Design and Implementation of Serious Games in Computer Curriculum for Self-regulated Learning

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Abstract

This study is to design and implement computer curriculum serious games with game-like elements added to induce students' interest in learning contents so that they can effectively perform learning about computer subject. Differentiated from the existing edu-games, this study applied serious games for the purpose of helping students obtain the learning effect while having fun playing games, and made it possible for learners to perform self-regulated learning in design and implementation. Besides, by making these serious games clearly different from the existing common electronic games, this study implemented a flash game, a kind of serious game, possible for students use in learning the computer subject and used it for G-learning and M-learning as well. With the design reused, it is possible to implement an application, even through various mediums, such as smart phones. The implemented serious games have merits to be reused for learning contents and learning UCC video clips and to be used in various different ways through editing, depending on the learners' learning goals as well.

Keywords: *self-regulated learning, serious games, re-engineering.*

1. Introduction

In an information society in which there is rapidly more information in terms of quantity and more advanced information in terms of quality, learners need to promote their self-regulated learning ability to judge, select and acquire information in a proactive, aggressive stance, transform the information they accepted and apply it to practice [1]. In addition, schools and institutions have consistently repeated research on the substantiality of e-learning contents and the methods of active application [2].

The integration phase of e-learning service is a period in which efforts were made to secure the effectiveness and efficiency of e-learning with the collapse of the dot-com myth, and technical improvement and standardization developed and services developed by companies and universities. However, since 2007, the world has been securing ubiquitous infrastructure by steady development and investment in information technology. Learning by means of these ubiquitous technologies and environment is 'u-learning.' U-learning is not a teacher-driven type, but learners will lead it, and as real-time interaction is made possible, the participants and lectures will develop into mutual partnership. In addition, with the spread of Web 2.0, through one person media (blog etc.), it will develop into a model in which learners participate in e-learning service directly and indirectly [3].

In online games, also, continued mission fulfilment of the games reduces repulsion to learning failure, can give a feedback about immediate results, and performing missions as a team and a community can naturally cultivate collaboration and communication skills. For this reason, e-learning services using games are attempted and global market research agency, Gartner forecasts that in 2011, games will stand out as an important factor of corporate training solutions [4].

Linear books as educational media are logical and may effectively be used to describe a conscious part. And yet, there is no better tool than game to learn patterns, repeat them through a direct experience, and

imprint in the brain. Learning and game are similar in that they have various feedback systems. According to Koster (2005), a good game is 'one that teaches the player everything until he or she quits it' [3]. Apart from cognitivism that educational media 'this world exists outside the learners', he aims at constructivism that 'knowledge is formed by creating a meaning to an individual's experience.' Game elements are a factor that cannot be ignored in the students' repetition through virtual participation and acquisition according to that.

A serious game refers to one that has newly constructed contents and story lines for particular purposes such as indirect experiences, secondary social learning and information delivery in the areas of education, public sector, medical treatment and simulation as its entertainment functions; e.g. Nintendo DS Brain Training and NHN Hanja Maru. In foreign countries, creativity-based games such as Free Rice to solve famine and Evoke, a social network game to help do world changing venture business have been developed, which are played by a computer, and optimized for a mobile phone, so the media were implemented reflecting the social environment by reflecting the preference of media in certain areas. Recently, in addition to treatment for the brain game for the elderly with dementia, a movement to seek for solutions to social issues such as environment, poverty and race integrated into a game also comes to the fore.

Previously, games simply containing educational factors emerged intermittently while recently, to that extent which a neologism, 'G-learning' appears, cases of direct applications of games to learning are increasing. Innately, games in which concentration acts strongly evolves to training customized for students. The reasons why serious games are introduced to educational contents are: first, learners accept them without repulsion. They are naturally 'motivated' through the games' fun and reward structures. Also, the games' various technical characteristics are free for the implementation of the intents the learners want.

