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Development of Virtual Reality-Based Edutainment Contents for Children's English Education

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Abstract

Background/Objectives: Owing to the development of smartphone, mobile educational applications are rapidly increasing, especially those for children. However, it is necessary to induce them to 'move their bodies for themselves'. **Methods/Statistical Analysis:** The purpose of this study is to produce virtual reality-based educational content <ABC House> that induces learners to naturally act and gain learning effects. Based on virtual reality device '(I-cube)' that induces learners to act, it hides alphabets here and there in the space. Learners can naturally learn English words by looking around like in the 'treasure hunt' and searching for cards with words. **Findings:** The implications of this study can be summarized as follows. First, the existing e-learning content could not arouse learners' interest or induce them to constantly participate in education as it consisted of passive interactions such as clicking buttons. This study can provide measures to solve this problem. Second, it shows the possibility to provide a new type of virtual reality. The fact that technology development costs for virtual reality are increasing but there are few successful business cases could be a risky element for virtual reality. However, if virtual reality and education can be integrated in Korea that has high education fever, it could make a great case. **Application/Improvements:** In order for the market of virtual reality-based content for children to develop, it is necessary to study how virtual reality devices would influence children's bodies.

Keywords: Behavior Affordance, English Education, Edutainment, Simulation, Virtual Reality

1. Introduction

Virtual reality is emerging as an alternative of means to provide learners with the feeling of being abroad at low cost. Virtual reality means an artificial three-dimensional world in which users interacts with the virtual environment through one's sense, response and behavioral process, recognition, perception, and body[1], and by using this, users can be provided with virtual experience of traveling foreign countries. Games, from the representative industrial sector of the application of virtual reality, are already utilized in the education sector widely and especially edutainment game which is a kind of combination of education and entertainment is taking center stage.

The purpose of edutainment content is letting the use attain knowledge through playing game. According to Brown, edutainment is, because of the nature of it that can support far more effectively the learner's activities such as reading, writing, calculating than any other media through the use of animation, sound, and video, a medium and a technology for teaching at the same time which makes the learner cannot do otherwise than just keep learning because of its interactive nature and he even said that it is, namely, a strong irresistible force for education[2]. He explains the effect of edutainment on education in terms of the use of various contents[3].

According to a survey of frequencies by commitment behavior of children attending class[4], active behavior and interactive behavior showed the highest numbers (Figure 1). This implies that children are engaged, or immersed in the learning activities the most when they behave by actually move their bodies.

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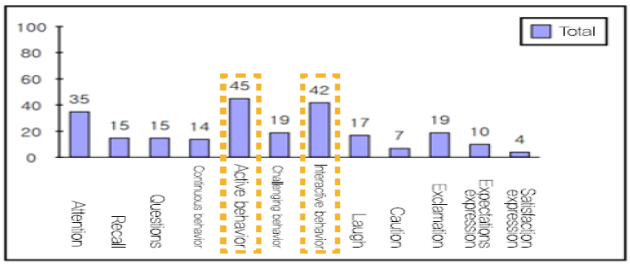

Figure 1. The survey of frequencies by commitment behavior of children attending class.

This study takes note of the role the virtual reality plays in education by providing the sense of immersion just like in a real world through the experience of virtual world, develops an edutainment type of English education content called <ABC House> which utilizes a virtual reality equipment, I-Cube, and using it, examines the relationship between virtual reality and English education.

2. Theorogical Background

2.1 Virtual Reality and Classification of Virtual Reality Systems

Virtual reality can be defined as 'Feeling a sense of reality in artificial spaces created with computers', though its definition varies with scholars[5]. Currently, virtual reality systems can, going beyond giving just effects on the senses of a person as an experienced, can setup the environments of the computers and peripheral input and output devices as intended, or even have technologies that can provide experiences within that environment[6]. Virtual reality systems can largely be classified into Immersive VR, Semi-Immersive VR, Desktop VR. The core of Semi-Immersive type is a large scale screen. Even though it does not obstruct the sight completely like Immersive VR type, it provides user with sense of immersion by projecting virtual reality images onto the large scales screen. Desktop VR is a kind of VR system that provides interaction between the user and virtual reality through the image on the computer monitor screen and also called as non-immersion VR or Window On World(WoW). As the virtual reality is unfolded over the monitor, user can have indirect experience such as looking outside the windows. The above explanation can be summarized as Table 1.

