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DEVELOPMENT OF A 3D VIRTUAL REALITY TOUR MEDIA FOR THE SIAK SRI INDRAPURA PALACE BASED ON THE THEASYS APPLICATION AS A SOURCE FOR LEARNING LOCAL HISTORY

Refli Surya Barkara[1], Chandra Perwira Negara[2], M. Afrillyan Dwi Syahputra[3], Roza Sri Susanti[4]
[1, 2, 3, 4] Universitas Riau
[1] raflysuryabagaskara@lecturer.unri.ac.id, [2] chandra.perwira@lecturer.unri.ac.id,
[3] m.afrillyan@lecturer.unri.ac.id, [4] roza.sri@lecturer.unri.ac.id

Abstract
The Siak Sri Indrapura Palace is a local historical heritage site with high historical and cultural value. However, a direct visit to this historical site requires time, effort, and expense. Therefore, innovative learning media are needed to bring the palace's authentic atmosphere into the classroom. Teasys is a web-based platform used to create interactive virtual reality tours. Through Teasys, users can upload photos from a 360° camera and then combine them into a virtual reality tour that appears to be directly on site. The purpose of this study was to develop a virtual reality tour media for the Siak Sri Indrapura Palace based on Teasys. This study used a Research and Development (R&D) approach to design and evaluate the effectiveness of the designed product. The development model used was the waterfall model, which includes the needs analysis stage, the media and content design stage, the product design stage, and the testing stage. The results of this study indicate that the 3D virtual reality tour media meets the adequacy standards and can be applied as a learning medium. In addition, student responses to the media showed very positive reactions.
Keywords: Local History, 3D Virtual Reality Tour, Siak Sri Indrapura Palace, Teasys

Abstrak
Istana Siak Sri Indrapura merupakan situs warisan sejarah lokal dengan nilai sejarah dan budaya yang tinggi. Namun, kunjungan langsung ke situs bersejarah ini membutuhkan waktu, usaha, dan biaya. Oleh karena itu, dibutuhkan media pembelajaran inovatif untuk membawa suasana otentik istana ke dalam kelas. Teasys adalah platform berbasis web yang digunakan untuk membuat tur realitas virtual interaktif. Melalui Teasys, pengguna dapat mengunggah foto dari kamera 360° dan kemudian menggabungkannya menjadi tur realitas virtual yang tampak seperti berada langsung di lokasi. Tujuan penelitian ini adalah untuk mengembangkan media tur realitas virtual untuk Istana Siak Sri Indrapura berdasarkan Teasys. Penelitian ini menggunakan pendekatan Penelitian dan Pengembangan (R&D) untuk merancang dan mengevaluasi efektivitas produk yang dirancang. Model pengembangan yang digunakan adalah model waterfall, yang meliputi tahap analisis kebutuhan, tahap desain media dan konten, tahap desain produk, dan tahap pengujian. Hasil penelitian ini menunjukkan bahwa media tur realitas virtual 3D memenuhi standar kecukupan dan dapat diterapkan sebagai media pembelajaran. Selain itu, respons siswa terhadap media tersebut menunjukkan reaksi yang sangat positif.
Kata kunci: Sejarah Lokal, Tur Realitas Virtual 3D, Istana Siak Sri Indrapura, Teasys

INTRODUCTION

Education in Indonesia currently faces various challenges in efforts to improve the quality and equity of access to the learning process. Despite reform efforts through policies such as the Independent Curriculum, which gives educators the freedom to adapt learning materials to student needs, significant gaps remain in terms of quality and equity of access to education, particularly in remote areas. According to research conducted by Adiyono et al.,[1] the learning process in Indonesia is less than optimal due to limited available resources, both in the form of learning media and teachers' ability to use advanced educational technology.

In the context of history learning, these challenges are even more complex. History lessons are often considered less engaging because they are delivered using limited, conventional methods, such as lectures and textbooks, which do not always stimulate optimal learning interest. This is exacerbated by the inability of many teachers to process local historical material and integrate it with the more general topics of the national curriculum. As explained by Fahrizal et al.,[2] many history teachers still struggle to access and utilize learning media that can bring local history material to life in a broader and more relevant context. This often results in history lessons appearing boring and irrelevant.

Furthermore, many historical sites in Indonesia, such as the Siak Sri Indrapura Palace, hold significant historical value but are difficult for the general public to access. Physical barriers such as long distances, poor road access, and a lack of supporting facilities prevent many from directly accessing and learning about this cultural heritage. Furthermore, conventional learning methods that rely solely on narrative or images cannot provide students with immersive, hands-on experiences. This aligns with research findings by Syaputra et al.,[3] which showed that history learning that relies solely on lectures and texts is less effective in enhancing students' understanding of history.

To address this issue, technology-based learning media, such as Virtual Reality (VR), offer a potentially powerful solution. VR allows individuals to "visit" historical sites and experience the historical experience more realistically, even without being present at the site. Research by Bunari

[1] A. Adiyono et al., "Peran Guru Pendidikan Agama Islam: Peningkatan Hermeneutika Materi Pembelajaran Pada Siswa Sekolah Dasar," *Dharmas Education Journal (DE_Journal)* 4, no. 2 (2023): 458–64.

[2] F. Fahrizal et al., "Pembelajaran Sejarah Berbasis Kasab Aceh Untuk Meningkatkan Nilai-Nilai Karakter Siswa Di SMAN 1 Mila," *Education Enthusiast: Jurnal Pendidikan Dan Keguruan* 3, no. 4 (2023): 111–30.

[3] M. A. D. Syaputra et al., "Pemanfaatan Situs Purbakala Candi Muaro Jambi Sebagai Objek Pembelajaran Sejarah Lokal Di Era Digital," *Jurnal Pendidikan Sejarah Indonesia* 3, no. 1 (2020): 77–87.

et al.,[4] who developed a 3D Virtual Reality Tour application of Istana Sayap in Pelalawan as part of an effort to digitize history learning, demonstrated that the use of VR media successfully enhanced students' understanding of history and brought the learning material to life. The results of this study demonstrate that VR can be an effective alternative in overcoming physical limitations and providing a more engaging and interactive learning experience.

