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# Web-based VR Education Contents Supporting VR-goggles and User Study

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**Abstract:** This paper treats the user study for web-based VR education contents supporting VR-goggles. Educational materials using multimedia have ability to enhance the education efficiency rather than text books. Similarly, educational materials using new technologies like VR have ability to attract much interests of students. Based on Interest-Driven Creator Theory (IDC Theory), this means educational materials using VR may have high educational efficiency. For experiment subjects and exercise subjects, the most efficient learning environments should be the same as the real ones as possible. Educational materials using VR can provide virtually students with high immersive learning environments. Therefore, educational VR materials supporting VR-goggles may have higher education efficiency rather than the others. This may justify Seamless Interest-Driven Creator Theory (SIDC Theory). So, this paper introduces several web-based VR education contents, and also show simple user study results especially for the comparison between their web-browser mode and VR goggle mode.

**Keywords:** IDC Theory, SIDC Theory, Educational materials, VR, User study

## 1. Introduction

In this paper, we introduce several VR education contents supporting VR-goggles and show the user study results for the comparison between their web browser mode and VR goggle mode. This research is one of the activities of our center called ICER (Innovation Center for Educational Resources)(ICER, Aug. 2023) belonging to Kyushu University Library of Kyushu University, Japan because the mission of ICER is to provide students with educational materials using recent ICT and to support teachers for their creating such educational materials. In addition, our university established new institution called Data-Driven Innovation Initiative in April, last year. It consists of five divisions. We also belong to one of the divisions called NOE(Division of Next generation Open Education promotion)(NOE, Aug. 2023). Its mission is to promote Education DX(Digital Transformation), currently, we focus on the development of XR(VR/AR/MR) contents. Our ICER and NOE have various equipment and devices such as VR goggles, 3D scanners, and 360VR cameras for developing e-learning materials including XR contents like VR tours. Using these devices effectively, we want to develop a lot of e-learning materials for students of our university. To do so, we have already proposed the development framework for web-based VR education contents that supports lidar data(PCD: Point Cloud Data) and 360VR images/videos(Okada, et. al, Feb. 2023, Okada, et. al. Jul. 2023). In addition, we have proposed web viewers supporting VR-goggles for 3D model data, PCD and 360VR images/videos (Okada & Oki, Mar. 2023).

Educational materials using multimedia have ability to enhance the education efficiency rather than text books. Similarly, educational materials using new technologies like VR have ability to attract much interests of students. This can be derived from Interest-Driven Creator Theory (IDC Theory). For experiment subjects and exercise subjects, the most efficient learning environments should be the same as the real ones as possible. Educational materials using VR can provide virtually students with high immersive learning environments. Therefore, educational VR materials supporting VR-goggles may have higher education efficiency rather than the others. This may justify Seamless Interest-Driven Creator Theory (SIDC Theory). So, this paper introduces several web-based VR education contents, and also show simple user study results especially for the comparison between their web-browser mode and VR goggle mode.

The remainder of this paper is organized as follows: next Section 2 describes related work. We explain the proposed framework and its functionalities using the VR tour contents in Section 3. In Section 4, we briefly introduce the proposed web viewers. Section 5 shows the user study results and discuss about them. Finally, we conclude the paper in Section 6.

## 2. Related Work

Usually, we have to use any toolkit systems when creating web-based interactive 3D educational materials. Our laboratory proposed IntelligentBox(Okada & Tanaka, 1995) that is a development system for interactive 3D graphics desktop applications and uses it for our research purposes. There have been many desktop applications actually developed using IntelligentBox so far. In addition, we proposed web-version of IntelligentBox(Okada, 2013) and developed web-based applications using it. However, those cannot support VR goggles such as Meta Quest 2. Unity is the most popular game engine in the world (Unity, April 2023), that enables creating web contents supporting VR goggles such as Meta Quest 2. It is a very powerful toolkit for creating desktop and web-based 3D graphics applications including VR applications. However, the use of Unity requires programming knowledge and skills of the operations for it. Therefore, it is not easy for standard end-users like teachers to use Unity. Therefore, we proposed the development framework for web-based VR contents like VR tours.

