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The Virtual Museum Rubric: A Preliminary Report

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Abstract: Recent developments in virtual reality (VR) have opened the doors to many unique opportunities for individuals to create virtual exhibitions and museums. However, this does not guarantee the creation of successful museums, as many factors need to be considered to provide an enjoyable visitor experience. To this end, this paper describes our preliminary attempt to construct a rubric for assessing the quality of virtual reality museums. The development stage was divided into four main areas. First, a research team was asked to reflect on their desired expectations of the exhibitions, the goals for creating the museums, and their expectations. Second, the specifics of the evaluation of the design and structure were determined with reference to the museological literature. Thirdly, the related objectives were identified and grouped, leading to the formation of the core dimensions for the rubric. Finally, the core dimensions were used to create an evaluation rubric. The rubric was divided into four categories: Exhibition Planning, Spatial Design, Display, and Exhibition Graphics. For each category, the specific dimensions were selected, and the basic concepts were discussed. Furthermore, the evaluation criteria for successful exhibitions and experiences were presented, as well as how each dimension helps in the evaluation of virtual reality museums. The rubric we presented is expected to improve the overall quality of exhibitions and experiences of virtual reality museums.

Keywords: Museology, Virtual Reality, Metaverse, Evaluation, Gallery

INTRODUCTION

Background of the Study

The concept of museums has been around for centuries, with the earliest known examples appearing as private collections of wealthy individuals who wanted to display art and other artifacts (The Japan Society for Exhibition Studies [JSES], 2019). It was not until the 18th century that public museums became more common, with some of the most famous being the British Museum in London and the Louvre in Paris. These two museums are the pioneers of modern museums and set the standard for the type of institutions that exist today. Nowadays, there are many public and private museums around the world, each offering a unique opportunity to learn about a variety of subjects such as art, history, and science.

Owning and running a museum is a significant undertaking that requires not only financial resources but also a high level of commitment and expertise (Boylan & Boylan, 2004; Walhimer, 2015). Firstly, the acquisition of collections is a key aspect of running a museum. This involves sourcing, purchasing, or being gifted artifacts, artworks, or historical items. The process is often time-consuming and expensive, requiring knowledge of provenance, historical

significance, and valuation. In addition, items often require special handling and storage conditions to prevent damage and deterioration, adding to the cost. The physical building to house the museum is another significant expense. The building needs to be suitable for the storage and presentation of collections and may require special features like climate control, security systems, and display areas. Maintenance costs for such a building can be high. Additionally, the location of the building is critical. It must be easily accessible to attract visitors and must comply with zoning laws and regulations. Staffing a museum is another significant cost and involves hiring professionals such as curators, conservators, and managers, who have specialized skills and knowledge. These professionals are responsible for managing the collections, planning exhibitions, and running educational programs. They also ensure the museum complies with ethical standards and legal requirements. Given these factors, it's clear that the ownership and maintenance of a physical museum are not light tasks to undertake and are prohibitive for most people.

Virtual Reality Museum

In recent years, virtual reality technology has developed dramatically, with virtual reality devices and software environments for publishing virtual spaces becoming more affordable and accessible to the masses. This has enabled a shift in the way people experience and share knowledge, as both established museums and individuals can now create their virtual exhibitions and museums. The advantages over physical museums are numerous (Hill, 2022). The size of the exhibition space can be virtually unlimited, allowing a much greater degree of freedom and creativity in the design of the space and experience. In addition, sourcing artifacts for the exhibition is much less expensive than in a physical museum, as there is no need to worry about the fragility or cost of the items. This can be further helped by the fact that maintenance costs are significantly lower than in a physical museum. The cost savings associated with virtual exhibitions and museums also allow them to be much more accessible to a wider audience, as they can be easily shared online. All of these factors have opened up a wide range of opportunities for people to create and share their virtual exhibitions and museums with the public, enabling them to share their knowledge, passion, and creativity with the rest of the world.