Table 1. Classification of virtual reality systems and their characteristics[7]

Classification	Definition	Feature
Immersive VR	User can experience the virtual reality space by wearing special equipments such as HMD, Data Glove and, at this time, using the special equipment the person is wearing, user can operate the subjects directly. CAVE type is an immersion type in which virtual space is formed in a structure of dome or hexahedron and can be controlled using a controller device.	*Provides the most sense of immersion and for this end, use must wear a special equipment or a goggle. *Shuts the visual and audio sense from the real world and replaces those with manipulated sense in the programmed world. *The prices of equipments used were high in the past, but now are distributed even as personal devices.
Semi-Immersive VR	Provides sense of immersion to user by projecting virtual reality onto a large scale screen.	*Multiple of users can experience virtual reality at the same time. *Installation is convenient because hardware structure is simple compared to CAVE.
Desktop VR	This is a non-immersion type as it is a kind of desktop virtual reality. Interaction between the user and virtual reality occurs in the form of the image on the screen.	*As a non-immersion type, virtual reality is felt only in the form of visual cubic effect on the screen. *Even though sense of immersion is less than Immersive VR, its operation is possible even on the simple hardware structure such as a PC.

2.2 The Definition of Edutainment

Edutainment is a compound of education and entertainment. This is a type of learning tool that enhances effectiveness of learning by letting the learner to attain knowledge faster and easier through game and thus increasing the efficiency of learning[8]. Although edutainment contents have existed in the form of publishing, video and other learning materials in the past too, as the amount of knowledge and information has exploded with the development of digital technology, the time people acquire and use knowledge has shortened compared to this. Thus, it became difficult for people to acquire

knowledge or they came to dislike spending much time on learning, preferring methods of learning which is easier and more interesting to acquire knowledge. Therefore, edutainment contents, which aroused interest in learner and let the learner to attain knowledge by combining knowledge and information with the experience of learner, came to attract the attention of learners[9].

2.3 The Example of English Conversation Educational Contents based on VR

2.3.1 HoDoo English

Hodoo English(Figure 2, Left side), which is a English education content for children which was developed by the research staff at NC Soft and Cheongdam Learning spending 4 years of development time together, helps learner learn English as a communication means rather than as a subject to be simply memorized by letting the learner experience virtual fantasy world in ESL(English as a Second Language) environment and by doing so inducing dialogue between learner and the system. Further, for the purpose of increasing interest of the learner, game element such as carrying out Quest was also added. Although the service has been provided only at 'ClueVille', an offline learning center of Cheongdam Learning in the past, it is also possible to experience at home from 2015.

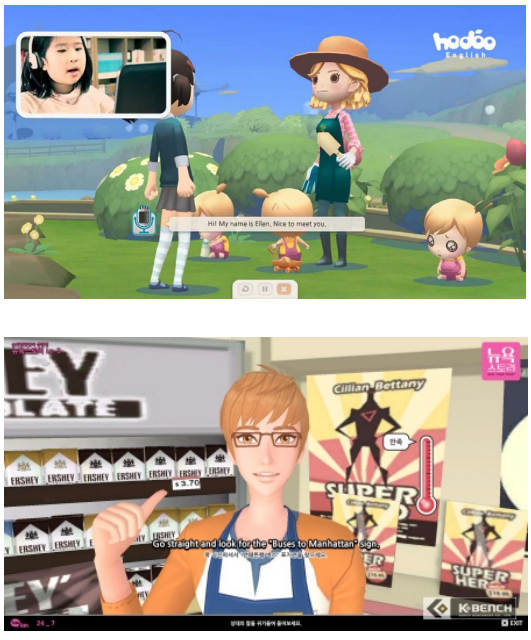

Figure 2. The example of English conversation educational contents based on VR.

