Learning Cultural Spaces: A Collaborative Creation of a Virtual Art Museum Using Roblox

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DongHyun Kang[1(✉)], HaRam Choi[1], SangHun Nam[1,2]
[1]Department of Culture and Technology Convergence, Changwon National University, Changwon, Korea
[2]Department of Culture Technology, Changwon National University, Changwon, Korea
hyunykk@changwon.ac.kr

Abstract—This study sought to improve art knowledge by engaging students in the creation of a virtual art museum and re-creating art museums and artworks. To this end, we proposed the Virtual Art Museum Education Program (VAMEP) using Roblox Studio, a metaverse platform. After visiting an actual art museum, students were divided into Architecture, Artwork, Avatar, and Contents teams for collaboration. To verify the activities of VAMEP, the educational effect of virtual art museum production on the acquisition of information about art museums was investigated using a questionnaire that was administered twice, both before and after the activity. It was found that the VAMEP helped acquire information on artists and works, as well as regarding the art museum. Additionally, the use of the metaverse platform not only aided production but also helped produce solutions to technical difficulties and improved production capabilities. This study suggests new possibilities for virtual art museums and arts education using metaverse technology.

Keywords—art education, metaverse, virtual art museum, Roblox

1 Introduction

At present, cultural spaces are being transformed into complex cultural spaces that can provide an open space for the local community to participate in culture. Among the cultural spaces, art museums have worked to develop art education by providing new information on artworks by novel means. The importance of information provision and interactive technology are being emphasized in education, and various forms of art education have been proposed to support effective knowledge acquisition. Accordingly, art museums around the world are adopting the use of virtual spaces that can function as art museums where artworks can be studied, and information can be obtained while barriers to art are reduced. Several art museums have been putting exhibitions online through 360-degree real images and text information. However, as this is a form of learning information that moves in one direction when the participant enters the art museum thus produced, students generally lack communication with and interactive learning with the art museum [1]. Virtual art museums in the metaverse are emerging,

in which users directly or indirectly participate in art activities, displaying their artworks in a virtual museum or discussing with other users works that are displayed by others. This is becoming an important new trend in art education.

We focused on students' participation in the creation of the Metaverse Virtual Art Museum as an educational method for expanding the understanding of works of art. In addition to observing the virtual art museum that was thus created, this study investigates the effect of art education. Section 2 of this paper describes a virtual art museum, the use of game engines in education, and production education. In section 3, the proposed Virtual Art Museum Education Program (VAMEP) and the research content are explained in detail, and in section 4, the production activities are presented. Section 5 shows the results of the effects of VAMEP activities as ascertained in a questionnaire and presents the conclusions and potential future directions for research.

2 Related work

2.1 Virtual art museum

Virtual art museums can enable individuals to study artwork at a distance by providing information on works in virtual space, studied to help increase their learning motivation [2–4]. In this regard, recently, virtual art museums using metaverse technology to learn art in both directions are developed [5, 6]. A virtual art museum using metaverse technology provides complex media such as games and communities so that students can actively participate in the art museum [7, 8]. Some studies suggest virtual art museums and art education methods through activities in which students actively participate in using metaverse creation engines [9, 10]. This can help improve imagination and aesthetic sensibility [11, 12].

2.2 Use of game engines in education

A game engine can be used as a learning supplement that delivers the information, making learning more effective and fun than general learning tools [13, 14]. For serious games, in which learners can participate and interact with game objects, it is helpful to master specific topics or to improve their existing knowledge [15]. This provides a personalized learning process in which different learning styles are embedded in one set of educational materials with customization to the needs of the student [16]. Here, the game engine enables the modification of educational content and is reusable [17]. For these reasons, it can be used as learning materials provided by instructors to improve students' problem-solving ability in challenging math subjects [18] or to learn topics in interesting ways, such as ancient plays that may be difficult to experience in the classroom [19]. Thus education that incorporates a game engine can be used as an emerging educational method, as it can enhance student participation and motivation, as well as increase the effectiveness of learning [20].