However, setting up and running a museum, whether physical or virtual, is not just about building and collecting artifacts - many factors need to be carefully considered to create a great visitor experience. Throughout the design process, there should be an emphasis on the visitor's point of view, accompanied by a thorough understanding of the key components required for the museum. Firstly, it is vital to understand the target audience by analyzing demographics and researching specific trends to create content that truly meets the visitor's needs. Exhibits (especially those of historical nature) should be curated with a clear 'storyline' in mind, underlining the importance of narrative coherence, to ensure that points and themes are comprehensible to the visitor. This can be achieved through the use of audio and video guides, as well as the implementation of curated displays that change throughout the year. In addition, the accessibility of the museum's content is also a priority and should be included in the plans. All of this may sound obvious to museum professionals, but it may be an entirely new area of knowledge for the layperson.

Rubrics

One of the most promising ways to help non-professionals develop virtual reality museums is to provide a simple guidance system to assess whether the exhibitions are well-designed, easily accessible to visitors, and able to provide a positive experience. To provide this guidance, we focused on the use of rubrics. Rubrics are widely used for assessment purposes in many school and university courses. They are a very useful tool for assessing and evaluating the performance of an assignment, task, or group project by detailing the expectations in an organized and effective way (Stevens & Levi, 2013). On the other hand, rubrics have also been used for self-evaluation by students (Andrade, 2007). They can be an excellent tool for students to learn what quality looks like in a particular field, as defined by experts, and to guide their self-assessment. The use of a rubric can support the learning process and help students to understand the criteria used to assess the quality of their work, identify areas in which they need to improve, and develop strategies for achieving higher quality work. Krebs et al. (Krebs2022) reported that self-assessment rubrics for the quality of self-written scientific abstracts increased task performance, improved the accuracy of judgments, and reduced the cognitive load of self-assessment. Therefore, if designed correctly, a rubric can provide students with important guidance and feedback while still allowing them to be creative.

While rubrics have been used extensively in an educational context, they can also help evaluate educational software, including educational VR apps (Cherner et al., 2016; Lee & Cherner, 2015; Papadakis et al., 2017). Lee & Cherner (2015) developed a rubric specifically designed to analyze educational apps for tablet devices. The rubric was created to assist teachers in identifying high-quality apps for their students. Considering the existing literature, they

selected 24 evaluation dimensions to form the basis of the rubric, covering three domains: Instruction, Design, and Engagement. Each domain was specifically designed to determine how well an app can increase the speed, competence, and ability of teachers to complete daily tasks, and how effectively the setup, digital pathways, and design provide a pleasing user experience. Their rubric was created to ensure that teachers can stay informed and up to date with the best apps available to enhance the learning process for their students.

Fegely & Cherner (2021) expanded the rubric for educational mobile VR applications by adding four more domains to cover broader aspects of virtual reality. These include Positioning of Educational VR, Avatar Level, Virtual Environment, and Virtual Experience. The first domain assesses whether virtual reality is an appropriate and effective method of delivering educational content. Avatar Level assesses the appearance and interaction functionalities of the avatars, while Virtual Environment and Virtual Experience analyze the authenticity of the virtual environment and the quality of embodiment. The addition of these four domains further enhances the rubric to be more comprehensive in the evaluation of mobile VR educational applications, as each domain dictates a distinct attribute that needs to be considered.

We believe that a virtual museum rubric can help non-professionals to develop a space that is accessible, engaging, and educational. They can be assured that their efforts are well-directed and that the end product is of high quality. The use of a rubric can help improve the virtual museum experience by providing a clear framework for evaluation. It can also provide valuable feedback on areas where additional work is needed and suggest ways to improve the design and user experience. Ultimately, this can help ensure that the virtual reality museum is successful in achieving its educational and entertainment goals.

Purpose of This Study

It is now clear that rubrics can be used as both a self-assessment and evaluation tool for Virtual Reality (VR) applications. Consequently, likely, rubrics can also be used for the self-evaluation of virtual reality museums by individuals. While some attempts have been made to evaluate VR exhibitions using questionnaires answered by users, no specific rubrics have been created for those designing such exhibitions. We have therefore initiated the formulation of rubrics for the design of virtual reality museums. This article summarizes our initial findings. Using this rubric, we expect that people will be able to objectively assess the positive and negative aspects of their virtual displays and improve them to ensure a better visitor experience.