The Ministry of Culture, Sports and Tourism decided to use online games in regular school education since 2009, and serious games have been in use for actual education, so their various developments are necessary. In addition, the current instructional software developed by metropolitan and provincial offices of education or civil sectors and teaching-learning data built in Edu-net, usually aim at major subjects such as Korean, English and Mathematics, and it is very difficult to find data learners can use for subject learning by the nature of the computer subject belonging to elective courses. As a need to develop instructional software on various subjects comes to the fore, in computer education, such problems are being raised on an ongoing basis. Therefore, this study designs serious games with part of the middle school computer subject as learning contents, implements them to use for G-learning and further designs M-learning through developing apps by reusing the design. In the design and implementation of the games, controlling and regulating learners' own learning process for optimization, this study applied appropriate learning strategies to achieve the learning goals and realize self-regulated learning.

This study is an inquiry into the design and implementation of serious games for the computer subject learning adding game elements to educational contents for arousing the learners' interest so as to perform learning contents about the use of the computer effectively. The subjects of learning were middle school students, and the curriculum was the implementation of serious games for computer subject learning only in part of 'Humans and Computer' in computer subject of the 7th National Curriculum, which has a limitation to generalize and apply to all subjects. In addition, it was implemented for some units in computer subject, so there is a limitation to apply that to all units.

2. Theoretical background

2.1. Self-regulated Learning

Self-regulated learning refers to a process in which learners themselves understand learning needs, control and regulate learning process for optimization, and produce significant learning activities and results by applying appropriate learning strategies in order to achieve learning goals. Self-regulated learning allows learners to learn as active subjects and operate and perform effective learning process. In addition, in self-regulated learning, learners can improve their own learning ability through optional uses

of meta-cognitive, motivational and behavioral strategies and play a leading role in selecting and composing learning environment for their circumstances and selecting the quantity and form of learning [1].

2.2. Constructivism

Constructivist epistemology appeared as a new form of epistemology, pointing out problems such as oversimplification of learning in the existing system, objectified education view and delivery of simplified learning information and memorization-oriented learning method.

Constructivism continuously composes understanding of a given social phenomenon based on the individual's particular social experience and background by adding his or her personal cognitive actions. It was said that this results in knowledge. Thus, constructivism insists on appropriateness and applicability as corresponding concepts, instead of the concept of truth that objectivism mentions [5]. Like this, constructivism is closely related to learner-centered learning, and serious games have relevance like Table 1 if this learning model is considered from a structural perspective [6].

Table 1. Computer game learning using constructivist teaching-learning principle.

Constructivist teaching-learning characteristics		Use of computer game
Construction procedure Reflexive learning	⇨	Problem-solving through the game Learning and evaluation
Self-directed learning		Leading solution of game learning
Collaborative learning		Problem-solving through dialogue and discussion related to learning
Authentic task		Practical gaming activity related to learning contents
Teachers' role		Help and guide for teachers' and peers' learning

2.3. Edutainment

As every play having educational values in that it causes complex thought and action [7], this perception is the concept of edutainment.

2.4. Instructional Game as a Serious Game

A serious game refers to one containing enough game elements and a special purpose other than fun, usually one that has educational effect, healing effect and training effect. The area of serious games keeps expanding, but mainly depending on the purpose of the game, it is classified lie Table 3. Serious games mean those with game elements and various benefits and their range should be comprehensively defined as ones that are helpful for achievement and social dimension, considering the future growth potential, scalability and convertibility, rather than limiting their contents and formal dimension [8].

Table 2. Types of serious game (*2007 White Paper on Game*, Korea Development Institute for the Game Industry).

Classification	Fields and contents
Education	Edu-game: Language, knowledge, skills
Consciousness development	Psychological game: Mind game, Personality development game
Health	Health game: Health care and prevention
Treatment	Various kinds of therapy using virtual reality therapy, psychotherapy through mind games, rehabilitation, mental and physical recovery games
Similar serious games	Interactive leisure/sports, job simulation, military training, promotional game,

	training game

Table 3. Characteristic of serious game.

Classification	Characteristic
Surface	Provide fun as entertainment contents
Background	Game providing methodology that can perform a specific function
Contents	Cover socio-cultural functions such as education, medical science, military, politics, economics, public policy
Form	Include various platforms such as console, mobile, augmented reality, 2D/3D web-based virtual world

The above Table 3 shows the characteristics of serious games and in contrast, commercial games are process inferential on both surface and background pursuing fun factors only while instructional contents pursue result-oriented effects and functions on both surface and background.