Methods of education that participate in the creation of virtual spaces allow students themselves to plan and organize the learning content and the space of the contents. Such an approach is widely used in education that recreates real environments and buildings

in virtual spaces. Unlike ordinary game engines, the metaverse creation engine is very effective for education. It provides various functions to create content in the absence of professional knowledge. Using it, multiple students can create different objects in one space or post their creations and creative content in the virtual community and share them with others [21, 22]. In this way, students who create a virtual space on their own can help develop learning and understanding of a space, its cultural heritage and works [23, 24], as well as improve learning efficiency by improving the imagination [25, 26]. Doing so also induces curiosity about learning and helps promote experiential and exploratory learning [27].

From these factors, in this study, an art education program was constructed for which students participated in creating an art museum in a virtual space. The creation of a virtual art museum based on a real art museum includes art elements for recreation as 3D objects. Exploring artwork information through this process can lead to natural learning about art. And creating a virtual art museum using the Metaverse platform does not require technical skills, so all students can easily participate in its creation. Additionally, during the creation, students can exchange information through the community and resolve technical difficulties. Therefore, we hope to effectively acquire greater knowledge about a given art museum, an artist, and specific artworks, using the platform to create a virtual art museum and studying it experientially.

3 Methods and materials

3.1 Virtual art museum education program

In this study, we propose a virtual art museum education program, the VAMEP activity. The VAMEP is an activity in which students recreate a real art museum in a virtual space using a metaverse creation engine. In their creation of a virtual art museum, students acquire information about art museums, artists, and artworks. Using the metaverse creation engine that students can easily access, students can create art museums and artworks in various ways. In this way, VAMEP can encourage students to actively participate in art education by making them interested in art museums and artworks. The design of the VAMEP was largely divided into two phases, concerning research on the four phases of a participatory approach, namely, a) creation and b) evaluation [28].

In particular, the creation phase, which is the VAMEP Activity, includes the following: 1) workshop and training for using Roblox Studio, 2) visiting the actual art museum and discussion on creation methods, and 3) virtual art museum creation through collaboration and assembly (Figure 1). Workshops and technical training to create virtual art galleries are also included in VAMEP activities. This will help students build art galleries in various ways by demonstrating their creativity. Next, the process of visiting the actual art museum and discussing the production method will help students to understand the architectural characteristics and the artwork in expressing the art museum. Finally, full-scale art museum creation activities are conducted by team collaboration according to their interests. Each student has different interests depending on the production elements of the art museum, creating their preferred parts will increase the completeness of the virtual museum.

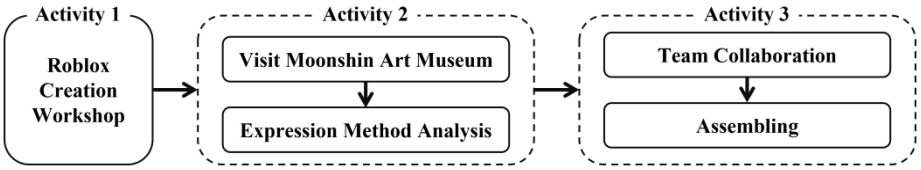


Fig. 1. The creation processes

The evaluation process consisted of a pre-questionnaire to assess background knowledge of the MAM before the activities and a post-questionnaire to test the effect of VAMEP after the activity on knowledge of MAM and ability to produce metaverse contents. According to these evaluation phases, we try to verify whether the VAMEP activity helps expand art knowledge by comparing the knowledge level of students before and after the activity.

3.2 Participants

In all, 15 students participated in the study, 13 college students and 2 graduate students from Changwon National University in Korea, male and female in their 20s.

Before the activity, participants answered questions about metaverse content and production. Of these, 80% of the participants said they had experienced metaverse content before participating in the project, while 20% said they had never experienced it. For the experience of creating metaverse content, 33.3% had creation experience using the metaverse platform, while 66.7% did not.

3.3 Subjects and software

This study selected the Moonshin Art Museum (MAM), located in Changwon, Korea, as the museum to be created in the Roblox space. The MAM is about sculptor Moonshin and has three buildings, different interior structures, and an outdoor garden. Thus, it has various architectural elements that can be expressed in a virtual space. It also displays a range of artworks, such as sculptures and flat paintings, so it would be interesting to create them as virtual 3D objects.

