Abstract

Objectives: Although individual learning using personal devices such as smart phones and tablet PCs is available with recent development of IT and media technology, analog educational methods are still widely used in actual education fields. In addition, the demand on edutainment, which allows learning through plays and entertainments, is increasing in order to overcome limitations of existing educational methods. Methods/Statistical Analysis: In this study, contents for edutainment consist of a touch screen, a touch table and IoT educational tools, as well as existing personal devices. The purpose of contents is to learn a fossil chapter in the elementary school science through a type of game, together with an educator. The objects of content such as fossils and mammoths were created using animation characters and UIs that were familiar to children and modelled with actual images to encourage the reality and involvement. A survey and a deep interview with education experts after an exhibition class for elementary school children were conducted to test the contents created. Evaluation criteria consists of 4 areas; educational content, design, interface and technology. Findings: According to the survey, there were positive answers with high satisfaction across the contents. In addition, it is assessed that understanding of students was high as the class was more realistic and provided more direct experience than existing analog classes conducted conventional books and images. Application/Improvement: The contents with various real educational tools simultaneously although the level of satisfaction about educational effects of the contents is high. We expect active studies about future orientation of edutainment contents and experiential educational contents, based on findings of this study.

Keywords: After School Learning, Edutainment Content, Experiential Educational Contents, Science Education

1. Introduction

The technology that has recently received spotlight due to the development of IT (Information Technology) is virtual reality. The user is not only immersed into virtual reality by manipulation or command using actual devices, but can also interact with the creations implemented in virtual reality. This virtual reality is being used in various fields in which the edutainment field is focused in this paper. Edutainment is an enjoying learning form or method of entertainment added to educational software. Due to the recent development of the IT field and media technology, individual learning using smart phones, tablet PC or personal devices is taking place due to this feature, but analogue education methods occupy most actual educational sites. However, virtual reality technology is based on 3D in which requirements can be directly performed by users interacting with virtual characters in
Development of Elementary Science Fossil Learning Contents Based on Virtualization

In a virtual space that is not possible in reality and these points become the educational advantages that can be provided by the virtual world. Beyond personal devices that are conventionally used, a tangible space seamlessly interconnecting various sensors and displays is established in this paper to be introduced in classrooms and experience spaces. By arousing interest and active learning motivation and relieving temporal and spatial restrictions through various stimulations in 3D space such as interactive video and sound, self directed learning contents were created to enhance interest and immersion on education with interaction between the learner and virtual character with the goal to improve learning effect.

2. Research Background

2.1 Virtual Reality

Virtual reality is reality made by artificial technology by arithmetic application of devices such as computers that is similar to reality or specific environment, situation or the technology itself. Virtual environment or situation that is artificially created enables time and space experience similar to reality to stimulate five senses of the user and allows the user to freely come in and out of the boundary of reality and imagination. The user is immersed into virtual reality by manipulation or command using actual devices in which interaction with the creations implemented in virtual reality is possible. Virtual reality is distinguished from unilateral simulation at the fact that users can interact and that experience of users can be created.

2.2 Edutainment

Edutainment is the compound word of education and entertainment as an enjoying learning form or method of educational software accompanied by entertainment. Targeting learning effect through 3D entertainment with conversation type methods is a general form and it is a learning type that increases educational effect by easily and quickly acquiring knowledge through playing.

Traditional education provides information based on texts or 2D images. However, virtual reality technology is a 3D based technology that helps the senses that people have to be perceived even in virtual space. Requirements can be directly performed by users interacting with virtual characters in virtual space that is not possible in reality and these points become the educational advantages that can be provided by the virtual world. Self directed learning is helped by using various interface devices that use virtual reality by stimulating factors such as exploratory behavior, interaction, participation, enjoyment, positive emotions, sense of presence, and immersion.

3. Design and Creation of Fossil Educational Contents using Virtual Reality

3.1 Design Background and Scenario

Educational games are no longer unfamiliar existences. However, actual use plans or research and diagnosis on the functionality of ‘application of edutainment in school sites’ are lacked. In this paper, after school classroom in elementary school was set as the goal to relieve this absence and the subjects of experience were set as early grade elementary students who feel that science is difficult. Also, rather than curriculum by grades for students to have interest in the subject called science, it was aimed for contents that help creative and logical thinking to be learned with instructors to propose a class teaching plan differentiated from regular classes.

The background in the contents is the future where 300 years have passed and the virtual character who interacts with learners is Doctor K who is a walking encyclopedia. The learner who is the main character finds a strange museum that Doctor K is solely guarding and looks around entering the museum. At this time, learners conduct game type missions under the instruction of Doctor K and the instructor and study about fossils according to chapters. The fossil content is composed of 3 chapters.

3.2 Contents Development Environment and Design

The system is composed of a touch table (55 inch), projector (can be substituted with touch monitor), and IoT teaching material (mobile phone) and specific setting details are thoroughly classified in the Table 1.