METHODOLOGY

Following Stevens & Levi's (2013) original guide for constructing rubrics for student assignments, we divided the development phase of our rubrics for virtual reality museums into four stages. The first stage was 'Reflecting', in which we spent time considering the desired experiences of the exhibitions, the purpose of creating the museums, the outcomes of similar VR experiences in the past, and our expectations of the museums. During this stage, we looked inwards and critically evaluated our goals for the virtual reality museums. While virtual reality museums can host a variety of exhibitions, such as an art gallery of Japanese paintings from the Edo period or scientific exhibitions about earthquakes, we decided to develop our rubrics primarily for history museums based on our expertise and experience in this field. These history museums are mainly aimed at children who want to learn about the history and culture of a country or region they live in, as well as visitors to the area. Such museums may have features such as interactive displays with multimedia content, 3D reconstructions, simulations, and recreations of historical events to ensure that children can learn in an effective, engaging, and enjoyable way. There can also be a variety of virtual activities and quizzes for children to explore and participate in, as well as plenty of vivid visual illustrations and multilingual support for visitors from other countries. To ensure the effectiveness of these exhibitions, our museum design rubric will take into account the right way to build this type of museum.

The second stage in the development of our rubric was 'Listing'. This stage was dedicated to the precise documentation of the specifics of the evaluation of museum designs required for the proposed objectives. According to Lord et al. (2022), the evaluation of museum exhibitions is commonly divided into four stages: front-end, formative, remedial, and summative. Front-end evaluation is carried out early in the planning process and includes the definition of objectives and audience. Formative evaluation develops content and tests communication methods. The remedial evaluation looks at aspects such as circulation and sight lines to improve the impact of the exhibition. Summative evaluation is carried out after the exhibition has opened and measures the success of the earlier stages. This data is then used to inform the development of future exhibitions. In this article, we focus on 'front-end' and 'formative'

evaluations to assist in the early stages of virtual museum development before it is made available to the public. In order to determine the design goals to be examined in the evaluations, we adopted a heuristic approach and drew heavily on the museology literature, both Japanese and English, for physical museums. By collecting relevant texts and figures, we identified the categories of attributes for effective exhibition design. Detailed descriptions of these categories are given in the RESULTS section.

The third stage is 'Grouping and Labelling.' Here we arranged the interrelated objectives discovered in the first and second stages to form the core dimensions of the rubric. We identified the important elements and the qualities each needed to have to achieve our desired outcome. Finally, in the fourth stage, 'Application,' we used the dimensions and descriptions from the previous stage to develop a comprehensive rubric. This is the time to combine theory and practice, supporting each element of the design with the appropriate criteria. As our project is still ongoing, we have not yet completed these two stages, but we will discuss the plan in the discussion section.

RESULTS

As mentioned in the previous section, we selected four categories of attributes for the dimensions of our rubrics: (A) Exhibition Planning, (B) Spatial Design, (C) Display, and (D) Exhibition Graphics. This section describes each of the categories and the proposed dimensions in detail (Table 1). We explain the basic concepts of the categories and the desirable characteristics associated with them. All these categories and dimensions of our rubrics are necessary to create successful exhibitions. Understanding their concept and desirable characteristics should help to explain why they were chosen and how they contribute to creating a successful exhibition.

A: Exhibition Planning

At the beginning of the museum production, the exhibition concept and planning are carried out. The exhibition concept is "to set the necessary goals for the design work based on the purpose, direction, or characteristics and tendencies of the exhibition materials and information" (JSES, 2019). It involves determining the purpose of the museum to be produced this time, investigating what will be exhibited and what information the exhibition will provide, and roughly creating the form of the museum. In addition, the plan is to decide on concrete matters such as the form of the museum and what kind of experience will be had in the museum. The plan determines the overall intention of the exhibition, the information to be conveyed, the flow of the exhibition, and the things to be displayed.