There are many commercial services for creating interactive web contents using 360VR camera images. The service of RICOH (THETA, April 2023) does support 360VR images but not 360VR videos nor PCD. The service of Matterport (Matterport, April 2023) does support 360VR images and PCD but not 360VR videos. Contrarily, our proposed development framework consists of three systems those are for walkthrough contents of 360VR images, for navigation contents of 360VR videos and for walkthrough contents of PCD. These are differences between our development framework and the others. For the convenience of standard users like teachers, we also proposed web viewer applications for 3D model data, PCD and 360VR images/videos.

As the educational efficiency of e-learning materials using VR, we have not investigated related works enough yet. As a preliminary research, we show user study results for web-based VR education contents supporting VR-goggles in this paper.

## 3. Web-based VR contents supporting VR-goggles

Last year, we made VR tour contents of the university library building for our open campus event to appeal that the building is one of the biggest university libraries in Japan. In the followings, we explain two types of VR tour contents of the university library using 360VR images and 360VR videos.

### *3.1 Walkthrough content of 360VR images*

Figure 1 includes three screen shots of the walkthrough content of 360VR images, 3rd floor of the library building. The map of 3rd floor appears in the left upper part of each screen shot. On the map, there are many orange dots totally over 100 each indicates the place at that each 360VR image was taken. By clicking on the orange dot, its corresponding 360VR image will be displayed as the next 360VR scene. Similarly, by clicking on one of the thin grey cylinders in a 360VR scene, the 360VR image taken at the same location will be displayed as the next

360VR scene. In this way, you can walk through on the floor. This VR tour content supports multimedia like standard image files and movie files as shown in the middle part(standard movie) and right part (standard image) of Figure 1.

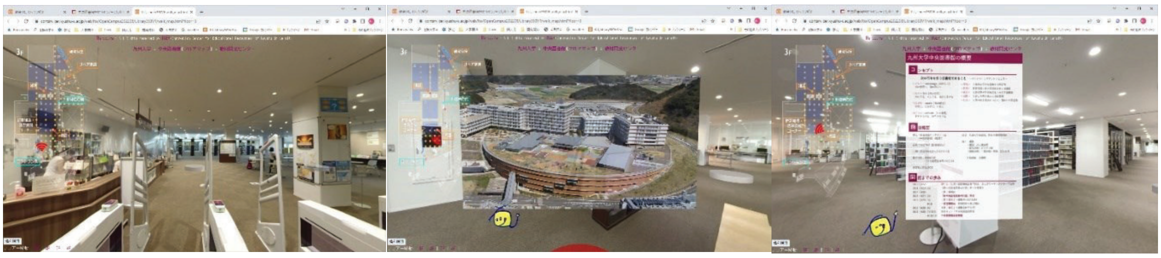


*Figure 1.* Four screen shots of the walkthrough content of 360VR images, 3rd floor of the library building.

### *3.2 Navigation content of 360VR videos*

Figure 2 includes three screen shots of the navigation content of 360VR video, 3rd floor of the library building. The lower middle part of each of the three screen shots is a control panel for the 360VR video, i.e., play, pause, backward, forward, etc. The upper left part of each figure is the map of 3rd floor. There is a cyan color closed polyline that means the moving path actually the person wearing a portable 360VR camera on the top of his/her head moved through the floor when taking this 360VR video. By clicking on the polyline, the 360VR video moves to the corresponding 360VR scene. Similar to the system for the above walkthrough content, this content also supports multimedia like standard image files as shown in the middle figure and the right figure. The 360VR scene automatically changes according to the current playing point of the 360VR video. Therefore, we call this type of contents are navigation ones.