2.3.2 Talklish New York Story

Talklish NewYork Story(Figure 2, Right side) is a PC-based content for English conversation learning which was developed by Dreamers Education Co., Ltd. While Hodoo English is for children, Talklish is for adults and provides not only contents for everyday life conversation but also those for business people. Learner can encounter with 240 episodes that an avatar is experiencing during one year of stay in New York by actually speaking in English. This kind of experience lets the learner naturally master English conversation. A compensation system in which the user is given items to decorate the avatar when he/she carried out Quest and a promotion program in which the user is refunded the fees for using the contents when he/she attended the 100 days in a row are in place so that user would be induced to play the contents continually.

3. Development of the Contents

3.1 I-Cube & EON Studio

I-Cube is a type of VR system in which 3D video that was composed using computer is diaplayed in a room (Room) enclosured with screen walls[10](Figure 3). CAVE ssytem

Figure 3. I-Cube(Left) and EON Studio(Right).

was originally developedby Illinois State University in 1992 and it was reprocessed by EON Reality, Inc., and marketed under the name of I-Cube. I-Cube is an immersion-type virtual reality machine that lets the usrs experience three-dimensional virtual reality world by mapping the video created on the computer using projectors onto the 4 large scale screens on the 4 walls that sorrounds the user[11]. I-Cube is equipped with an Infra-Red(IR) camera that is able to identify locations, By attaching a marker that the Infra-Red camera can detect on the 3D glasses weared by the user, the system can capture the movement of the head of the user in real time. As the view of contents is varied based on the movement of the user, it is possible to direct the perfomance to induce the action of the user. In this study, for the purpose of providing high sense of immersion at the same time enhancing the learning effect by inducing behavior of the child, selected I-Cube as the hardware for driving the contents.

EON Studio is a virtual reality authoring tool from EON Reality Inc.(Figure 3) and has the features of 'Hierarchy structure', 'Node type', and 'Route type' as representative features. In this system, every function used in the authoring of the virtual reality is stored in a Library as Node type and the method of connecting these libraries is Route method. And the stratification of these Nodes can be said as the Hierarchy. In the case of simple virtual reality, it is possible to author the virtual reality just using these three tools. Further, there is an advantage that content can be converted into one for I-Cube easily.

3.2 Planning and Design

In this study, using I-Cube, a system in which virtual reality images projected on the display in the form of a Room induces the user to go around the room and enjoy the contents there and EON Studio, a virtual reality authoring tool dedicated to I-Cube, an edutainment content named <ABC House> with a concept that the user finds alphabet cards that are concealed in various places around the room and combine those cards into words as if he/she is playing a 'treasure hunt' game was developed. By inducing the learner to go around the given space by moving his/her body to find the alphabet cards that are concealed in every corner of the room, it has a feature of enhancing the immersion in learning.

As the I-Cube that is used in this study is composed of 3 planes of walls and 1 plane of the bottom and thus is appropriate for the first person simulation contents where 'space' dominates, the room was used as the background and, based on the characteristics of children who prefer primary colors[12,13], primary colors were used in the design of cards, GUI, or logos in general. In addition, so as the children who have less cognitive ability than adults can easily recognize, designs were created as simply as possible such as by using pictograms. (Figure 4)

3.3 3D Modeling

The size of one cell of grid provided by virtual reality authoring tools is 1m and it is the same in EON Studio, too. However, as the default size of one cell of grid of 3Ds MAX is 1mm, before the creation of the virtual reality content, the grid size of 3Ds MAX must be changed to 1m. One thing to take care in producing background object is to make the character(user) that will fit into the space not awkward. For that reason, a cube of 165cm of height, which is the average height of a person was created and used as the criteria for the background in this study.

First, using simple figures basic layout was setup and then detail modeling work is started. After this, additional props were added to decorate the background amply. As for small props, it was possible to save time by using open sources that are available for free. In this study, files from Archive 3D(http://archive3d.net) were used. (Figure 5)

Table 1. the concept of <ABC House>

Title	ABC House
Background	In children's room of a private home
Mission	To find the hidden alphabet card and make 5 English words.
Target	6-8years old children
Genre	Education
H/W	I-Cube
S/W	EON Studio, 3Ds MAX, Photoshop, Illustrator
Play time	About 15 minutes

Figure 4. The alphabet cards and the logo design.