Therefore, we selected the following dimensions for this category of the rubric: (A-1) Concept of the exhibition, (A-2) Target audience, (A-3) Structure of the exhibition, and (A-4) Story of the exhibition. The concept of the exhibition is about the theme of the exhibition. This is the core of the exhibition, and the creator must clearly define what they want to tell and what experience they want visitors to have. Secondly, the target audience must be identified. Targeting helps to clarify the aims of the museum.

Once the concept and target audience have been decided, the structure and story of the exhibition should be formulated. The 'structure' here is not about how well 3D models of the museum are designed. It is a hierarchical outline of the exhibition structured around its theme. Wakatsuki said that "just as books have a hierarchy of chapters, sections, and subsections, exhibitions can be structured into stories with a hierarchy of large, medium, and small sections." (Wakatsuki, 2021). The hierarchy can consist of exhibition zones, exhibition corners, and exhibition items. An exhibition zone is a unit that forms an exhibition space. It consists of a number of exhibition corners. An exhibition corner consists of several exhibition items. An exhibition item is an item for visitors to browse. In principle, the order of zones, corners, and items should be determined in this order.

As exhibition designers decide on the structure, they should also decide on the flow of the overall story. Story flow refers to the order in which exhibits are displayed. Wakatsuki (2021) divided it into the following categories: chronological, parallel, environmental restoration, single-item, and a combination of these. In the chronological type, items are presented according to the passage of time. The parallel type, on the other hand, has no particular order of priority for the exhibits. In this style, an exhibition on food may show Japanese food earlier than Indian food, but it does not imply that it is superior or was invented earlier than Indian food. In the environmental restoration type, the exhibition space becomes a kind of parallel world, such as a reproduction of a historical scene or a large diorama. Finally, in the single-item type, each item has a complete story, with few connections between items.

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Table 1.

The Virtual Museum Rubric

Dimensions	Criteria
(A)Exhibition planning	
(A-1) Concept of the exhibition	1. Is the overall concept of the museum well-established? 2. Is the aim and positioning of the exhibition clear? 3. Is the exhibition theme easy to understand?
(A-2) Target audience	1. Does the determined exhibition concept and theme match the audience's needs? 2. Do the overall philosophy and target of the museum align well? 3. Is the persona of the intended visitors identified in each exhibit?
(A-3) Structure of the exhibition	1. Is the exhibition content appropriately hierarchized according to the exhibition theme? 2. Is the exhibition organized in a structured manner? 3. Are the hierarchies divided into major elements (exhibition zones), medium elements (exhibition corners), and minor elements (exhibition items)? 4. Are the fundamental aspects of the exhibition, such as spatial design and graphics, clearly defined at the basic design stage?
(A-4) Story of the exhibition	1. Is the overall flow of the exhibition in place, considering the exhibition structure? 2. Is the story appropriate for the theme?
(B) Exhibition space	
(B-1) Design of routes	1. Can the overall route of the exhibition be classified into a suitable type (central square type, corridor connection type, flat touring type, etc.)? 2. Does the choice of route align with the size, arrangement, and exhibition story of the exhibition space? 3. Is the route designed to avoid being unnecessarily long to prevent fatigue from prolonged walking or VR sickness?
(B-2) Zoning of exhibition areas	1. Is the size and arrangement of spaces organized according to their functions and characteristics? 2. Has the introductory area, exhibition area, and educational area been considered? 3. In the introductory area, is space secured for visitors to familiarize themselves with the VR environment, and is the connection to other areas clear? 4. In the exhibition area, is the space arranged in a way that matches the flow of people anticipated from the route planning? 5. In the education area, is there sufficient space secured for interactive content, and has it been evaluated how the experience of the content can affect the flow of people?