In Riau Province, there are many historical sites with great potential to be used as history teaching materials, one of which is the Siak Sri Indrapura Palace, a legacy of the Siak Sultanate. This palace holds significant historical value for the Indonesian nation, but the lack of access and media connecting students to this site means many of them are unfamiliar with it. As explained in research by Rawi et al.,[5] the Siak Palace not only houses historical evidence of the Siak Sultanate but also plays an important role in social and cultural development in Riau. Therefore, the application of VR technology in accessing this historical information is expected to overcome existing obstacles.

The use of 3D VR media is expected to provide users with a more in-depth learning experience by allowing them to explore the Siak Palace virtually. Through applications such as Theasys, users can access digital tours that provide historical information interactively, explore the palace rooms, and learn about the values contained in each of its relics. The use of VR in history learning can also help students better understand the local historical context, relate it to real experiences, and foster a sense of love for their cultural heritage. As stated by Chiao et al.,[6] the application of technology in history education can create a more meaningful and enjoyable learning experience, while encouraging someone's interest in better understanding and preserving their historical heritage.

As technology advances, more and more research is proving that the use of digital learning media, such as Virtual Reality, not only enhances understanding of historical material but can also foster critical thinking skills. Recent research by Syaputra et al.,[7] shows that VR-based history learning can motivate students to be more active in learning, as they can interact directly with historical objects and their surroundings. This experiential learning is crucial in the digital age, where people tend to be more attracted to fun and interactive learning. Thus, VR technology is not

[4] R. Bunari et al., "Perancangan Media Virtual Reality Tour 3D Istana Sayap Di Pelalawan Menggunakan Aplikasi Theasys Sebagai Sumber Belajar Sejarah," *Jurnal Praksis Dan Dedikasi Sosial (JPDS)* 7, no. 2 (2024): 214–26, https://doi.org/10.17977/um022v7i2p214-226.

[5] M. Rawi et al., "Proses Pemugaran Istana Sayap (2003–2016)," *JISIP (Jurnal Ilmu Sosial Dan Pendidikan)* 7, no. 1 (2023): 75–81.

[6] H. M. Chiao et al., "Examining the Usability of an Online Virtual Tour-Guiding Platform for Cultural Tourism Education," *Journal of Hospitality, Leisure, Sport & Tourism Education* 23 (2018): 29–38.

[7] Syaputra et al., "Pemanfaatan Situs Purbakala Candi Muaro Jambi Sebagai Objek Pembelajaran Sejarah Lokal Di Era Digital."

only a tool in history learning but also has the potential to change the educational paradigm previously dominated by more conventional learning methods.

In the context of history learning in Indonesia, the importance of using technology to bring people closer to hard-to-reach historical sites cannot be underestimated. Based on research by Ismavida et al.,[8] VR-based learning allows for a more holistic understanding of local history, which is rarely accessible through conventional methods. In Riau, the Siak Sri Indrapura Palace can serve as a model for using VR in local history learning, which is expected to increase historical awareness of the surrounding cultural heritage. The implementation of VR can help overcome geographical and infrastructure challenges, while providing users with a more immersive, hands-on experience of local history and culture.

Thus, the development of the 3D Virtual Reality Tour media of the Siak Sri Indrapura Palace using the Teasys application is expected to be an effective source of historical learning, providing an innovative and interesting learning experience, and supporting efforts to preserve local historical heritage for the younger generation of Indonesia.

RESEARCH METHODS

In this study, the method used to design the 3D Virtual Reality Tour media for the Siak Sri Indrapura Palace adapted the Waterfall approach, which consists of four main, systematic and clear stages. This method was chosen because of its ability to manage project stages sequentially, facilitating monitoring and development from start to finish. This approach has proven effective in developing digital technology-based learning media (Malleswari et al., 2018). The development process was carried out through several stages as follows:

Application Needs and Requirements Analysis

The first stage was to identify user needs and the technical requirements of the application to be developed. At this stage, researchers conducted interviews with relevant parties at the Siak Sri Indrapura Palace, including managers and staff working on-site, to obtain information about the site, its collections, and historical aspects that needed to be prioritized in VR. These interviews provided insights into important elements to include in the virtual tour, such as the palace's architectural details, the collection of historical relics, and important rooms within the palace that hold high historical value.

[8] P. Ismavida et al., "Pengaruh Society 5.0 Terhadap Pembelajaran Bagi Mahasiswa Universitas Negeri Semarang," *Journal of Education and Technology* 2, no. 1 (2022): 41–48.

Content and Media Design

After obtaining the necessary data, the next step was designing the media content to be incorporated into the virtual tour. Researchers selected 360-degree images from various angles at the Siak Sri Indrapura Palace using a Samsung Gear 360 camera. Additionally, panoramic and spiral photos were taken to provide a more immersive visual experience for users. This content was then edited and adapted to the needs of the VR application. Photo editing was performed using applications such as Adobe Lightroom Pro to enhance image quality and remove unwanted objects.

Product Processing and Design

After the photos are edited, the next step is to compile the 360-degree images into a panorama ready for upload to the Teasys app. The images are stitched using Nadir Patch to transform the raw photos into a 360-degree panorama for users to enjoy. The Teasys app is used to create an interactive virtual tour that allows users to explore various parts of the Siak Sri Indrapura Palace, with the addition of audio elements, directions, and descriptions of objects in each room of the palace.

Testing and Evaluation

The final stage is testing the application. Testing was conducted in two stages: a small-scale trial and a large-scale trial. The small-scale trial involved a number of students with a background in history studies to evaluate the app's usability, interactivity, and visual and audio quality. The large-scale trial involved a larger number of participants to obtain more representative feedback on the app's usability among students and general users. The results of these trials were then used to refine and improve the app, ensuring that the VR app was seamless and provided an effective and engaging history learning experience.

RESULTS AND DISCUSSION

Needs Analysis Stage

In this research, the first step before creating a 3D Virtual Reality Tour media was to conduct a needs analysis. The needs analysis aimed to determine what students needed to make history lessons easier to understand. Through observations and interviews with 38 third-semester students, it was discovered that there were challenges in the use of learning media. Although learning generally went quite well, media use still relied on projectors, PowerPoint, and other conventional media. Meanwhile, students' need for advanced technology was still rarely used, even though it could boost student motivation in learning.