Roblox Studio is an essential tool for creating Roblox virtual spaces and games. This provides intuitive interfaces and functionality for space and 3D object production, making it easy for users to use metaverse content for the first time. It is easy to create by the team because users can collaborate to create through the Team-Created function. It also allows the use of externally produced objects. The external images required to produce virtual art museums can be inserted into objects or used in billboard format. Roblox Studio uses its coding language, Lua, to implement the game and interaction. Thus, users can obtain information on the coding of the content and game design and code through the Roblox Developer Hub [11, 29].

3.4 Measurement tools

To investigate the effects of the VAMEP, two Likert 5 scale questionnaires were administered, one before and one after the activities. The pre-questionnaire consisted of the presence or absence of metaverse content experience, background knowledge about MAM, and individual characteristics of the participants. The second questionnaire after the activity consisted of items on the degree of knowledge acquisition of MAM, metaverse content creation ability, and collaboration satisfaction. The items regarding MAM were classified into items regarding the MAM, Moonshin, and artworks, and the detailed questionnaire configuration is shown in Table 1. The questionnaires were constructed by referring to the survey used in the study of virtual art museums and metaverse content production [30–32].

Table 1. Questionnaire configuration

	Construct	Items	Type of Measure
Pre- questionnaire	Metaverse Content Experience	2	Likert 5 scale
	Background Knowledge of MAM	3	
	Personal Characteristics	2	
Post-questionnaire	Degree of Information Acquisition on MAM	3	
	Metaverse Content Creation Ability	2	
	Collaboration Satisfaction	2	

Before analyzing the results of the survey, we conducted a reliability test of the two questionnaires and identified the reliability of the questionnaire by deriving Cronbach's alpha coefficient. Then, a paired-sample T-test was performed and analyzed to compare the degree of improvement in MAM knowledge of students before and after the activity as a questionnaire.

4 Description of VAMEP activity

The group met twice per week for two hours and 10 weeks, using individual PCs in the computer room of Changwon University in Korea. In activity 1, Roblox Studio Creation Workshop was held to explain the functions of Roblox Studio and how to create objects using the platform. This phase was conducted for 4 of 10 weeks. The students learned the interaction mechanism that can be applied to metaverse content through simple coding and making 3D objects. In the last stage of the workshop, the students trained their skills in creating a virtual space by constructing individual buildings (Figure 2).

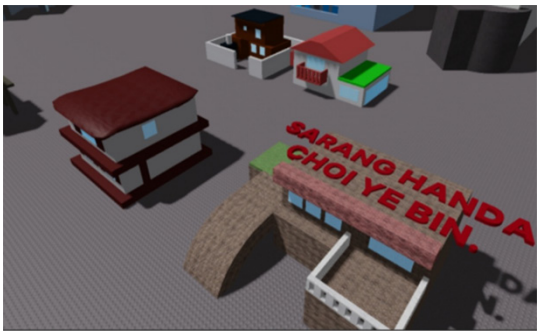
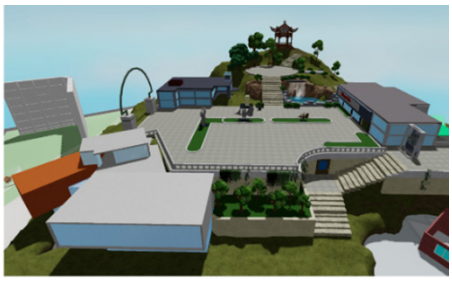


Fig. 2. Structures made by students in creation workshop

Activity 2 focused on exploring a real art museum before recreating it in a virtual space. The students visited the MAM to see the architecture and works. They observed the structure of the actual building, the shape of the stairs, and the textures and shapes of the artwork. By this means, the main factors to be considered in the creation of a virtual museum were identified. Afterwards, the students classified the parts to be expressed in the virtual space and discussed how to represent them as a virtual museum. The virtual space creation task was divided into four areas—architecture, artwork, avatar, and contents—according to students' preferences. As a production method, it was suggested to create a building exactly like the real one or to talk with an artist, which is only possible in the virtual world.