(C) Display	
(C-1) Display formats	1. Has an appropriate display format, such as static, dynamic, and participatory/experiential exhibitions, been chosen? 2. Does the chosen display format effectively draw visitors' attention and maximize educational benefits? 3. Are interactive participatory exhibits successful in immersing visitors in the exhibition narrative? 4. Is excessive staging avoided so as not to diminish interest in the exhibits?
(C-2) Design of exhibition spaces	1. Does the design of the exhibition room align with the content and display formats of the exhibits? 2. Is the size of the space chosen appropriately, taking into account visitor comfort and avoiding feelings of claustrophobia? 3. Is the route within the exhibit room clear for visitors?
(C-3) Visibility of display objects	1. Has the visibility of the exhibits been ensured. 2. Have the viewpoints and fields of view for various devices, including VR headsets, PCs, and smartphones, been adequately considered? 3. Has the experience been tested on various devices to ensure optimal viewing for all visitors? 4. When multiple works are displayed together, are they hung so that the center of each work is at the same height? 5. Is there sufficient distance between large objects and the viewer to ensure comfortable viewing? 6. Has the optimal distance been set, considering a comfortable vertical field of view, which is approximately 30 degrees?
(D) Exhibition graphics	
(D-1) Visibility of exhibition graphics	1. Is the font legibility high? 2. Has the font size, line spacing, and font been chosen considering the resolution of the VR headset? 3. Is the number of characters minimal and the content efficient? 4. Is the resolution of the image texture sufficient? 5. Is the font still visible even when the display quality on the app is lowered? 6. Is the color contrast appropriate? 7. Has consideration been given to individuals with color blindness?
(D-2) Organization of exhibition graphics	1. Does it convey information clearly and enhance the overall atmosphere of the gallery? 2. Are the graphics presented in a logical (usually hierarchized into large, medium, and small) and easy-to-understand sequence? 3. Can visitors quickly and easily find the information they need and move between the objects? 4. Is the logical structure of the exhibition story made easy to understand following a consistent design standard? 5. Do the large panels include the title panel and introductory panel? 6. Are the medium panels comprised of items that explain the themes or topics of the exhibition? 7. Are the small panels dedicated to individual exhibits?

B: Spatial Design

The study of museums requires careful consideration of both curatorial intent and spatial design. While curatorial intent has been studied extensively, the importance of spatial design in the museum experience has only been recognized in recent years (Hillier & Tzortzi, 2007). It is now well established that the right spatial design can significantly enhance the museum experience. This is particularly true in virtual reality museums, where designers can start with a blank canvas and carefully construct the entire building with both curatorial and architectural considerations in mind. However, this can be challenging for those without museum design experience, as this degree of freedom can be daunting. In addition, the environment must be meticulously planned to ensure a smooth flow of visitors and a coherent aesthetic for the building. For example, in a physical museum, a particular exhibit may be intricately designed, but if it is placed in an area that is not aesthetically pleasing or has too little space to move around, the content of the exhibit can easily be lost on the visitor. This highlights the importance of space in enhancing the overall museum experience.

With these considerations in mind, we chose two dimensions for this category: (B-1) Design of routes and (B-2) Zoning of exhibition areas. The design of routes is an essential element in the design of museum exhibitions, as it can help to reinforce the narrative of the museum and ensure that visitors have a pleasant experience. Although virtual museums may cause less fatigue than physical museums, a long session in VR can be stressful and cause nausea and other physical discomfort. Careful route planning is therefore essential. A well-designed route can facilitate visitor flow, allowing individuals to move around the exhibition space smoothly and comfortably. It can also allow visitors to linger in certain areas or move quickly through them, depending on their preferences.