3D Virtual Reality Tours are a cutting-edge approach suitable for replacing in-person visits to museums or historical sites. They are useful for maintaining students' independent learning and enabling them to understand the material in depth. Furthermore, this technology can address limited classroom time. 3D Virtual Reality Tours are not just a substitute for in-person visits; they also provide an emotional impact on users, making them feel as if they are living and residing at the historical site.

The development of the 3D Virtual Reality Tour media involved collecting data such as images and historical documents. This data was then integrated through a 360-degree camera, which can display historical objects in their entirety. To this end, researchers distributed a questionnaire to assess students' needs related to history learning. The results of the needs analysis questionnaire are shown in Table 1 below.

Table 1. Media Development Needs Analysis

Student Needs Aspects	Achievement Indicators	Average	Percentage (%)	Category
Learning methods	Students' need for varied learning methods	3.4	65%	Very Needed
Instructional Media	Students' need for learning media	3.4	66%	Very Needed
Historical Sources	The need to learn through technology	3.4	66%	Very Needed

The table above shows that the need for media development *Virtual Reality Tour* 3D is highly needed by students. This is evident from the high percentages, with 63% needing varied learning methods, 65% needing learning media, and 68% needing technology-based learning. Based on the data above, this study focuses on developing a 3D Virtual Reality Tour of the Siak Sri Indrapura Palace based on the Theasys application as a learning resource for local history.

Media and Content Design

This section demonstrates the steps involved in creating a 3D Virtual Reality Tour using Theasys. This section utilizes several components, including a 360-degree camera, the Power Director application, Nadir Patch, and the Theasys application. For more details, see the image below.