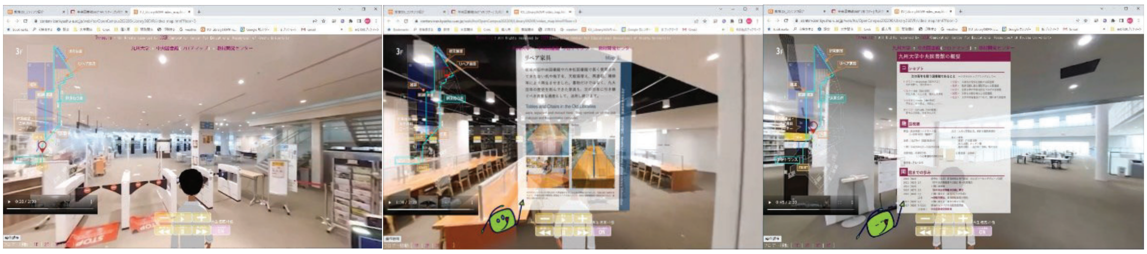
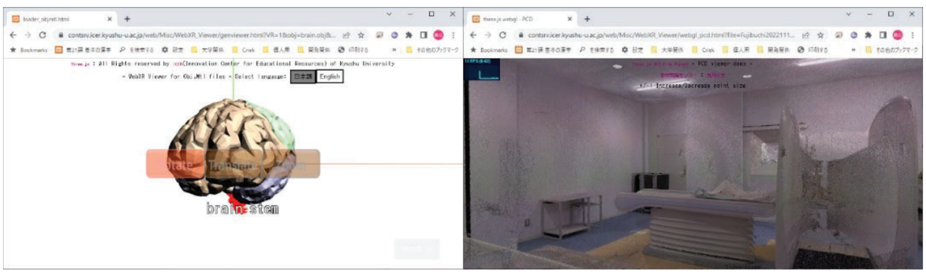


*Figure 2. T*hree screen shots of the navigation content of 360VR video, 3rd floor of the library building, and 3rd floor map.

## 4. Web Viewers for 3D model, PCD and 360VR images/video

Figure 3 shows four screen shots of the web viewers. Its left upper part is the 3D model viewer of a brain model. Its right upper part is the PCD viewer of CT exercise room. Its left lower and right lower parts are the 360VR image viewer and the 360VR video viewer of CT exercise room. You can see [Enter VR] button on the right lower part in each screen shot. This button is for changing web-browser mode into VR-goggle mode.



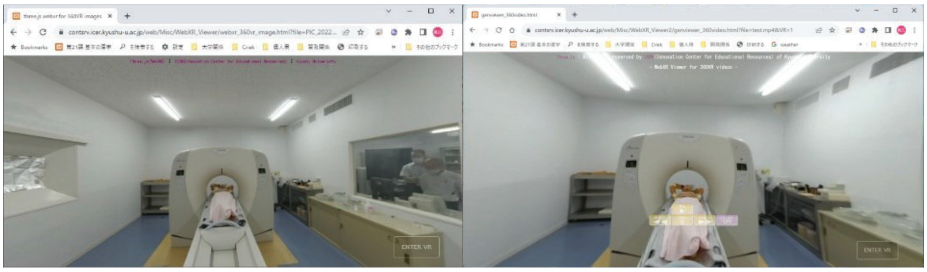


*Figure 3.* Four screen shots of the web viewers of 3D model(left upper), PCD(right upper), 360VR image(left lower) and 360VR video(right lower).

## 5. User Study Results

We carried out simple user evaluation by the students of Graduate School of ISEE(Information Science and Electrical Engineering) of our Kyushu University. The number of students is 26. The user evaluation contents are VR tours (Walkthrough and Navigation) of University Library already shown in Figure 1 and Figure 2, and 3D model viewer of a Skeleton model. These contents in VR-goggle mode are shown in Figure 4, Figure 5 and Figure 6.

Table 1 includes three questions and Figure 7 shows their results. The left of the figure is for the walk-through content of 360VR images, the middle is for the navigation content of 360VR video, and the right is for the 3D model viewer of a skeleton model.

About question 1: Operability and responsiveness, the answer results are not bad because the mean values of the three contents are 3.2, 3.5 and 3.8. Although the usage of VR-goggle controllers was not explained, most students can operate by their selves.