The classification of routes is complex, but a variety of patterns have been proposed (Saraoui et al., 2018). For example, Kurita (2019) identified three types of routes: the central square type, the corridor connection type, and the flat touring type. In the central square type, the center of the museum is occupied by a hall or square from which each exhibition room is accessed, and the rooms are disconnected from each other. Whilst this gives visitors maximum freedom in the order in which they visit the rooms, there is a greater risk of people colliding as routes are likely to overlap. It may therefore be less efficient for a large and crowded museum. In the corridor connection type, each exhibition room is connected by a corridor, which is often circular but can also be straight, as in the Centre Pompidou in Paris. This type limits the order in which rooms can be visited, but visitors can still choose whether or not to enter each room. This form is more spatially efficient than other forms and is therefore often used by large museums. Finally, in the flat touring type, the exhibition rooms are directly connected. As a result, the route becomes a straight line, and visitors are forced to visit all the rooms. It is therefore most suitable when the museum is small or when large numbers of visitors are expected, and the flow of visitors needs to be strictly controlled.

In addition to the route design, the zoning of exhibition spaces is also an essential aspect of the museum's spatial design, as the two are closely related. Here, zoning refers to the organization of spaces according to their functions and characteristics (Kurosawa, 2014). It is important that the zoning is straightforward, avoiding the crossing of different routes and ensuring that the size of spaces is sufficient for the expected number of visitors. While securing backyard areas, such as staff areas and storage rooms, is only applicable to physical museums, the careful allocation of introductory, educational, and exhibition areas is essential for both physical and virtual museums. Introductory areas in virtual museums are vital, especially for inexperienced visitors, as they often provide an overview of the exhibition. They can include welcome messages, a guide to navigating the museum, and a brief overview of the various exhibits and collections. They help visitors find their way around and foster a sense of connection with the museum and its content. Educational spaces, on the other hand, provide visitors with an interactive learning experience that can help them understand the various exhibits in a museum. As interactive content often requires a significant amount of space and time to be experienced, it is essential to consider whether sufficient space has been allocated and how this may affect the flow of visitors. Exhibition space is the main purpose of the museum, and designers should arrange the zones and information in a way that is consistent with the visitor flows expected from the route planning. If this is done poorly, visitors may become confused and disoriented and find it difficult to follow the story of the exhibition.

C: Display

The display of artifacts can draw visitors into the exhibition and bring to life the stories that exhibitors want to tell through objects. Through careful placement of objects, museums can evoke a range of emotions in visitors that would not otherwise be possible. The arrangement of artifacts in an exhibition should be deliberate and thoughtful in

order to maximize visitor engagement. Display areas should create an atmosphere that is welcoming, comfortable, and accessible to all, including children and people with disabilities. Display designers should consider the use of color, contrast, light, and sound, as well as the placement of objects, to create an effective exhibition experience. Location, orientation, and scale are also important factors, as they can be used to highlight certain artifacts or create a narrative that links different objects together. Ultimately, the quality of a museum's displays can make or break an exhibition.

Our rubric assesses the quality of a museum's displays in three dimensions: (C-1) Display formats, (C-2) Design of exhibition spaces, and (C-3) Visibility of display objects. Display formats are crucial for exhibition design because they help to create a visually engaging experience for visitors. Because virtual reality museums offer a variety of display formats that are not available in physical displays, choosing suitable formats is essential (Hill, 2022). They define how information is presented, which objects are highlighted, and which stories are told in each exhibition space. Display formats also determine how visitors interact with objects and create a memorable experience that encourages further exploration and learning.

In his book, Kurosawa (2014) classified exhibition display formats into seven categories, including static, dynamic, and participatory (experiential). We excluded other categories (e.g., live animal and plant displays) here as they are not relevant to virtual museums. The static type of display is the most traditional and does not use interactive elements or multimedia. Calligraphies, photographs, paintings, artifacts, and specimens can be displayed in this format. This format is suitable for didactic exhibitions that aim to educate visitors on a particular subject or provide an overview of a topic in an organized and structured way. It is important to make it easier for them to gain a deeper understanding of the subject without overloading them with information, which can become boring. Dynamic displays can include audio-visual media and interactive installations using 3D models. They can show real footage of historical events so that visitors can experience the past or demonstrate how objects move and function in real-life situations. They allow visitors to engage with the exhibit in a more engaging and meaningful way. It should be noted that dynamic displays are more technically challenging and often malfunction (e.g., videos do not stream properly). In addition, technical flashiness can distract visitors from the content of the exhibition.