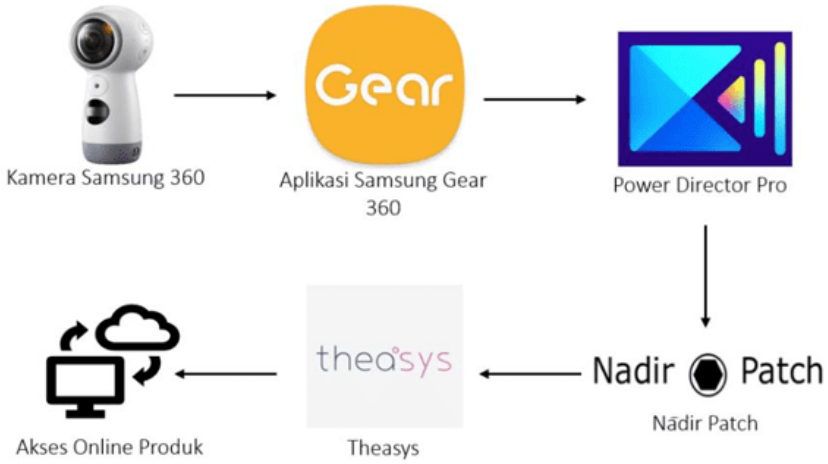
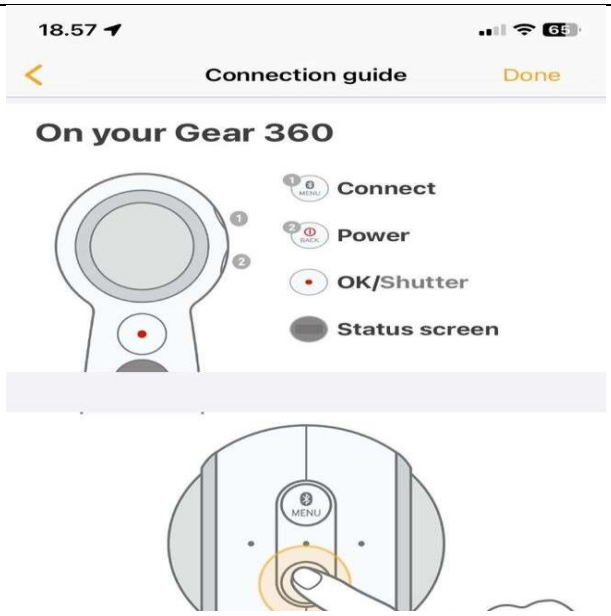
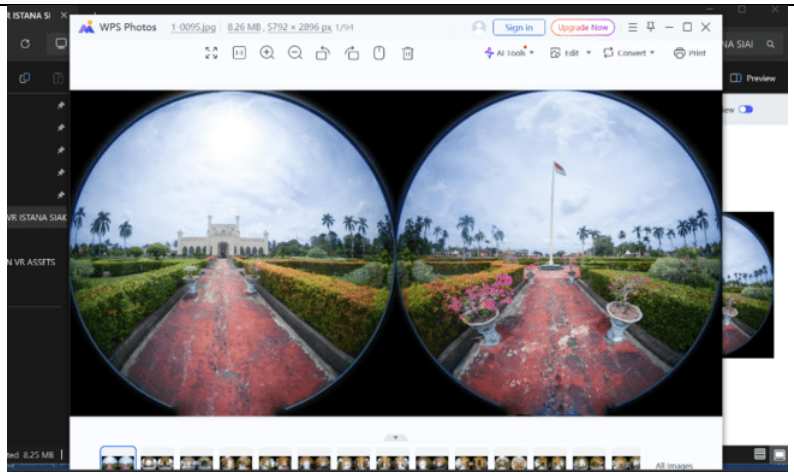
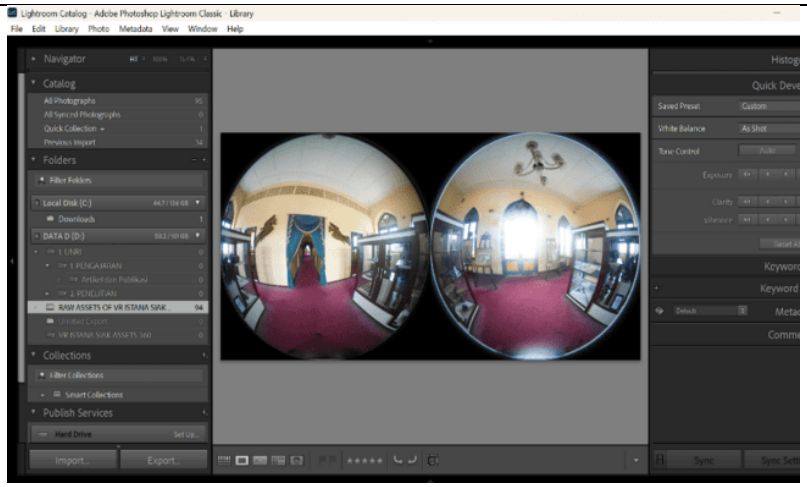
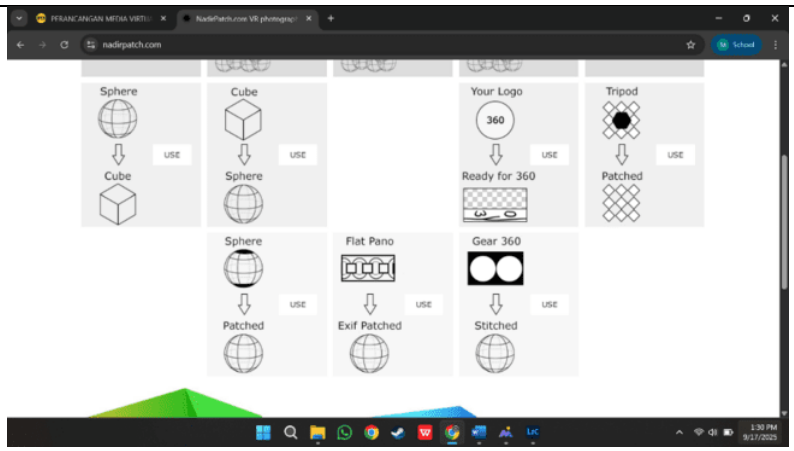
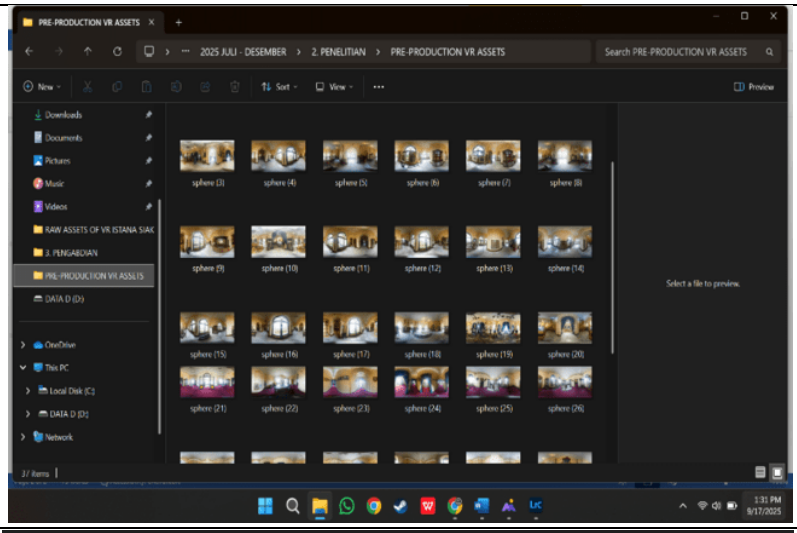
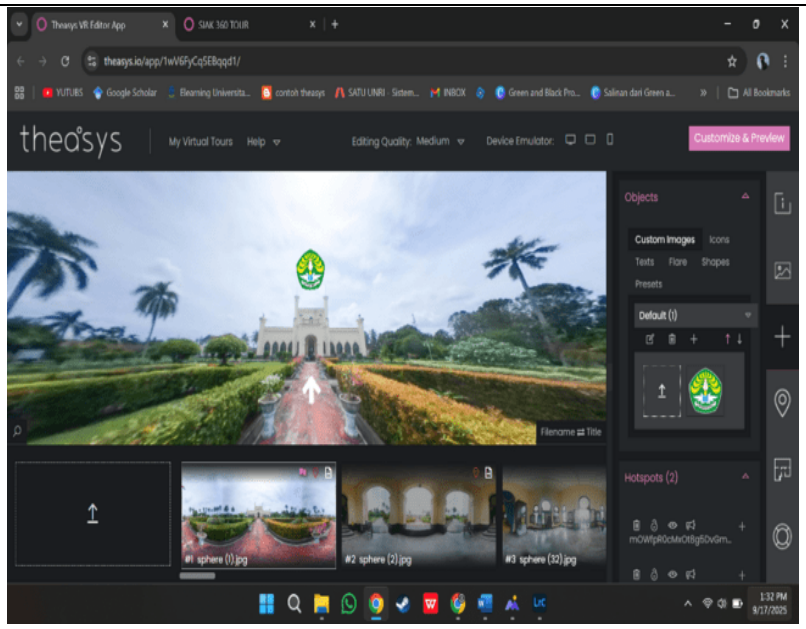


Figure 1. Stages of Designing 3D Virtual Reality Tour Media Based on Theasys

In the image above you can see that the first stage involves using a Samsung camera.3600 is used to capture spherical images of historical objects. For easier and more practical shooting, you can use the Samsung Gear 360. Because images captured by the 3600 camera cannot be used immediately, they are first edited using Adobe Lightroom Pro. This application aims to remove unwanted objects and brighten dark photos. Furthermore, Adobe Lightroom Pro can also edit videos captured by the 3600 camera.

After being edited through the application, the photos are then stitched or "*stitch*" using the Nadir Patch application. This application makes it easy to process 360° photos into 360° panoramas with just one press of a button, without the need for complex editing processes. After the photos are successfully stitched into a panorama, the results are uploaded to a digital tour application website called "Theasys". In the application, elements such as audio, directions, and descriptions of objects in the digital tour are added. Next, the rendering process (the process of converting digital data) is carried out. Once the process is complete, researchers can ask the Theasys application developer to download the final results for public access. For more details, see Figure 2 below.