3. Design of Serious Games of Computer Assembly

3.1. Direction of Design

The serious games proposed in this study were designed according to the procedure of Fig. 1.
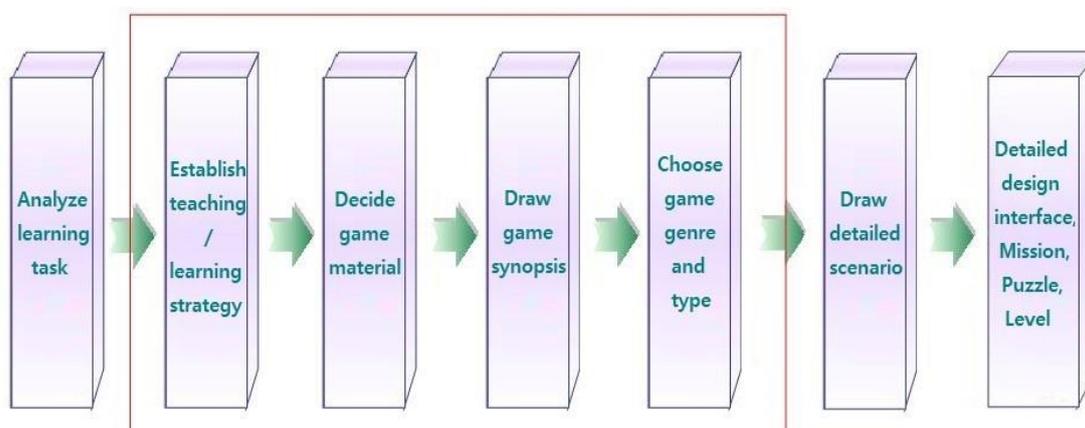

Figure 1. Design phase of instructional serious games (Korea Development Institute for the Game Industry, 2003).

3.1.1. Direction of Design

To implement serious games for middle school computer curriculum, this study considered the learners' characteristics for design as follows [9].

First, according to the formal operation theory of Piaget (1932), middle school students belong to early adolescence period, who are lacking abilities of combining and presenting systematically and clearly related factors.

Second, they need fun elements, but they need to concentrate on learning and repetitive feedback is necessary.

Third, they tend to focus on multi-media elements rather than texts.

3.1.2. Teaching-learning Strategy

First, the game's overall structure is formed by phase considering learners' cognitive characteristics, which is composed of sequential and proactive plots;

Second, it takes a form of serious game to arouse interest, which is composed to allow natural learning in an easy game method;

Third, the phase of the serious game for computer curriculum is formed sequentially for the level of the users' understanding, so that they understand the configuration of the real computer hardware and classify them by each device so as to cultivate the ability to assemble a computer;

Fourth, use actual images in the game to increase the understanding of the device and reduce reluctance to hardware;

Fifth, implement sub-games independently by each phase, so as to reuse them individually; and

Sixth, the implemented serious game for computer curriculum should complete learning goals.

3.1.3. Choose Learning Contents

In serious games, learners make decisions, so they can develop reading comprehension and thinking skills of a large amount of linguistic data. Carefully choose parts in which students are uninterested and which are hard to teach to implement an integrated learning game, so it is predicted that the interest is maintained while learning effect can be obtained, and these are reflected in choosing the learning contents and referring to Table 4 Middle school computer subject teaching process by unit, units that can have the greatest effect by serious games were chosen.

Table 4. Middle school computer subject teaching process by unit.

Unit Title	Teaching Process
Ⅰ. Humans and Computer	Theory-oriented Classes
Ⅱ. Basics of Computer	Use Hands-on of Windows Cloud OS
Ⅲ. Word Processing	Edit Various Hangul Documents
Ⅳ. PC Communication with Internet	Practice Website Creation
Ⅴ. Multimedia	Practice Power Point

Most units are taught in parallel with practices while "Unit I. Humans and Computer" is carried out by theory-driven lessons, which mostly consist of class contents related to the theory and hardware which students may find difficult.