Finally, the participatory (experiential) display is about understanding the content of exhibitions through hands-on experience. This encourages visitors to actively engage with the objects on display through interaction, exploration, or experimentation. It allows visitors to experience the museum not only visually but also emotionally and personally. Examples of participatory displays include hands-on activities, mini-games, and virtual experiments. This type of display is even more technical than dynamic display and may not be possible in certain virtual reality platforms. It may also require guidance and intervention by human staff, in which case the time and number of people who can participate will be limited.

Once the display format has been decided, the design of the exhibition space needs to be determined. Unlike physical museums, exhibition spaces in virtual reality museums can be easily customized, so they should be adapted to suit the content and formats of the displays. Visitor comfort should also be considered. For example, smaller rooms may provide a more intimate and focused experience, but they may feel uncomfortable and claustrophobic. A larger space with a high ceiling may give visitors a sense of awe, but an oversized room may force them to walk long distances, which can cause motion sickness. As a guide, the ceiling height is around 4 m for small rooms and 6~8 m for large rooms (Stanwick & Maximea, 2022).

Finally, the visibility of display objects should be considered. For example, artwork should be hung so that the center of the artwork is at eye level, which is usually around 1.6m from the floor for an average adult (Dean2002). Larger paintings can be hung higher, while smaller paintings can be hung lower for better visibility. And when hanging several works together, the center of each work should be at the same height. When displaying large objects, it is also vital to ensure that there is sufficient distance between the object and the viewer. For most viewers, a comfortable vertical field of view is around 30 degrees (Kurata & Yajima, 1997), so the optimum distance will be around 1.5~2 times the height of the object. It should be noted that the visibility of display objects can be a complex issue for virtual reality museums, as visitors may use VR headsets, PCs, or mobile devices to access the sites. These devices have different fields of view, and users may have different viewing heights depending on whether they are navigating in a seated or standing position with VR headsets or how the default heights are set for PC and mobile device users. Therefore, it is essential to test the space with as many different devices as possible to ensure the best experience for all types of visitors.

D: Exhibition Graphics

Exhibition graphics (or simply graphics) are the visuals and text used to convey information in museum exhibitions. These graphics can include labels, captions, panels, and maps. According to Wakatsuki (2021), exhibition graphics have three functions. The first is to provide basic information about an object, such as its name, creator, and year of completion. The second is to organize information. It is essential for exhibitors to differentiate and structure information into well-defined categories and to standardize fonts, colors, and other elements for each of these categories when designing the graphics. This technique helps to give a sense of cohesion and distinction to the overall design and effectively presents the content the exhibitor wishes to communicate. Finally, graphics can be employed to create a dramatic visual impact in an exhibition space. They can act as directional signage, giving the viewer a visual indication of the location and placement of exhibits within the space. They can also take on the role of narrator, helping to tell the story of the exhibition. In addition, graphics can be used to recreate historical settings and conditions that were relevant to the exhibits on display, creating a realistic setting that further stimulates visitors' interest in the subject matter.

To evaluate whether the exhibition graphics fulfill these functions, we chose two dimensions for this category: (D-1) Visibility and (D-2) Organization of Exhibition Graphics. We decided to exclude the Impact of Exhibition Graphics because there is not enough literature to create evaluation criteria for this dimension. All of these dimensions apply to both visual and textual entities. While graphics are a key component of exhibitions, visitors may not have much time to devote to reading directional signs. Understanding that visitors must absorb content while walking or standing, which can be a source of stress, it is vital to ensure that the visibility of exhibition graphics is achieved with understanding and maximum legibility in mind. This will minimize the burden on visitors and allow them to absorb content as quickly and easily as possible. Graphics should be appropriately sized so that all content can be seen from a distance and include larger font sizes for easy reading. In addition, exhibit graphics should be placed in areas where they are easily visible to all visitors and at eye level to ensure they are not overlooked. And the placement of graphics should guide visitors as to which objects or exhibit areas are being referenced (Serrell, 2015). Standardization of design elements needs to be implemented to reinforce this. Taking all of these factors into consideration will help ensure that visitors have the best possible experience while viewing the exhibit.