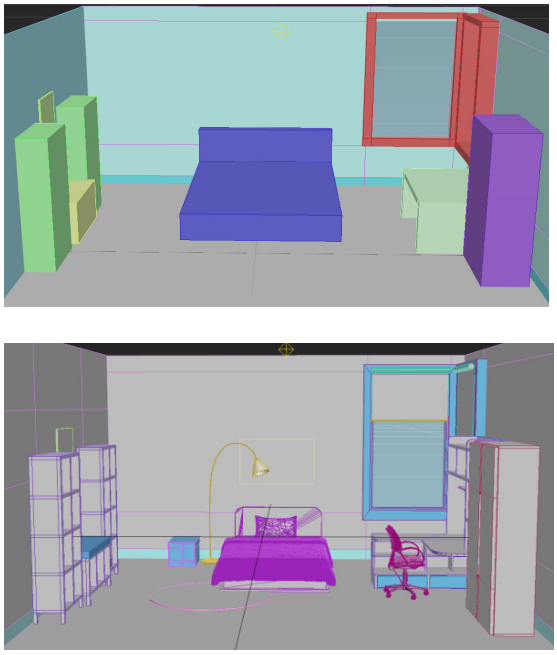

Figure 5. Process of modeling the background of <ABC House>.

After the completion of modeling, files should be sent to EON Studio. EON Studio provides a separate Plug-in, EON Raptor and by using this, 3d modeling files can be converted into .eoz, which is a file format for EON Studio. If those .eoz files thus converted are run in the EON Studio, 3D objects are applied to Hierarchy structure.

3.4 Implementation of Interactions

3.4.1 Implementation of Multiple Events through SF/MF Node Data Type and Prototype

<ABC House> has a structure where several events occur at the same time and then this process occurs repeatedly. For example, when an object is selected, and animation in which alphabet cards come down from the above and mixed and then disappear is activated and the pronunciations are heard and speech bubbles explaining the words appear. During the time the cards are mixed, slots for inserting the cards that were searched slowly appear on the screen. For the purpose of implementing this structure effectively, SF/MF Node and Prototype were used in this study.(Figure 7) In the script of EON Studio, in addition to the basic data types such as Boolean, Float, two new data type, namely, SF Node, MF Node are provided. SF denotes Single Field and MF denotes Multi Field and while fields are crated, sub folders depicted as in [Figure 6] are created.

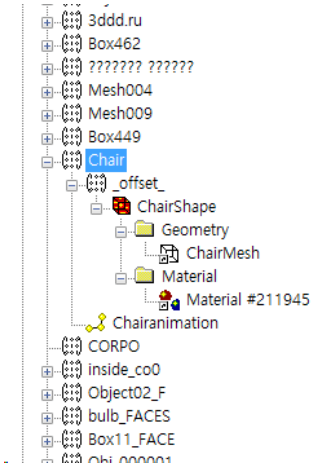

Figure 6. The 3D objects's hierachy appiled to EON Studio.

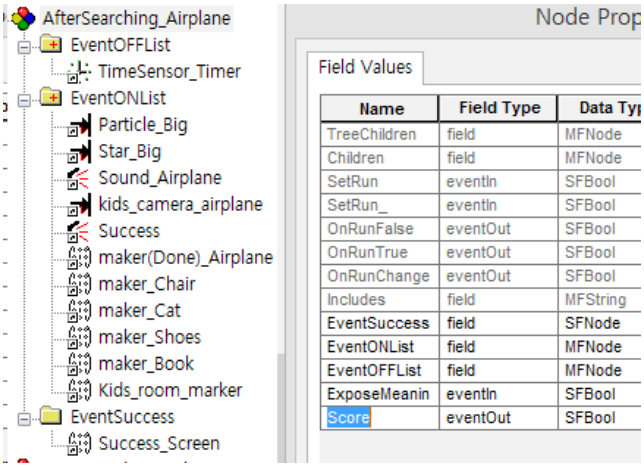

Figure 7. The part of SF/MF Node prototype use in <ABC House>.