Unity 3D program which is a game development engine was used in overall development and 3DMAX and Cinema4D was used for 3D modeling. Graphic tools Adobe Photoshop and Adobe Illustrator were used for designing to design and compose the UI and UXdesign inside the virtual reality contents.
The classroom type model was developed to instantly download newly created contents by real-time interconnecting through a tangible creative experience platform based on virtualization computing technology was to be interconnected even for low specification computers that schools possess to enable creative experience functional contents service.

### 3.3 Contents Implementation

The proceeding image of the classroom type model is shown in the Figure 1. The touch tables are manipulated by the learning students and the teacher who leads the learning uses the touch screen in front of the lecture desk. Basic manipulation of the touch tables are touched by the students and IoT teaching materials are additionally used. Learners interact with 3 actual people besides oneself and 1 virtual person.

The proceeding chapters were made with 3 steps in the Figure 2. The first chapter is making fossils in which 2~4 students gather around the touch table, find fossil material, accumulate sediments, and recreate the material into a fossil by turning the watch. The second chapter is becoming a fossil in which a kinetic sensor is used moving close to the touch screen that the students aligns oneself to the fossil and gains a fossil with his or her image engraved in it. In the last chapter, the results from the previous chapters are used to make an invitation that is sent through the touch screen and a presentation on the created invitation can be given.

### 4. Contents Usability Evaluation

#### 4.1 Survey Composition and Analysis Method

Demo classes were given to actual target subjects to collect high quality feedback and assess the value of contents in order to gather the effectiveness and supplement points. Thirty 8~10 year old (elementary school third grade) students and thirteen elementary education workers (elementary school teacher, education association, etc.) were gathered, and survey investigation and intensive interview were conducted to the teachers and experts who participated the demo class. The questions were composed of 16 items with satisfaction on contents educational contents, design, interface, and technology. Likert 5 point scale was used to measure evaluation responses and SPSS Statistics 23 was used for analysis.

#### 4.2 Survey Investigation and Evaluation Standards

Frequency analysis was conducted on the basic demographic factors of the users by gender, job, and age. Regarding the research subjects, there were a total of 13 subject including 1 male (7.7%) and 12 females (92.3%), and 2 subjects were in their 20s (23.1%), 6 subjects were in their 30s (46.2%), and 5 subjects were in their 40s (30.8%) in which they were mainly in their 30-40s. Regarding teaching profession and related career, 1~3 years for 2 subjects (15.4%), 3~5 years for 1 subject (7.7%), 5~7 years for

### Table 1. System Composition

<table>
<thead>
<tr>
<th>Display</th>
<th>Contents</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Wall Type Display</td>
<td>Learning led by teacher with various multimedia material in projection screen or LCD monitor (wall type display varies depending on classroom condition)</td>
<td>1)~4) activities are proceeded in cross order</td>
</tr>
<tr>
<td>2) Touch Table+ IoT Teaching Aids</td>
<td>Various test activities in group of 2~4 members</td>
<td></td>
</tr>
<tr>
<td>3) Wall Type Display Linked with Table</td>
<td>Group competition activity by sending to wall by manipulation at table</td>
<td></td>
</tr>
<tr>
<td>4) Analogue</td>
<td>Making teaching material</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1.** Environment Composition of the Classroom Type Model.

**Figure 2.** Progress Screen of Fossil Contents.
Development of Elementary Science Fossil Learning Contents Based on Virtualization

2 subjects (15.4%), 7~10 years for 2 subjects (15.4%), and 10 years or longer for 6 subjects (46.2%) were responded that slightly more than half the participants have worked 5 or more years in the related job field.

Educational software evaluation standard related researches are still in progress and they must be carefully selected by considering the unique characteristics of education because the range of software and hardware that applies with various contents has become very broad. In this research evaluation, contents assessment items were redefined fitting the evaluation standards restricted from the ‘Research on Usability evaluation Standards of Web-based Educational Software’ by researcher7 show in the Table 2.

By categorizing 4 areas into educational contents, design, interface, and technology, software evaluation elements and standards were proposed based on learners who use the usability evaluation standards of web-based educational software and it has great meaning in the context that it is evaluation based on learners. Also6, the proposed evaluation standards analyze the teaching-learning software certification standards of educational software evaluation and Korean academic information researchers by2 to define the evaluation standards by categorizing into 4 areas of educational contents/design/interface/technology. In this study, characteristics of the contents developed following the evaluation standards of these 4 areas were considered to design the survey shown in Table 3 to perform survey evaluation5.

4.3 Survey Results

Shown in the Figure 3 the content of the contents and goal were set as evaluation elements in the educational content area. Evaluation items on effectiveness and appropriateness of learning, motivation/interest of learning, and suitability of learning contents were composed. Looking into the values in the bar graphs, it can be seen that ‘satisfied’ in the contents area and ‘average’, ‘satisfied’, and ‘very satisfied’ in the goal were highly shown in order.

