An Adaptive Edutainment System for Learning Computer Operating Principles

Min Kyeong Cha[1], Ju Yeon Mun[1] and Seong Baeg Kim[1,1]

Department of Computer Education, College of Education, Jeju National University, Jeju, 690756, Republic of Korea
mkcha@jejunu.ac.kr, wnduszz1129@jejunu.ac.kr, sbkim@jejunu.ac.kr

Abstract

Recently, play learning becomes important and is emphasized as a useful tool. Thus, interest in edutainment contents is growing. Digitalstorytelling is considered first as a method that improves the transmission of information and draws a learner's interest when planning edutainment contents. In this study, we designed and implemented edutainment contents in the form of an adventure game that applies a digital storytelling method on both smart device and PC. The edutainment contents also provide questions and items to be constituted dynamically and the adaptive learning contents through analysis of the evaluation results. It allows learners to solve various questions through an effective iterative learning. We analyzed our edutainment contents implemented. As a result, we showed that the learners can reach a mastery learning on computer operating principle using our adaptive edutainment system.

Keywords: Digitalstorytelling, Edutainment, Mastery learning, Computer operating principle

1. Introduction

According to recent studies by educators and psychologists, play in learning has been emphasized. Also, the interest in edutainment contents of teachers, students, and parents is growing. In addition, with the development of information and communication technology in the 21st century, the development scale of educational content which is based on the computer is to be gradually increased and the paradigm of education is changing at the same time [1].

Edutainment storytelling is a method that can be first introduced when considering factors in edutainment learning. When one applies a story, the listener gains interest and transmission of information becomes easier. However, the story, as a means for providing educational content, is simply just an educational content itself, which is different from edutainment storytelling. New information and personal information of inmates' context, socio-cultural context, and experiential context created by well-connected stories of the trainees acquire the information and knowledge to be able to accept and makes an interesting [2]. It produces a synergistic effect for the portions about superficial theme along with the internal purpose. The advantage in the method of storytelling is that learning and awareness are very obtainable. In the edutainment storytelling, it is important to transmit the knowledge through storytelling with narrative based on the interaction and get it dissolved with learner's experiences [3, 4].

In addition, storytelling techniques include appropriateness, images, and originality. Therefore, the properties in entertainment storytelling can be transformed based on the

different contents by the learners [5]. Therefore, edutainment storytelling can be different from the roles and functions in response to a target [6].

Therefore, we will develop an edutainment contents utilizing the techniques of storytelling for learning the principle of operating a computer, based on our previous study [15]. Unlike the existing contents that provide learning contents with one-dimensional techniques, we will provide learning contents that are customized to each learner through a dynamic rate control system. Thus, it is possible to reach mastery learning through enhancing interest and achievement with increased interaction.

2. Background

2.1. Edutainment

Edutainment is a compound word that consists of 'education' and 'entertainment'. It focuses on educational games to draw and interest and immersion [7]. The purpose of edutainment is to draw the attention of the learners by providing a game format such as an animation. McKenzie defines 'technotainment' as technology and entertainment. It means that it relies largely on technology [8, 9]. There were studies on edutainment using an educational game or simulation [16, 17].

2.2. Storytelling

Storytelling is a means for sharing and interpreting experiences. Stories are universal in that they can bridge cultural, linguistic, and age-related divides. Storytelling can be adaptive for all ages leaving out notions of age segregation [9]. Storytelling can be used as a method to teach ethics, values, and cultural norms and differences [10]. Learning is most effective when it takes place in social environments that provide authentic social cues about how knowledge is to be applied. Stories provide a tool to transfer knowledge in a social context [11].

2.3. Mastery Learning

There is a school of thought that presumes all children can learn if they are provided with the appropriate learning conditions. Learning for mastery or mastery learning, are terms coined by Benjamin Bloom in 1968 and 1971 respectively. Bloom hypothesized that a classroom with a mastery learning focus as opposed to the traditional form of instruction would reduce the achievement gaps between varying groups of students [13]. In mastery learning, "the students are helped to master each learning unit before proceeding to a more advanced learning task" in contrast to "conventional instruction" [12].

3. Methods

3.1. Storyboard

In order to organize and visualize specifically the scenario of learning contents, we made a story board as shown in Table 1. The storyboard indicates a scenario, animations, graphics, sounds, and programs of learning contents.