By using Node type, other nodes can be controlled without connecting them using route method.

3.4.2 Scoring Function

In <ABC House>, there is a point system in which one star is completed every time the user finds an alphabet card and user can collect the stars every time eh/she completes a word. (Figure 8)

As stars are filled in total of five steps but number of cards varies according to the words, the following formula(Figure 9) was used and for the purpose of applying the numbers in accordance with the steps of the stars, a rounding command (Math.round) was used at the end of the formula.

Figure 8. Steps in which stars are completed.

$$\frac{\text{The status of stars}}{\text{The number of slots}} \times \text{The number of slots filled with cards}$$

Figure 9. The fomula of the scroing function.

Table 1. the script of the scroing function

```
var routes = new Array();
function initialize()
{ SlotWithCardNo.value = 0;
size = Place.GetMFCount();
for (i=0; i<size; i++)
{routes[i] = eon.CreateRoute(Place.GetMFElement(i),
"SetRun", eonthis, "SlotOn");}}

function shutdown()
{ size = Place.GetMFCount();
for (i=0; i<size; i++)
{ eon.DeleteRoute(routes[i]);}}

function On_Reset_CardNo()
{SlotWithCardNo.value = 0;}

function On_SlotOn()
{SlotWithCardNo.value++;
size = Place.GetMFCount();
if (SlotWithCardNo.value == size)
{ IsSlotFull.value = true;}
var StarLevelNo = 3;
var temp = (StarLevelNo / size) * SlotWithCardNo.value;
StarLevel.value = Math.round(temp);}
```

3.4.3 Optimization of I-Cube

Although all the tasks up to this point were works based on desktop, as I-Cube based contents should be created in this study, a task of transferring the contents thus are created is needed. As contents are implemented on just one of the displays if the contents of PC-version are run on the I-Cube as they are, for the purpose of making the videos applied to all of the 4 PC screens divided and to enable the position recognition of the head of the user through the Infra-Red tracking system, a separate work is required. As I-Cube uses 4 PCs, the field of vision is expanded to 4 fold of that of PC. Thus, adjustment to camera is needed. Further, as I-Cube uses a game pad as an input device rather than a mouse, existing Click sensor node should be switched to wand node which is a dedicated node for game pad. Wand node is imbedded in the template for I-Cube so that it appears according to the position of the game pad. As the mouse cursor is changed into hand shape when it reaches an object for which Click Sensor node is applied after it was moved on the screen, for the enablement of the use of the Wand node, all the Click Sensors should be replaced with Wand Sensors. In this study, in preparation for any unexpected errors, Click Sensors and Wand Sensors were inserted together. (Figure 10)

4. Discussion

This study suggested <ABC House>, a virtual reality based edutainment content, as a method to learn English naturally overcoming the grammar-oriented English education. The following effects can be expected through this. Firstly providing the learners with play-type education will result in less resistance and more interest in English, which leads to improved study efficiency. Secondly, the existing e-learning content including mobile apps consists of negative interaction such as clicking buttons, and therefore they cannot attract the interest of students and

Figure 10. Wand & Wand sensor(left), The example of 'Wand' in <ABC House>.

induce continuous participation in education. This study can be an alternative to solve these problems. Thirdly, this study shows the potential of action inducing as a new type of virtual reality education content. The limitation of this study is the fact that, in proceeding with the research, usability assessment to examine whether the contents have any educational effects on children in early elementary school was not performed. In the future, the following researches should be performed. First, a study on the effect of 3D stereoscopes and HMD had on the vision of children is needed. Especially, in the case of HMD, as the display is considerably close to the eyes, this kind of research should be performed for the purpose of the development of the virtual reality. Second, although is the case of <ABC HOUSE> children's room is used as the background, if the background was expanded not only to the other rooms such as living room or rest room but also to other places such as hospital and school, it would be possible to provide the learners with more various words. Third, although just one user is experiencing the virtual reality in this study, it would be possible to expand the platform with a scenario in which multiple users find virtual cards in a virtual space like actual space at the same time by using technologies such as mobile augmented reality and position recognition.

5. Acknowledgment

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