Therefore, the design of serious games for computer curriculum was implemented by choosing Subunit, "What is Hardware?" the basic theory of computer in "Unit I. Humans and Computer" in the middle school computer curriculum.

This unit consists of types of functions of five devices of computer as major learning contents, the textbook and lesson plan were analyzed, elements that could help learning by implementing learning goals and contents into games were extracted to analyze learning elements, which were produced into flash games that would reflect these elements best. The games can be expanded to flash games and smart phone apps by the media, which can be developed programs optimized for the media. The missions and learning the contents of the developed games are like the following Table 5.

Table 5. Mission and learning the contents of the games.

Mission	Learning Contents	Game progress method and restriction
Mission 1 Classification of devices and Learning function	Input Devices	Drag and drop method Puzzle application
	Control and Storage Devices	Drag and drop method Puzzle application
	Output devices	Drag and drop method Puzzle application
Mission 2 Classification of System Devices	Classification of Computer System by Device	Drag and drop method Puzzle application
	Division of Primary Storage and Auxiliary Storage	
Mission 3 Assembling Main Board	To know the structure of main board and install parts in the right position	Drag and drop method Puzzle application

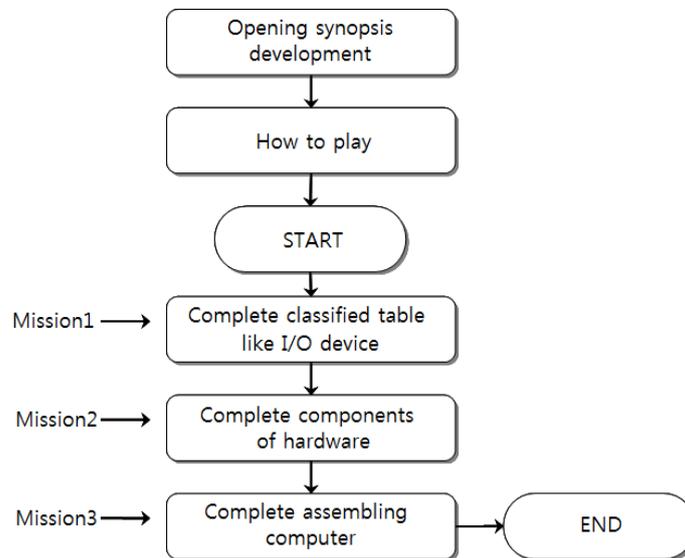### 3.1.4. Game Construction Plan by Learning Contents

Figure 2. Game construction plan by learning contents.

As shown in the above Fig. 2, the game is played sequentially by missions, and if a mission in each stage is completed, voice compensation, "Well done!" is given, and it was implemented to provide a simple user interface (UI) so that learners can get the maximum learning effect by immersing themselves in the serious game itself.

In addition, with sub-games under each mission, the appropriate amount of learning would be made, which was implemented so that the design of the games of each mission could independently be used and it was designed to use for learning contents, instructional UCC video clips and evaluation in the future.

With these design characteristics, learners can achieve significant learning by using various self-regulated learning strategies.

4. Implementation of Serious Games for Computer Assembly

4.1. Development and Operating Environment

For the design and implementation of the games, Flash 11 was used, which secured action scripts and for video processing and title production, Adobe Premiere CS5 was used. The environment of the implementation of the system is as follows:

Table 6. Environment of implementation of the system.

Classification		Specifications
S/W Environment	Operating System	Windows 7
	Web Browser	Internet Explorer 8.0
	Images and Animations	FLASH 9, Photoshop CS5.5
	Video Processing	Adobe Premiere Pro CS5
	Video Capture	Camtasia Recorder
H/W Environment	CPU	Pentium-4 2.4G or higher
	RAM	512MB or more
	HDD	40GB or more
	Monitor	17-inch or higher recommended
	Speaker	PC Speaker

4.2. Implementation of Game

In order to improve concentration along with motivation of learning about the games, subtitles were processed for a supplementary description of situations, how to play and status of the games. Between the games, games to motivate learning and missions to learn the contents in the main learning were presented in 3 stages.