No	Appearance	Description
1		Samsung Gear 360 Home Screen
2		Raw photo results before the editing process
3		Editing process using Adobe Lightroom Pro to remove unwanted objects

4		The process of stitching 360 photos into panoramas via the nadirpatch.com web app
5		After the stitching process, the raw 360 photo is converted into a panorama format that is ready to be uploaded to Theeasys.
6		The process of creating a 360 VR virtual tour using Teasys

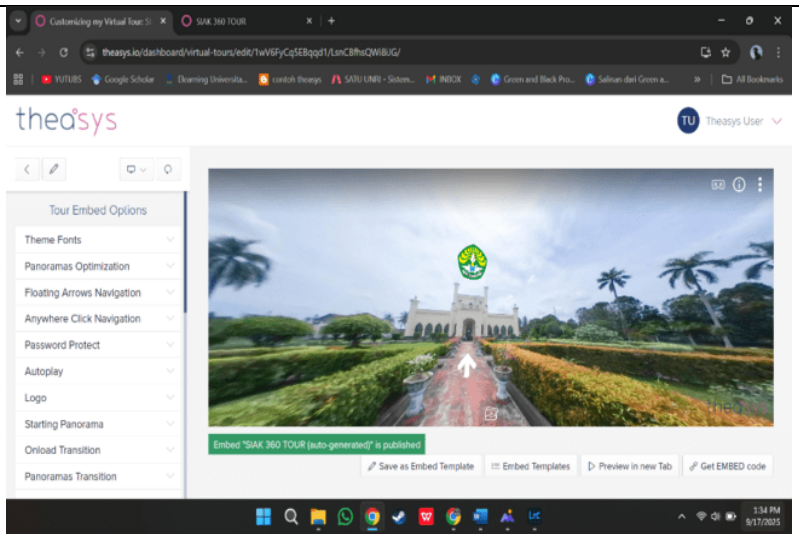
		The process of creating a 360 VR virtual tour using Teasys showing the courtyard of the Siak Palace

Figure 2. Stages of Planning for a 3D Virtual Reality Tour Media for the Siak Sri Indrapura Palace

Product Processing and Design

The product design stage is the stage that reviews the final result of the product, namely the media.*3D Virtual Reality Tour.*This stage explains how to use and implement the media. Figure 3 below shows the link to access it.*3D Virtual Reality Tour*Theasys-based Siak Sri Indrapura palace.

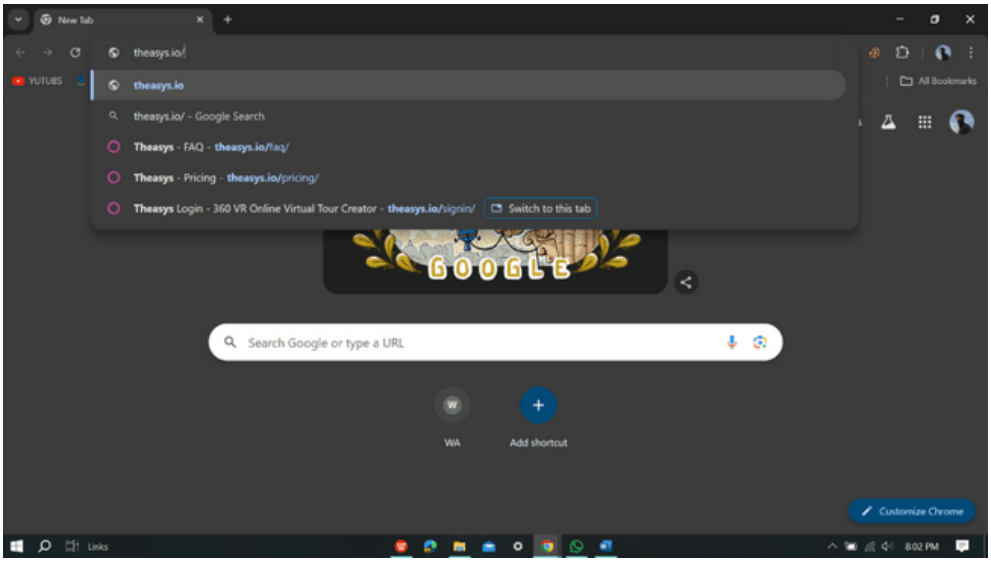


Figure 3. Website Address for Accessing Theasys

After clicking on theeasys.io shown in figure 3, the web page will switch to a menu display of several digital tour options as shown in figure 4. Next, select the "Siak Sri Indrapura Palace" option shown in the image below.

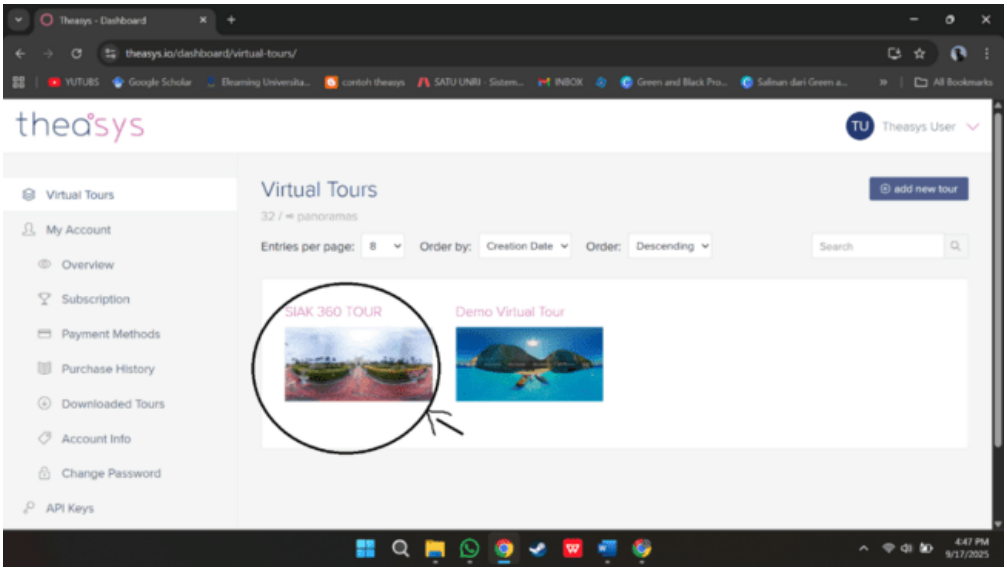


Figure 4. Digital Tour Option Selection

After clicking this option, the display will change to a full 3D digital tour that can be moved as desired. Users can click the arrows to view the next object, as shown in Figure 5 below.