Table 1. Storyboard

Scenario	Long time ago, wise king of Tando called ENIAC lived. He made a ripper with the eight scholars in order to protect the Tando kingdom. However, there was a group of people who tried to use the ripper for evil purposes. The eight scholars and the ENIAC king hid the ripper to protect him. Then, after displaying on the map, the position of the ripper was divided into nine parts. Later, story of the ripper became a legend. One day, the evil king called the creeper in the virus kingdom caused a war to conquer the Tando kingdom. UNIVAC who is king of Tando made an expedition to find the ripper to protect the Tando kingdom on the basis of the legend.
Animation	▪ Thumbing through the pages of a book ▪ Islands appearing ▪ Displaying the current section ▪ Movement of the ship ▪ Showing learning contents ▪ Learner obtaining items ▪ Increase or decrease of points
Graphics	▪ Background images ▪ Navigation map ▪ Ship ▪ Item (parrot, telescope, compass) ▪ Person who tells learner learning contents ▪ Points
Sounds	▪ Background music ▪ Thumbing through the pages of a book ▪ Movement of the ship ▪ Learning start & end ▪ Learner obtaining items
Programs	▪ Flash ▪ Photoshop ▪ Blender

3.2 Learning flow chart

A learning flow chart as shown in Figure 1 explains the relationship by dividing the order of process. After each section is complete, learners must solve the five questions in that section, then, checks if the learner is in section 8 or not. If the learner is not in section 8, move on the next step. If current section is 8, the points are confirmed and obtained from the evaluation. If the learner scored more than 90 points, that means the learner had achieved the learning completely and contents would be terminated. However, if the score is lower than 90 points, learners will repeat learning.
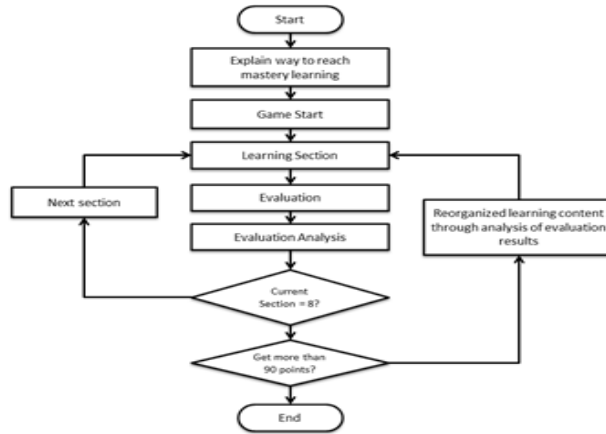
Figure 1. Learning Flow Chart

4. Prototype

This paper implemented the prototype of edutainment contents based on the learning flow and storytelling mentioned above. We'll describe the prototype at the following.

4.1. Contents of Each Field

Table 2 shows the learning contents of each component for computer operation principles applying a storytelling approach. The learning proceeds from step 1 through step 8 in sequence.

Table 2. Section Title and Content

Step	Title	Content
1	Meeting with genius mathematician Babbage	Hardware and software
2	Meeting with geek scientist Douglas	Input and output device
3	Guardian of the Turing Island	Control unit
4	Monster of Pascal Island	Operation unit
5	Remains of Williams	Main memory
6	Ruins of the dragon and RAMAC Island	Secondary storage
7	Temple of wisdom in the Thru Island	Communication device
8	Fairy village in the Von Neumann Island	Computer operating principle

4.2. Screen Description

Figure 2 shows the loading screen, and screen of 'START' appears at the end of the loading screen as shown in Figure 3. On the start screen, press the start button and it will switch to the next screen.
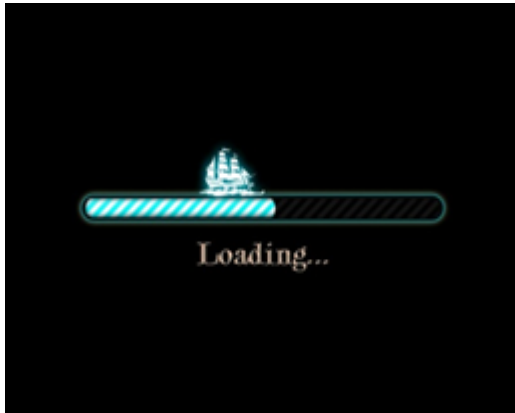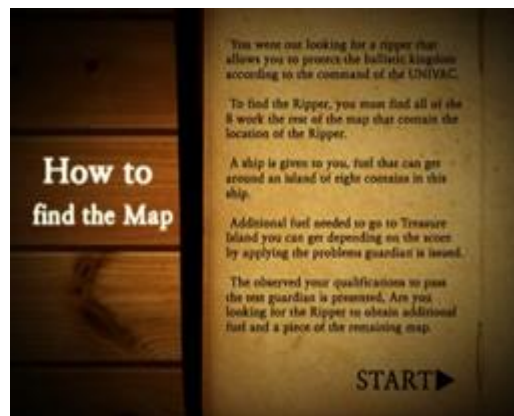
Figure 2. Loading Screenshot