*Table 1: Questions*

Q1: Operability and responsiveness ( 1: Bad - 5: Good )
Q2: Immersive ( 1: Weak - 5: Strong )
Q3: 3D sickness ( 1: Strong - 5: Weak )

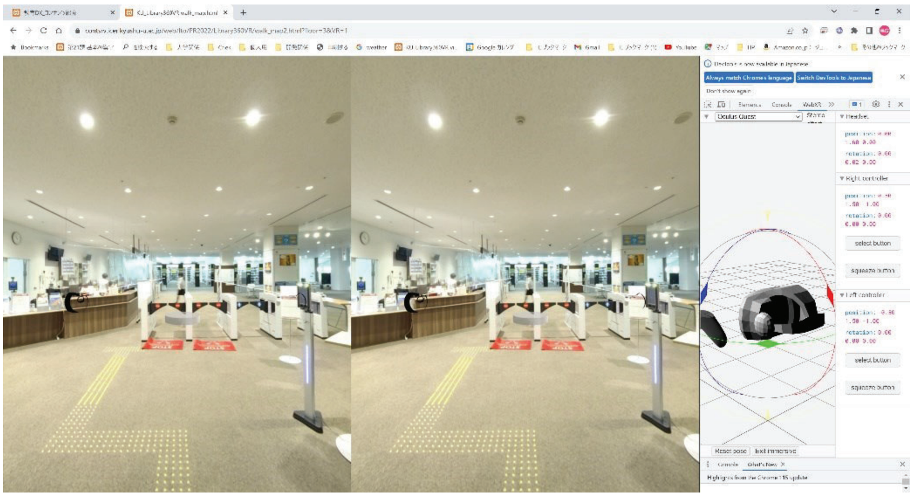


*Figure 4.* Screen shot of the walkthrough content of 360VR images, 3rd floor of the library building, in VR-goggle mode.

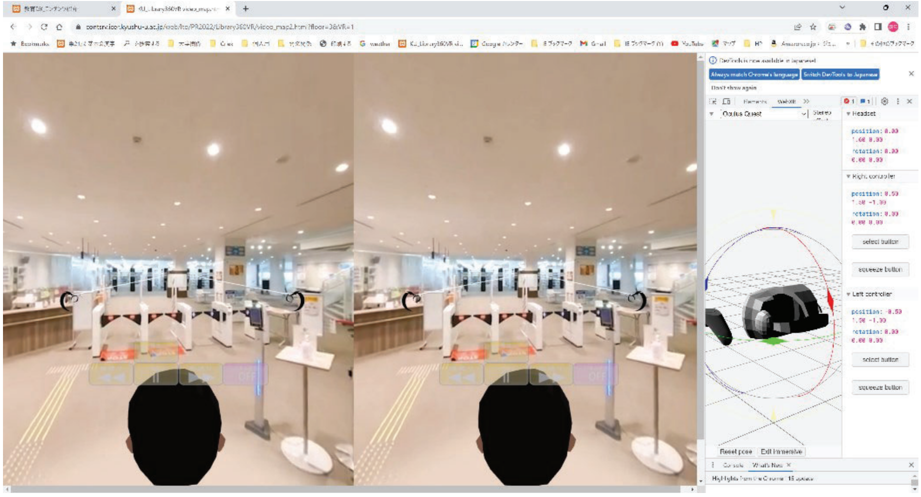


*Figure 5.* Screen shot of the navigation content of 360VR video, 3rd floor of the library building, in VR-goggle mode.

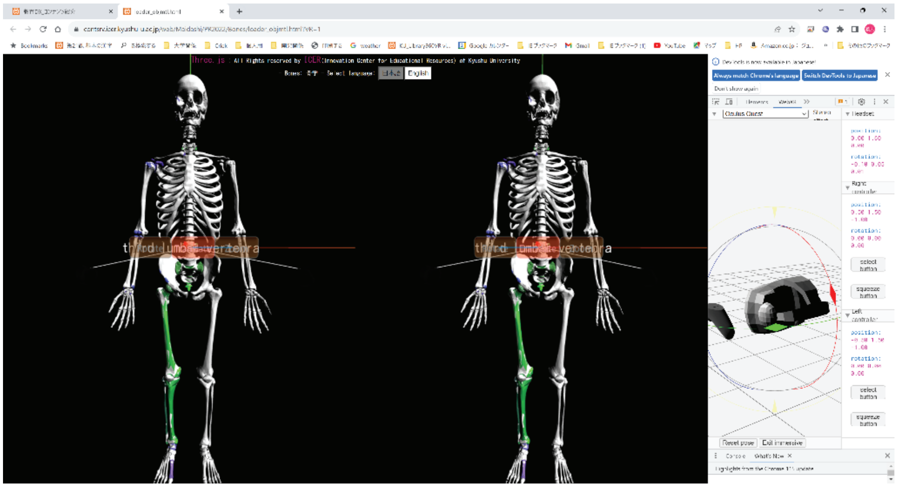


*Figure 6.* Screen shot of the 3D model viewer, a skeleton model, in VR-goggle mode.