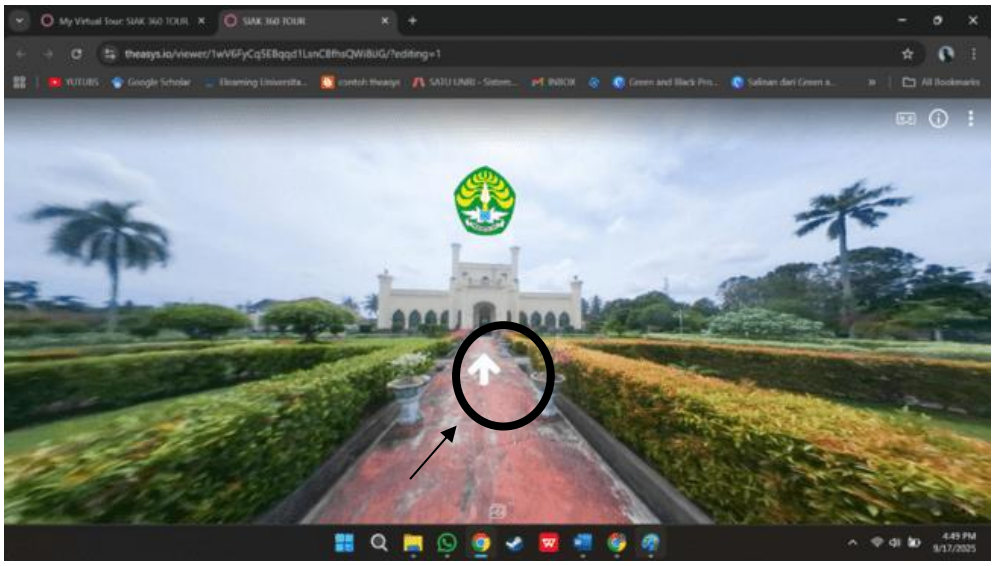


Figure 5. Virtual Reality View3D Tour of Siak Sri Indrapura Palace

When the arrow is clicked, the image will switch to the next object, namely the front door of the Siak Sri Indrapura Palace, as shown in image 6 below.

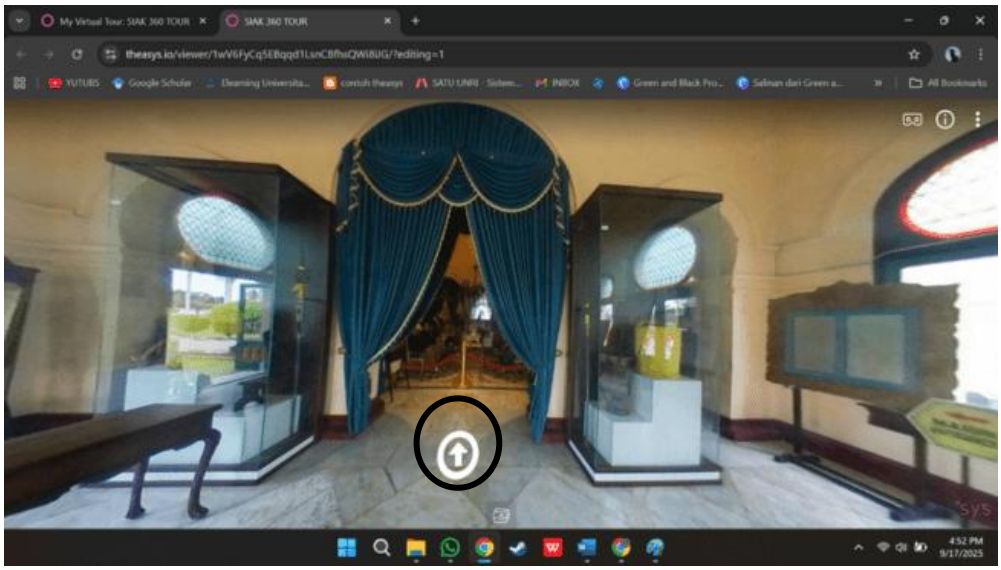


Figure 6. Front view of Siak Sri Indrapura Palace

Next, clicking the arrow will take you to the throne room of the Sultan of Siak Sri Indrapura. Users can see and imagine the Sultan's position during meetings and giving orders, as shown in Figure 7 below.

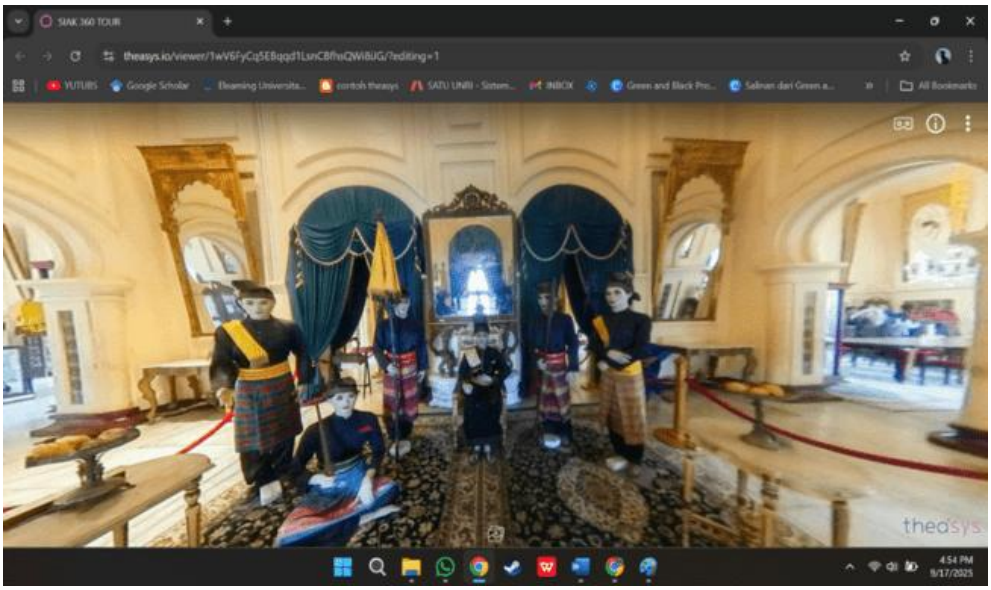


Figure 7. Throne of the Sultan of Siak Sri Indrapura

Next, if the user wants to switch to another page, they can click the arrow to the right of the Sultan's throne, as shown in Figure 8 below.