Figure 3. Starting Screenshot

In Figure 4, the content of the screen is the beginning of the background story. Skip button to skip this section. At the end of the screen, Figure 5 appears and shows how to reach the level of mastery learning. From this screen, press the start button at the bottom and it will enable the user to study the contents about computer operating principles.

Figure 4. Story Screenshot

Figure 5. Mastery Learning Screenshot

The lesson section appears like island as shown in Figure 6. It is to be learning along the line you see on the island. When a light comes up on the island in the appropriate section, click the island. Once you click, learning contents will be displayed, as shown in Figure 7. Evaluation is also done at this stage. There are multiple choice questions in each section.
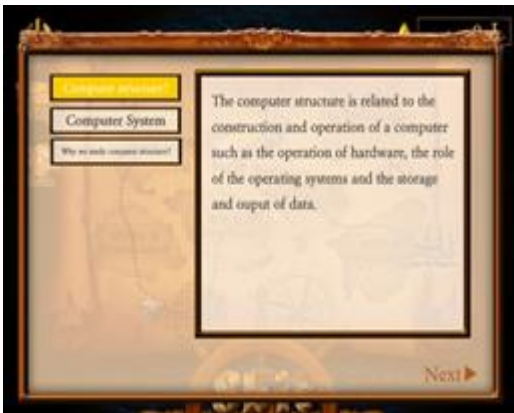
Figure 6. Learning Section Screenshot

Figure 7. Learning Content Start Screenshot

There is the section on learning method of contents from Figure 8 to Figure 10. As Figure 8, the learner could learn the important concept by pushing a button directly. And as Figure 9, the learner could also learn these contents more interestingly by putting the puzzle together applied game factors, and drawing and matching the line as Figure 10. It appeared that participation and controlling the button through interaction with contents improve the concentration on the contents, thus it could improve the interest and achievement of the learner. As for Figure 11, it would evaluate the score and relearning or not after solving total 5 problems.
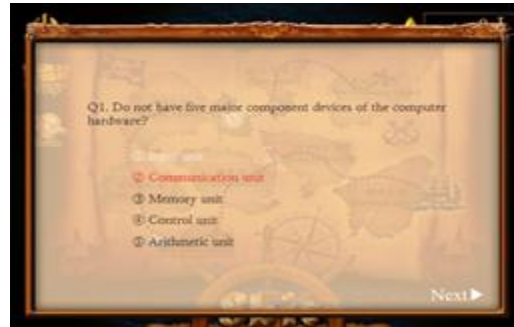

Figure 8. Learning Content 1 Screenshot

Figure 9. Learning Content 2 Screenshot

Figure 10. Learning Content 3 Screenshot

Figure 11. Evaluation Screenshot

If more than 4 problems in each chapter are correct, the screen can appear such as Figure 12, but if less than 3 are correct, Figure 13 appears. If all the screens appear as Figure 13 in each chapter, it leads to the relearning after all learning.

Figure 12. Map Success Screenshot

Figure 13. Map Failure Screenshot

When all stages are finished, the screen asking if mastery learning has been achieved or not would appear as Figure 14 and Figure 15. If the learner acquires the all maps for correcting more than 4 in each chapter and the fuel more than 90L, the screen for the completion appears as Figure 14. It not, the screen for relearning appears as Figure 15.

Figure 14. Notifying Learning End

Figure 15. Notifying Relearning Start

Once learning is finished, a relearning is made according to the score as shown in Figure 16. In this screen, islands of sections that need to be relearned will be lightened up. The

learner is able to relearn by clicking on the island of that section to solve the questions one more time. Learning contents is different from the screen in Figure 8 to Figure 10. Contents of problems will be showing the questions that the learner got wrong. At the end of relearning session as shown in Figure 18, the ending screen will be displayed. And then, the learner will be allowed to exit the content.

Figure 16. Reorganized Learning Content

Figure 17. Finishing the Story of Content

Figure 18. Ending Screenshot

The above prototype could be operated through flash player, and the others could be operated by a smartphone and in a website as below Figure 19 and Figure 20. Only the smart phone and the web that has installed the flash player could operate it. It could be the opportunity to improve the participation and interest of learning by raising the accessibility on the learning.