For activity 3, the 15 students were assigned to architecture (4), artwork (4), avatar (3), and content (4) teams based on the creative elements of the virtual art museum and participated in collaborative work. The students used Roblox Studio's Team Create function to create a Roblox virtual space based on their team.

(a) Terrain and Building Layout



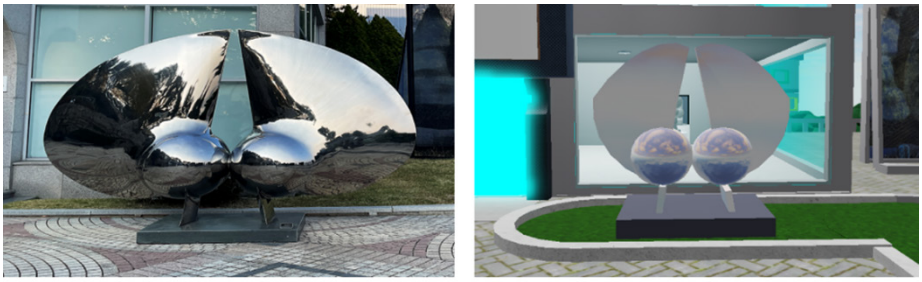
(b) The Art Museum Buildings

Fig. 3. Architecture team

The architecture team imitated the topography and architecture of the MAM. To realistically represent the actual terrain, building layout, size, and distance between buildings, the students used Google Maps' contour map and Roblox Studio's Terrain Editor (Figure 3a). The building's walls, glass windows, floors, and stairs were constructed by referring to the architectural drawings that the MAM provided. To reproduce the

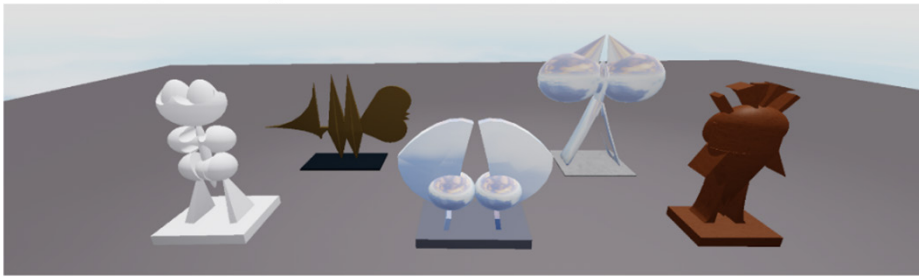
outdoor garden, the students used the free resources provided by Roblox to create a pond, flower beds, and trees (Figure 3b).

The artwork team was tasked with creating and arranging the artwork. 12 artworks were selected based on the experience of observing the real space and the artwork information provided by the MAM website. The team used Roblox Studio's 3D objects (block, ball, cylinder, wedge part) and Solid Modeling function to join, negate, or separate the objects and then copy the shape of the actual sculptures (Figures 4a and 4b). The materials and properties were also adjusted in detail to reproduce the materials used for the artworks, such as metal, plaster, and wood (Figure 4c). The artworks were then arranged according to their actual location in the outdoor garden and exhibition hall, and their sizes and orientations were adjusted.



(a) Actual sculpture

(b) 3D Artwork in Roblox Studio



(c) 3D Artworks

Fig. 4. Artwork team

The avatar team created a Roblox avatar of Moonshin, the sculptor and added animation to implement a moving non-player character. Figure 5a shows five concept avatars created based on Moonshin's photos and videos. By setting the movement using the animation source provided by Roblox and LUA coding, the Moonshin avatars were animated to perform drawings or greetings (Figure 5b).

(a) Moonshin Avatar (b) Avatar in Roblox

Fig. 5. Avatar team

The content team worked on wall labels & descriptions and storytelling planning. The wall labels and descriptions provided artworks or spatial information by creating artwork descriptions, constructing location or floor information boards, and the artist's biographical images. Because Roblox Studio allows users to import images produced using other programs, images such as wall labels and information boards were created in Photoshop and then transferred to the virtual space (Figure 6a). Storytelling planning is the task of planning content that other Roblox users can enjoy when visiting a virtual art museum. Using the interaction options and LUA coding of Roblox Studio, students implemented sitting on chairs, space movement, and conversation with the artist NPC (Figure 6b) and made the game using the model produced by Artwork Team (Figures 6c and 6d).