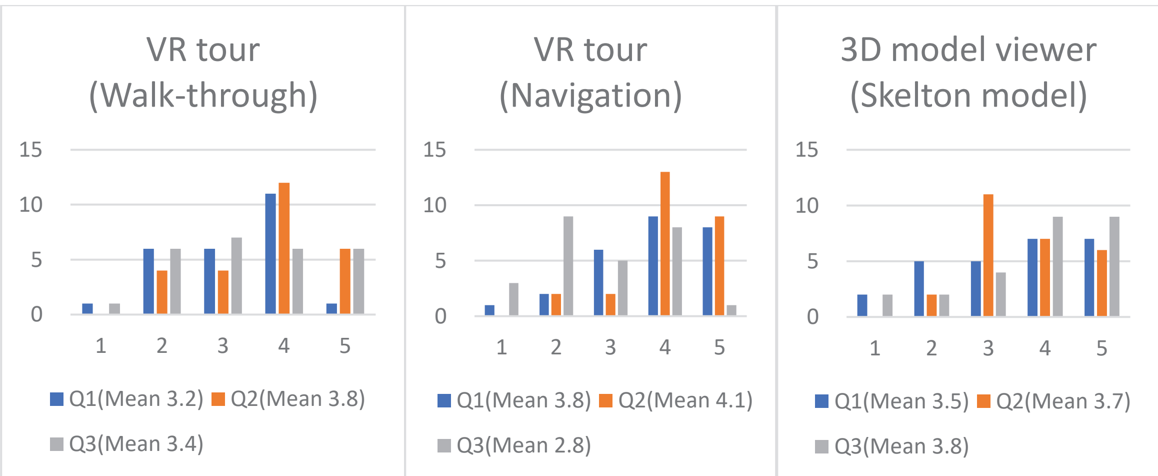



*Figure 7.* Answer results against the questions of Table 1, left is for the walk-through content of 360VR images, middle is for the navigation content of 360VR video, and right is for the 3D model viewer of a skeleton model.

About question 2, Immersive: the answer results are very good because the mean values of the three contents are 3.8, 4.1 and 3.7. Because the experience of a VR-goggle is the first time for most students, many students felt wonderful experience by the high immersion of VR-goggle.

About question 3, 3D sickness: the answer results are not bad because the mean values of the three contents are 3.4, 2.8 and 3.8. The navigation content is the moving action of a 360VR video, so most students felt 3D sickness rather than the other two contents.

We also received some free description comments such as “This was my first time using VR goggles, and the immersive experience greatly changed due to the image quality and operability. I was intrigued by the high level of technology that makes me think that the VR industry will become more popular in the future” and “I was surprised because it was more immersive than I expected. I wanted some VR goggles”. Totally, most of the comments are positive and a few are negative. Therefore, we should develop more VR education contents to provide students.

## 6. Conclusion

The development of educational VR contents is not easy and needs much time. So, in this paper, we introduced our proposed development framework for web-based VR education contents and our proposed web viewers for 3D model data, PCD and 360VR images/videos. We should use new technologies for educational materials because we think that they can attract much interests of students and have possibility to enhance educational efficiency derived from IDC Theory. In this paper, we also showed simple user study results about web-based VR education contents like VR tours. From some comments of the students, it was clarified that education contents supporting VR-goggles are more interesting than those not supporting VR-goggles.

As future work, we will try to ask teachers to use the proposed development framework for actually creating more web-based VR education contents to clarify the usefulness of the framework. Furthermore, we will create several educational VR contents with the framework and ask students to learn using the contents. After that, we will consult the students for more deeply evaluating educational efficiency of the contents.

## Acknowledgements

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