is shown as Table 1 where M is the average (mean), S is the value of root-mean-square, F indicates the statistical degree of freedom, p indicates the statistical significant, and t is the statistical t value. The achievement test is based on four subjects: rectangle, parallelogram, triangle, and trapezoid in this paper and verification. Every student has twice paper-exam for testing the acknowledgement of problem solving. Pre-test exam is given before the primary student playing the proposed *Education Theory and Vertical Curricular Organization Based learning game*. In opposite, the post-test exam is given after each student playing the designed game for 40 minutes. By using SPSS statistic application, the problem solving abilities of students are obviously improved ($p < .05$). In other words, via playing the designed game, the students indeed learn the skill or acknowledgement to solve the problems in paper-exam.

Table 1. Statistical experiment result of difference

between pre-test and post-test

Subject	<i>M</i>	<i>S</i>	<i>t</i>	<i>F</i>	<i>p</i>
rectangle	-0.67	1.38	-3.70	57	.000
parallelogram	-0.88	1.41	-4.73	57	.000
triangle	-0.51	1.21	-3.23	57	.002
trapezoid	-1.38	1.63	-6.44	57	.000

5 Conclusion

In this paper, *Education Theory and Vertical Curricular Organization Based with Individual RFID Integrated Game-Learning for Primary Education* is proposed to provide a learning game based on education theory and vertical curricular organization with individual RFID integrated. Each game-learning user can be identified. The information and playing progress can be recorded individually in database and RFID. The learning game is easy for use. Even a primary student with finite IT knowledge can play the learning game. The experimental result also shows that students actually learn the teaching content from the designed game and have obvious progress in the test. Besides, based on RFID, the individual continuous assessment to each student can be enhanced.

REFERENCES

- [1] Marc Prensky, 2001 Digital Game-Based Learning
- [2] Bowmaw, R.F.(1982). A Pac-Man theory of motivation: Tactical implications for classroom instruction. *Educational Technology*, 22(9), pp. 14-17.
- [3] Braccy, G.W. (1992). The bright future of integrated learning system. *Educational Technology*, 32(9), pp. 60-62.
- [4] Randel, J. M., B. A. Morris, C. D. Wetzel, and B. V. Whitehill (1992). The Effectiveness of Games for Educational Purposes: A Review of Recent Research. *Simulation & Gaming* Vol. 23, No. 3, pp. 261-276
- [5] Ming-Shen Jian, Chau-Chen Wu, and Ta Yuan Chou, "Environmental Affection Based RFID Potential Bio-Disease Tracking/Tracing System," *WSEAS Transactions on Systems*, Vol. 10, Issue 2, pp.38-48, 2011.
- [6] M.-S. Jian, Ta Yuan Chou, and Shu Hui Hsu, "RFID Encryption/Decryption Technology Aided Multimedia and Data Intellectual Property Protection," *WSEAS Trans. on Communications*, Vol. 8, Issue 7, pp. 734-743, Jul. 2009.
- [7] Ming-Shen Jian, Long-Yeu Chung, Kuen Shiuh Yang, Chang-Hua Lien, and Yi-You Hou, "Dual RFID Module based Medical Management System with Existed Gate System Integration," *International Journal of Control Theory and Applications*, vol. 2, pp.27-37, Jun. 2009.
- [8] Shu-Hui Hsu and M.-S. Jian, "Digital and Modular Design Scheme based on education theory in RPG Learning Game," *Proc. ICACT'09*, pp.1733-1737, Feb. 2009.