(a) Wall Description (b) Sitting Moonshin's Work Chair

(c) Climbing Game using Moonshin's Artwork (d) Roblox Users Can Interaction with Artwork

Fig. 6. Content team

After each team completed their collaborative tasks, they assembled their created contents in one space to complete the virtual MAM (Figure 7). Then, Roblox Studio's Testing Mode was used to check and modify the space, 3D object size, interaction, and gameplay from the perspective of a Roblox user.

(a) Moonshin Art Museum in Roblox

(b) Outdoor of Moonshin Art Museum

(c) Exhibition of Moonshin Art Museum

(d) Users in Main Hall of Moonshin Art Museum

Fig. 7. The completed virtual Moonshin Art Museum

5 Results

Table 2 shows the results of questionnaires on the acquisition of VAMEP, which is about the MAM, Moonshin, and the artworks. As a result of the reliability analysis of the questionnaires on MAM, the pre-questionnaire Cronbach's alpha coefficient was 0.696 and the post-questionnaire was 0.741. Q1 and Q4 are for the MAM, Q2 and Q5 are for Moonshin, and Q3 and Q6 are for the artworks. The average values of these responses are given. The pre-questionnaire consisted of items Q1, Q2, and Q3, respectively. Among them, Q2 (Moonshin) had the highest average value. Meanwhile, the post-questionnaire focusing on the student's degree of information acquisition was composed of Q4, Q5, and Q6. Among them, Q5 (Moonshin) and Q6 (Artworks) were the highest with the same score.

Table 2. Questionnaire items for the Moonshin Art Museum

	Question	Average (SD)
Pre-questionnaire	Q1. Did you know about the Moonshin Art Museum before this project?	2.73 (1.22)
	Q2. Did you know about the sculptor Moonshin before this project?	3.20 (1.08)
	Q3. Did you know about Moonshin's artwork before this project?	2.33 (1.35)
Post-questionnaire	Q4. I think I acquired information about the Moonshin Art Museum by creating a virtual art museum.	4.40 (0.63)
	Q5. I think I got information about the sculptor Moonshin by creating a virtual art museum.	4.53 (0.64)
	Q6. I think I got information about Moonshin's artworks by creating a virtual art museum.	4.53 (0.64)

To compare the degree of knowledge before and after participating in VAMEP, a paired-samples T-test was performed. As shown in Table 3, the T values were derived as −4.80, −4.98, and −5.78, indicating that the score values were higher in the post-questionnaire than in the pre-questionnaire. The derived value of p=0.000283, p=0.000220, and p=0.000047 was taken as statistically significant based on the significance level of 0.001. Therefore, a difference was seen in the level of knowledge after activities.

Table 3. Paired t-test results of Moonshin Art Museum

		N	SD	t-test (df=14)
Moonshin Art Museum	**Q1**	15	1.22	−4.80 p= 0.000283***
	Q4	15	0.63	
Moonshin Artworks	**Q2**	15	1.08	−4.93 p= 0.000220***
	Q5	15	0.64	
	Q3	15	1.35	−5.78 P= 0.000047***
	Q6	15	0.64	

Notes: *p<.05, **p<.01, ***p<.001.

Table 4 shows the results for the metaverse content creation ability surveyed by the post-questionnaire, and the Cronbach's alpha coefficient was calculated to be 0.689. Q1 and Q2 pertain to creating metaverse content, respectively. Meanwhile, Q1, which refers to metaverse content creation knowledge, was highly derived. Q3 and Q4 are about collaboration. Q3 had the highest score, indicating the helpfulness of this collaboration.