Figure 19. Execution Screenshot on the Smartphone

Figure 20. Execution Screenshot on the Web

5. Analysis

It has asked questionnaires of the level of difficulty on learning contents in the chapter 1 to improve discrimination and evaluate the level of difficulty objectively for the students who major in the Computer Education Teacher College in Jeju National University. In the questionnaires, it let the students solve the problem directly, to have a percentage of correct answers; and it considered the problem for the real learning subject and separated the level of difficulty as the high, middle and low. The questionnaire result is from the sum of score according to the level of difficulty for each grade. After separating the level of difficulty objectively according to it, it could consist of the dynamic formation evaluation system. Table 3 shows typical questions and evaluation results for evaluating the content subject: computer operating principles.

Table 3. Content Evaluation Question

Chapter 1. Computer system evaluation questions			
1. Which is the correct pair of the appropriate word in the black? A computer could process task proper for purpose with (A) that is the user of a computer, (B) that guide necessary instructions, (C) that is the object for a computer to process the data, and (D), (F) that perform the processing task. ① A: Hardware ② B: Manual③ C: Software ④ D: Data ⑤ E: Person			
Good	2	4	5
Average	5	5	2
Bad	3	1	3
2. Which of following can NOT be processed by computer? ① Picture ② Sound ③ phrase ④ Flavor ⑤ Video			
Good	0	0	0
Average	0	2	1
Bad	10	8	9
3. Which of following is the name of mechanism of a computer and all peripheral equipment of a computer? ① Desktop ② System ③ Program ④ Hardware ⑤ Software			
Good	2	0	0
Average	5	7	8
Bad	3	3	2
4. …… 　　: 　　:			

For the objective middle evaluation of contents, it performed the questionnaires for the students who experienced the above contents. The original development purpose of the above content is to improve the interest and achievement of the learners by applying the

edutainment story telling technique contrasting to the existing learning contents which offered the learning contents one-dimensionally. However, as the result of the questionnaires shown in Table 4, the contents which performed at the exhibition showed that the learning contents screen was not suitable for the above purpose, even though it was good that the contents was made of the scenario and image in the adventure game based type. Thus, it was modified and improved by analyzing and applying this result of questionnaire.

Table 4. Results of the Questionnaire

Evaluation questions	Score				
	1	2	3	4	5
1. Animated effects and background music is appropriate?	0	0	3	26	31
2. Is not difficult to learn the operation of the content?	1	0	6	28	25
3. Scenario is good?	0	0	7	23	30
4. Is composition of story helpful for concentration at learning?	0	0	5	24	31
5. Element to induce the interest of the learner is whether enough?	0	0	3	27	30
6. Is the learning content composed well to read easy?	0	2	11	21	26
7. Is the learning content helpful to understand the constitution and operation principle of a computer?	0	1	7	25	27
8. Are the evaluation questions composed well to evaluate the degree of understanding of learners?	0	2	7	21	30
9. Is the relearning of the learning contents composed well for effective relearning?	0	1	7	23	29
10. Is the relearning helpful to reach the mastery learning by effective iterative learning?	0	0	6	25	29

As for the analysis of the result, No. 2 and 6 had a relatively low score; and No. 1, 5, and 4 had a high score. In the case of the low score, it was on the formation of the learning contents and action of contents. According to it, it improved the action of contents for fast changing without repetition, and modified the learning contents for experiencing learning with not only text, but game. Moreover, it was modified as the scenario with voice reflected by the other opinions, and the contents was modified to be accessed by not only a computer but a mobile.
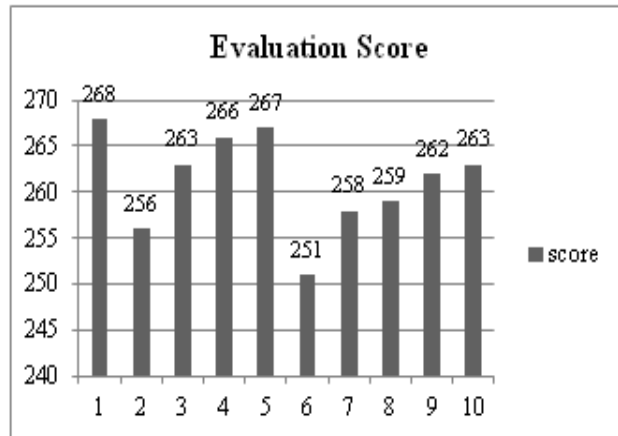
Figure 21. Evaluation Score Chart