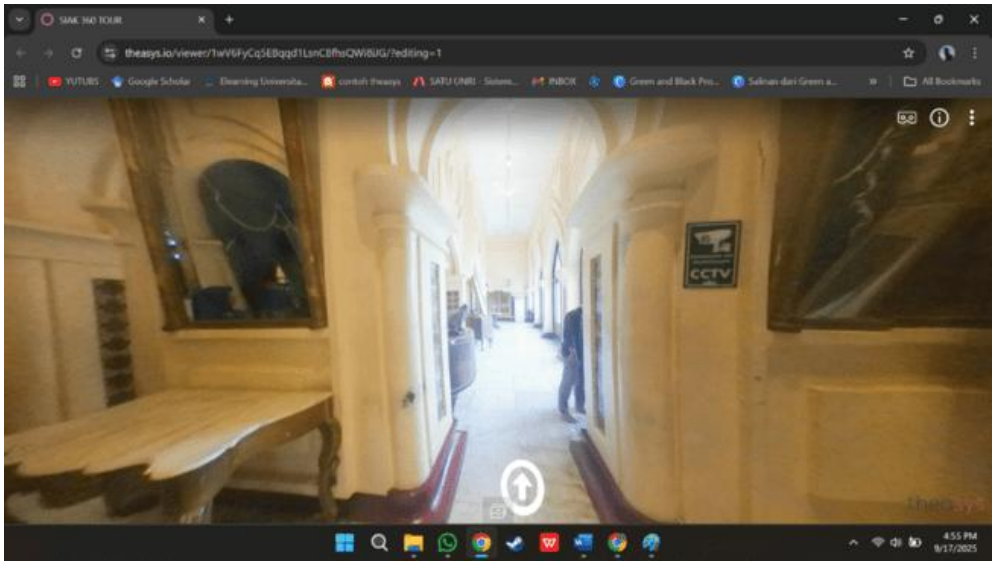


Figure 8. Arrow Pointing to the Next Page

Users can see the arrows for reference. The arrows will point to specific locations within the Siak Sri Indrapura Palace. To move on, simply click the previous arrow and the page will return to the desired location. In Teasys, the back arrow is shown in Figure 9 below.

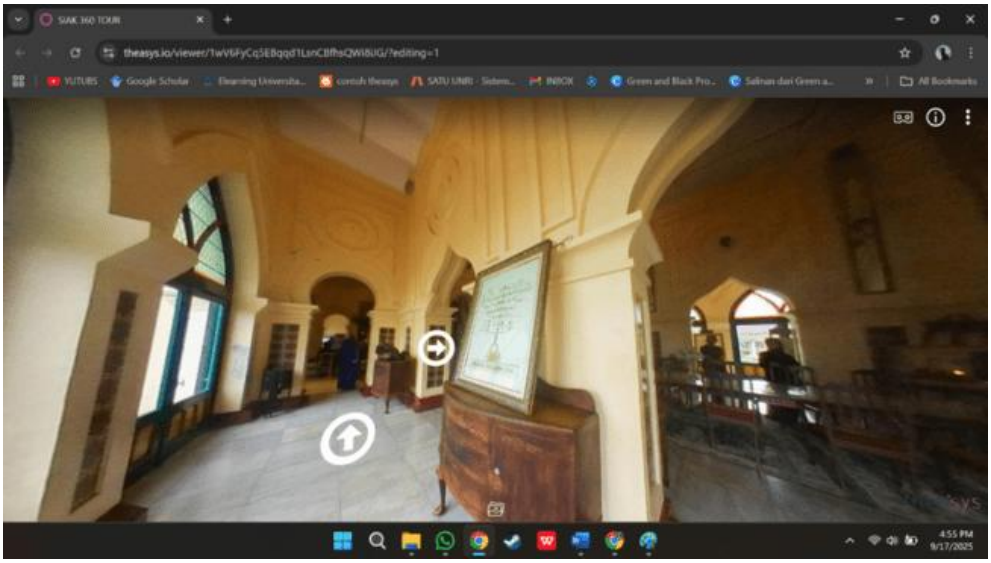


Figure 9. Display of the Arrow Sign Showing the Next Direction (Next) or Back

And so on, users simply follow the provided arrows. The arrows will point to different locations than before. Users can also view photos, statues, drawings, and other ornaments in greater detail by clicking on the arrow. The display will become more detailed (zoomed in) and clearer, allowing users to see the information contained within the object.