Shown in the Figure 4 the design area was categorized into consistency and structural/visual clarity, and was composed with items on suitability of main character and clarity of composition proportionate to screen configuration. Looking into the values in the bar graphs, it can be seen that ‘average’, ‘satisfied’, and ‘very satisfied’ in consistency and ‘satisfied’, ‘average’ and ‘very satisfied’ in structural/visual clarity were highly shown in order.

<table>
<thead>
<tr>
<th>Area</th>
<th>Evaluated Area</th>
<th>Evaluation Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational</td>
<td>Contents</td>
<td>Clarity / Rationality of Contents Organization / Suitability of Media Selection /</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appropriateness of Core Contents / Considering Recognition Competence of Learner /</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appropriateness of Learning Quantity / Metaphor / Misprint or Typo of Language</td>
</tr>
<tr>
<td>Goal</td>
<td></td>
<td>Validity of Stating Goal / Suitability of Teaching Strategy</td>
</tr>
<tr>
<td>Design</td>
<td>Consistency</td>
<td>Consistency of Page Arrangement / Consistency of Navigation / Consistency of Object</td>
</tr>
<tr>
<td></td>
<td>Structural/Visual Clarity</td>
<td>Clarity of Composition / Brevity of Composition / Clarity of Layout / Suitability of Used Color / Aesthetic Integrity of Screen Composition / Visual Stability</td>
</tr>
<tr>
<td>Interface</td>
<td>Navigation</td>
<td>Structuralization of Menu / Provide Link / Provide Information of Current Location</td>
</tr>
<tr>
<td></td>
<td>Functionality</td>
<td>Use of Plug-in / Printer Possible / Convenience of Providing Data / Provide Searching Function</td>
</tr>
<tr>
<td></td>
<td>Interactivity</td>
<td>Learning Control of User / Possible to Cancel Work / Interaction with Program / Useable Site Community</td>
</tr>
<tr>
<td>Technology</td>
<td>Feedback</td>
<td>Category by Level / Provide Error Message / Possibility of Supplementing Advance Learning</td>
</tr>
<tr>
<td></td>
<td>Voice/Effectiveness</td>
<td>Convenience of Use / Easiness of Information Acquisition / Stability of Program / Satisfaction of Learner / Degree of Learner Effort / Save and Provide Learned Results / Provide Help Function / Provide Manual</td>
</tr>
</tbody>
</table>
‘very satisfied’. It can be seen that ‘satisfied’ was highest in functionality and that ‘satisfied’ is substantially high in interaction.

Shown in the Figure 6 the technology area has 2 evaluation elements including feedback and voice/effectiveness, and was composed of items on educational help and satisfaction of learner and convenience of contents. Looking into the values in the bar graphs, ‘satisfied’ was highest in feedback, ‘average’ and ‘very satisfied’ were the
Development of Elementary Science Fossil Learning Contents Based on Virtualization

surveys were performed to verify the suitability and value of the contents by categorizing into educational contents, design, interface, and technology areas. As result, overall contents gave highly positive response. Feedback within the contents should be performed based on these results and the following research should be conducted in the future. First, positive results were shown in causing motivation and interest, but it is seen that application in classes by all steps will be difficult when only considering the class. Therefore, it is considered that learning effect should be increased by using supplementary teaching material and segmentation of intensive steps by necessity. Second, it is important to see and touch objects in the science chapter that plans to combine actual objects with contents should be devised. Lastly, only classroom type contents were currently created for after school activities, but it is expected that expansion to form of experience centers or science museums can be possible to maximize physical activities and cause interest of science contents.

Figure 5. Satisfaction of Navigation, Functionality, and Interaction of Interface Area.

Figure 6. Satisfaction of Feedback and Voice/Effectiveness in Technology Area.

same, and was followed by ‘not satisfied’. It can be seen that ‘satisfied’, ‘very satisfied’, and ‘average’ values were similarly shown to be high in voice effectiveness.

5. Conclusions

The elementary generation is free in using personal media based wired and wireless digital devices. Individual learning using smart phones, tablet PC or personal devices is taking place due to this feature, but analogue education methods occupy most actual educational sites. For this, various sensors were interconnected to displays to establish a virtual reality tangible space in this paper to solve the absence and limitations of digital contents. With the goal to help students to acquire 3D knowledge and learn contents that help creative and logical thinking with a game method, contents were created to propose a differentiated class teaching plan for after school activities.
6. Acknowledgment

This work was supported by Institute for Information & communications Technology Promotion (IITP) grant funded by the Korea government (MSIP) (No. R0126-15-1039, Technology development of tangible creative functional contents education service based on virtualization).

7. References