The organization of exhibit graphics is key to conveying information and enhancing the overall atmosphere of the gallery. By organizing exhibition graphics logically and sequentially, visitors can quickly and easily find the information they need and move between works of art. This allows them to get the most out of their museum visit by quickly finding the relevant information they need without feeling overwhelmed or confused. Exhibition graphics are often grouped into different "levels" (Kurosawa, 2014). According to JSES (2019), the top level includes title panels and introductory panels that show the title of the exhibition and invite visitors into the exhibits. The second level consists of the items that explain the themes or topics of the exhibitions, and the third level is for individual objects. The structure of the hierarchy should follow the logical structure of the story of the exhibition to enable visitors to understand the story presented in the exhibition. The logical structure of the exhibition graphics should also accurately reflect the production process in order to maintain a consistent design standard (Yacob & Tang, 2022). Any graphic templates used should be well structured and help to maintain the desired hierarchies of graphic elements. Such consistency is evaluated in this dimension of our rubric.

DISCUSSION

This paper discussed four categories of rubrics (A: Exhibition Planning, B: Spatial Design, C: Display, and D: Exhibition Graphics) and their related dimensions necessary for creating successful exhibitions. The categories and dimensions were carefully chosen based on the literature and the characteristics of virtual reality museums. Examination of each category and its related dimensions revealed that creating successful exhibitions requires decisions on various issues, ranging from concept and target audience to display formats and exhibit path design.

Our rubric does not yet incorporate scales. Typically, rubrics have a scoring system so that evaluators can assign numerical values to each dimension and calculate an overall score for student work. In addition, rubrics usually include criteria for how each dimension should be scored. These criteria are quantifiable so that evaluators can accurately assess the quality of the museum's design. Although we still believe that it may be better to have such scoring systems to compare the attributes of multiple museums, they may not be essential for self-evaluations whose purpose is to improve the quality of museums rather than to evaluate which museum is superior to the others.

Accordingly, we used a methodology similar to the scoring guide rubric that outlines the criteria for the highest level of performance (Stevens & Levi, 2013). While this type of rubric allows for more flexibility and personalization in grading, it requires graders to explain in writing in which areas students did not perform at the expected level. This often results in increased grading time and is therefore not ideal for school settings. On the other hand, such detailed articulation is not required for self-assessments, and its benefits are particularly useful in virtual reality museums, which tend to be highly varied and often personalized. Thus, we believe it was appropriate for this paper to focus on identifying the dimensions of quality and what is required to be considered desirable in each dimension.

However, we recognize the need to analyze whether our rubric, developed in this style, can aid in the design of the museum. Currently, we are designing a virtual reality museum of local history in a city in Japan and using our rubric to improve the quality of the museum. Through this research, we want to determine whether the criteria for the dimensions are suitable for judging the quality of the museum and whether additional dimensions should be included in the rubric. Additionally, exploring interrater reliability would provide further insight into whether the criteria laid out in the rubric are clear, precise, and universally applicable. If different raters interpret and apply the criteria differently, it may indicate that the rubric needs refining for better clarity and consistency. This will not only improve the rubric but also contribute to a more rigorous and objective assessment of virtual reality museums. It is also important to experiment with this rubric on a variety of virtual reality museums. As mentioned above, the rubric in this paper was primarily intended for history museums, and therefore further modifications will be necessary to make it applicable to different types of museums on a broader scale.

CONCLUSION

This paper presented a comprehensive rubric for evaluating and designing virtual reality museums that included essential elements for successful exhibitions. A rubric is a practical tool that can be used by individuals, including teachers and hobbyists, to evaluate the quality of their virtual museums and ensure that the exhibition is engaging and of the highest quality. Once fully developed, our rubrics can play a revolutionary role in making virtual reality museums accessible and allowing more people to share their knowledge, passion, and creativity with the world.

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