6. Conclusion

We developed an edutainment contents in the form of an adventure game with digitalstorytelling. We showed the prototype of the edutainment content. Digitalstorytelling was used to improve the transmission of information and increase the learner's interest. Also, the reorganized learning content through the analysis of the evaluation results is provided for an effective iterative learning. We aimed to reach mastery learning while learners learn and play the edutainment content. The edutainment content helps students to learn computer operating principles easier and more joyful. Also, it will be used as a supplementary learning tool. For further study, we will examine how to apply our approach to other learning topics.

Acknowledgements

References

[1] K. Bang, "Exploring edutainment-based elementary design education" Korea Society of Basic Design & Art, vol. 8, no. 3, **(2007),** pp. 193-203.
[2] J. Lee, "study on the storytelling of exhibition design", Master's thesis, Kyonggi University, **(2004)**.
[3] B. Baek, "Research on creating an effective storytelling strategy for child edutainment animations", Master's thesis, Kyungsun University, **(2009)**.
[4] J. Seo, "A study on the edutainment storytelling for the series of "Magic Thousand-Character Classic" – focus on the aspect of media transition", Master's thesis, Dankook University, **(2012)**.
[5] B. Na, "Development and application of digital storytelling model of instruction", Master's thesis, Seoul National University of Education, **(2011)**.
[6] Y. Hwang, "Using storytelling in arts education content development –focusing on cultural literacy education through musical OSMU", Master's thesis, Dankook University, **(2011)**.
[7] H. Kim, "A study on factors of reuse of edutainment contents – in the context on educational of games", Master's thesis, Kwangwoon University, **(2010)**.

[8]   Z. Okan, "Edutainment: is learning as risk?". British Journal of Educational Technology, vol. 34, **(2003)**, pp. 255-64.

[9]   S. Song, "The development of education game for creativity as edutainment contents", Master's thesis, Sangmyung University, **(2008)**.

[10] M. N. Atta-Alla. "Integrating language skills through storytelling", English language teaching journal, vol. 5, no. 12, **(2012)**, pp. 1-13.

[11] M. Davidson, "A phenomenological evaluation: using storytelling as a primary teaching method", Nurse Education and Practice, vol. 4, no. 3, **(2004)**, pp. 184-89.

[12] D. Andrews and D. Hull, "Storytelling as an instructional method: descriptions and research question", The Interdisciplinary Journal of Problem-based Learning, vol. 2, no. 3, **(2009)**, pp. 6-23.

[13] T. T. Guskey, "Closing achievement gaps: revisiting Benjamin S. Bloom's learning for mastery", Journal of Advanced Academics, vol. 19, **(2007)**, pp. 8-31.

[14] Y. Jung, "Design and implementation of edutainment game for mobile environment – focusing on computer curriculum in middle school", Master's thesis, Dankook University, **(2007)**.

[15] M. K. Cha, J. Y. Mun and S. B. Kim, "Development of personalized edutainment contents through storytelling", World Academy of Science, Engineering and Technology, International Science Index, vol. 86, **(2014)**.

[16] W.-T. Lim, M-B. Yang and S. B. Kim, "A novel card-based security game development on SNS, International Journal of Security and Its Applications, vol. 7, no. 6, **(2013)**.

[17] J. Y. Hong, I. J. Kang, S. B. Kim and C. J. Park, "Development of information security contents for learning hacking principles", International Journal of Security and Its Applications, vol. 7, no. 6, **(2013)**.

Authors

Min Kyeong Cha, she is currently an undergraduate student of the Dept. of Computer Education at Jeju National University. Her research interests include computer science education and edutainment.

Ju Yeon Mun, she is currently an undergraduate student of the Dept. of Computer Education at Jeju National University. Her research interests include computer science education and edutainment.

Seong Baeg Kim, received the B.S., M.S., and Ph.D. in Computer Engineering from Seoul National University, Korea, in 1989, 1991, and 1995 respectively. He is currently a professor of the Dept. of Computer Education at Jeju National University, where he has been since 1996. He was a visiting scholar at Dept. of Computer Science, Montana State University from 2001 to 2002 and Dept. of Electrical & Computer Engineering, University of Cincinnati from 2008 to 2009. His research interests include computer science education, IT-fusion education, global education, computer system architecture, and computer security.