Considering the characteristics of the subjects, middle school students, learning factors were reflected in the games so that they could maintain motivation and interest in learning and concentrate on the subject learning through consistent gaming method and interface, which are repetitive and easy

The games were designed so that the learners could learn the knowledge systematically and systematize and memorize that while they thought that they were simply enjoying them by providing a variety of visual and auditory information in the design part in various ways.

Mission 1 allows the learners to learn the functions of hardware components as well as learning the devices' names and classification of them by simple operations of the mouse.

Mission 2 allows them to systematize the classification of the hardware components and learn each function.

Mission 3 allows them to cultivate an ability to "assemble the computer" by assembling the hardware components they learned through previous games to the actual mother board by simple operations of the mouse.

Table 7. Game title and description of each stage.

Title	Learning hardware components
Introduction	1. Read the question, find an appropriate picture, drag and drop it with the mouse to complete the mission. 2. This is a game for all age groups to learn hardware pleasantly and learn how to assemble the computer.
Mission	Mission 1: Complete a classified table referring to the figure below.

	Mission 2: Complete a figure of hardware components.
	Mission 3: Install computer components to the mother board to assemble the computer.

4.3. Implementation Screen

4.3.1. Composition of Starting Screen

The implemented "Learning hardware components" game provides a user interface by which middle school students can easily understand and pleasantly play the game. In order to play the game on the starting screen, it provides with simple necessary information.

Figure 3. Game title and starting screen.

Fig. 3 shows the game title and the starting screen, and to play the game, a download link from which they could download the required software was put at the bottom, and a notice was posted so that they could receive the teacher's guide unless it was normally operated.

Figure 4. Description of how to play.

Like Fig. 4, the second screen shows descriptions of how to play. The game is one for all age groups, by which they can learn the names of hardware devices and how to assemble the computer main board. Read the questions presented on the screen at each phase of the game, find an appropriate picture and use the mouse to drag and drop it to complete the mission.

 was presented at the right upper part to inform the players of the progress of the game.

4.3.2. Implementation of Missions by Stage

Figure 5. Progress screen of Mission 1 Complete classified table of hardware.

Figure 6. Completion screen of Mission 1 Complete classified table of hardware.

Like the above figure, when you find all input devices and complete the classified table in the example, "Next" button appears at the bottom of the screen and a voice feedback, "Well done!" appears. In addition, different sound effects are provided when an inappropriate picture was chosen and the right answer was chosen.

The games implemented above are summarized as follows:
On Stage 1, the learners can learn the names and functions of the devices. They can learn the devices' names, functions and images naturally through the games. If the first phase mission is over, they can classify and understand input and output devices and control storage devices. In each sub-game on Stage 1, there will be the feedback, "Well done!" if the missions have been completed, and then they may proceed to the next stage. Stage 1 consists of 3 sub-games, and each sub-game is respectively to complete 1) classification of input devices; 2) classification of control storage devices; and 3) classification of output devices. Like this, through Stages 2 and 3 on each phase, they can understand input devices, output devices and storage devices naturally.

5. Conclusion

This study designed and implemented serious games for computer subject learning that adds game elements to arouse the players' interest in the educational contents in order to perform learning contents about the use of the computer effectively, practicing self-regulated learning. While an edu-game is designed to allow the player to get the learning effect enjoying it like playing a game, the serious game in this study is one that aims at learning by adding game elements to induce continuous learning and arouse the player's interest between learning and learning. The contents learned with the serious games are contents about the types and functions of hardware components. The implemented Flash game can be used for G-learning in the form of a game, and reused as learning contents and UCC video clips for learning. In addition, it has a merit that learners can use editing in various ways for their learning goals. Through app development by reusing the design, it can be used in smart phones. The implemented output was limited contents only according to design procedures set up in order to see the effectiveness of serious games. In the future, it will be used to cultivate creative/convergence talent in knowledge-based society through applying drag and drop, a unique playing method of the implemented output, enriching

game elements through various analyses and development and expansion to an app. Moreover, since there is a problem that existing serious games are too serious and learning effect can be doubled if it is fun, full of emotional factors such as passion, excitement and imagination, thus, close collaboration of experts in the field and the game designers is necessary.

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