Table 4. Post-questionnaire items on metaverse content creation

Post-Questionnaire	Average (SD)
Q1. I think I have acquired the technical knowledge to create content in the metaverse through activities.	4.73 (0.46)
Q2. I can create my own interactive space using Roblox Studio.	4.53 (0.52)
Q3. I think the collaboration helped the production.	4.73 (0.46)
Q4. The collaboration could solve technical difficulties.	4.47 (0.64)

6 Discussion

Our purpose was to examine how creating a virtual art museum by students using the Metaverse platform affects the improvement of art knowledge. The results showed that our proposed VAMEP program contributed to the improvement of students' art education. This can be confirmed by the results of the pre-and post-questionnaires. As a result of comparing the questionnaires on the MAM, Moonshin, and Moonshin's artworks, the degree of information acquisition on all items after the creation of the virtual museum increased. These results suggest that exploring information in the process of creating a virtual museum by producing 3D works and planning content helps obtain more information about artists and works as well as museums. Our findings suggest a new way of thinking that utilizes art education and metaverse platforms. VAMEP is different from traditional art and art museum learning methods that unilaterally acquire knowledge. In this activity, students visited an actual art museum and analyzed its architectural and formative elements and studied the artworks. Then, participants explored how to express the art museum in a virtual world through discussion. By utilizing the functions of the Metaverse platform, students created virtual objects that are similar to actual spatial shapes and works of art. By taking advantage of the characteristics of virtual reality, the storyteller's planning created various fun elements, such as games using artworks and artists that do not exist. Through this, a virtual art museum with interactive elements that are only possible in the metaverse environment was completed based on the real art museum. Depending on the student's interests, dividing the tasks into teams by Architecture, Artwork, Avatar, and Content allowed students to focus on what they wanted. As a result, students were able to further improve the completeness of the virtual museum. In addition, the collaboration provided a unique way to share and supplement technical challenges. As such, VAMEP activities provided new opportunities for students to actively participate in art education.

Many studies on the effects of art education through virtual art museums have been conducted. Most of these studies were researched as a way of measuring the educational effect by experiencing them based on the pre-fabricated virtual museums [1–9, 23–24]. While VAMEP in this study is characterized by students directly participating in the creation of virtual art museums and investigating the effect of education on them. Existing studies using the metaverse platform have been used to provide students with virtual 3D models and then develop them accordingly [22, 30–31]. However, VAMEP differs in that after visiting real space, students discuss how to create a virtual art museum and proceed with the creation. In this way, the procedure of visiting a real art museum and observing its space and artworks enabled flexible planning and creation and made it easier to grasp the elements for expression.

There are several limitations in this study, and each limitation provides an opportunity for future research. First, the questionnaire that was conducted to verify the results of this study lacked reliability and validity. Although the questionnaire was composed regarding similar studies, this was insufficient to show the results of knowledge improvement through VAMEP. Thus, in future research, it will be necessary to verify the educational effect through the design of superior questionnaire items and contents. Additionally, the number of students participating in the study was small. Later, improved means of confirming the results of the treatment group and the control group with more participants may also strengthen the meaning of the study.

7 Conclusion

The results of VAMEP suggest that student participation in the creation of a virtual art museum is an effective method of art education that can promote the acquisition of knowledge about art museums, artists, and artworks. Through the activities shown in this study, students directly participated in art education by creating and planning a building, artwork, and avatar and their interaction in a virtual art museum. Furthermore, the students could naturally explore and acquire information about the art museum. Educational programs such as VAMEP should be incorporated into the curriculum to develop students' educational curiosity and encourage them to participate more actively in educational activities. To this end, we plan to use VAMEP for education in local cultural spaces and museums. This work will be applied in the spatial revitalization and cultural education contexts. This study is expected to open new possibilities using metaverse technology in delivering education about art museums.

8 Acknowledgments

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10 Authors

DongHyun Kang is a master's degree student in the Department of Culture and Technology Convergence, Changwon National University, Changwon, Korea. Her research is specialized in space and interaction in Virtual Reality and Metaverse. (email: hyunykk@changwon.ac.kr)

HaRam Choi is Ph. D student in the Department of Culture and Technology Convergence, Changwon National University, Changwon, Korea. Her research area is to analyze user experience in Virtual Reality using bio-signals. (email: gka4003@changwon.ac.kr)

SangHun Nam is an assistant professor in the Department of Culture Technology, Changwon National University, Changwon, Korea. His research interests include the haptic user interface, experience, and biomedical technology in Virtual and Augmented Reality. (email: sanghunnam@changwon.ac.kr).

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