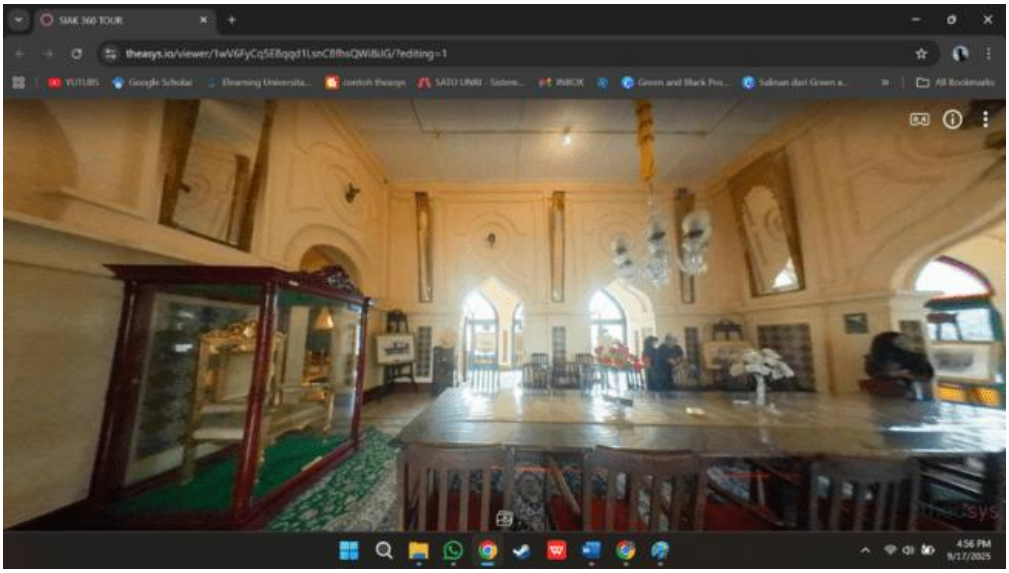


Figure 10. View of the Meeting Room at the Siak Sri Indrapura Palace

Testing and Evaluation

To assess the quality of the 3D Virtual Reality Tour media used in this study, user trials were conducted. The implementation and trials of the product were conducted to ensure a match between the media's use and its intended impact. The implementation and trials are described in the following steps.

1. **Small Group Test**

   This small group trial was conducted on 5 students as respondents who provided an assessment of the feasibility.3D Virtual Reality Tour media. Respondents were students taking a history learning media course. This small-group trial used three assessment indicators: product appearance, product usability, and audio, image, and video quality. The results are shown in the image below.

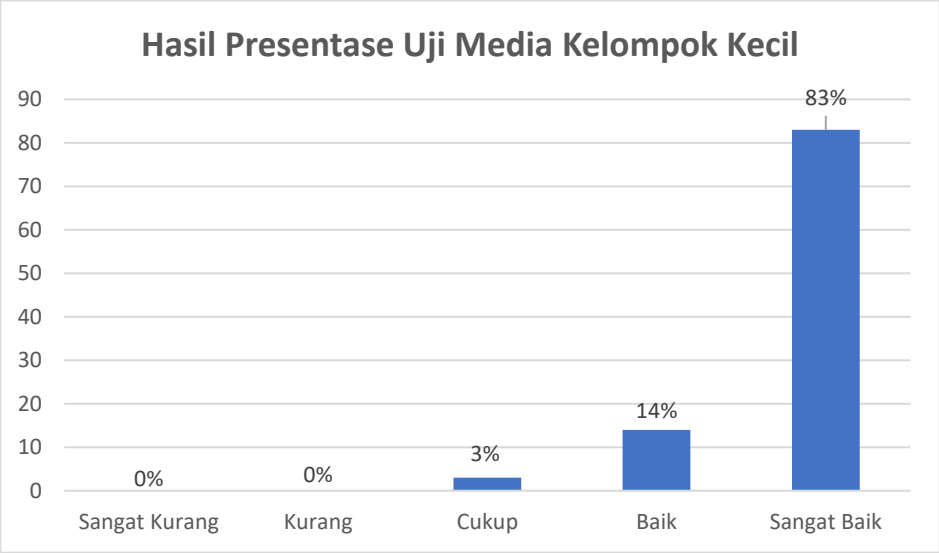


Figure 11. Small Group Limited Test Percentage

Based on the image above, it can be seen that the majority of respondents stated that the 3D Virtual Reality Tour media was very good, reaching 83%, while 14% stated that it was good. Then, no respondents chose the options "very poor" and "poor" (0% each). Furthermore, only 3% of respondents stated that the media was quite good. The total number of overall scores carried out on 5 respondents was 239, with an average score of 4.8 and a percentage of 80% in the "very good" category. Therefore, the product is ready for wider testing.

2. Large Group Test

This broad-group test was conducted with 38 respondents to assess the broad and comprehensive impact of 3D Virtual Reality Tour media. Respondents assessed the product's suitability, including product appearance, usability, and audio, image, and video quality. The respondents were students taking a history instructional media course. The results of this broad-group test can be seen in the following graph.

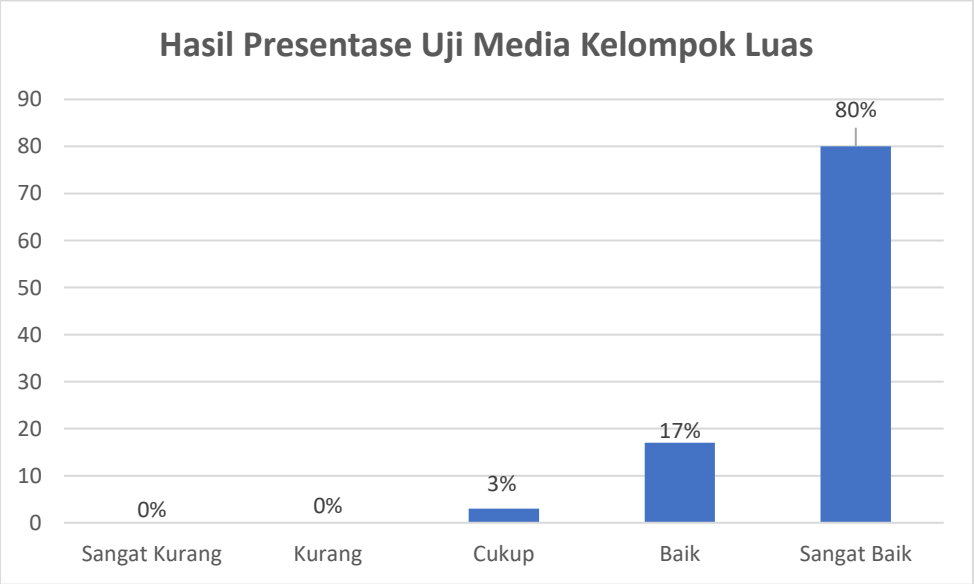


Figure 12. Percentage of Limited Test of Large Group

Based on Figure 12 above, the results of the limited test to a broad group show that as many as 80% of respondents stated that the media's suitability was in the very good category and as many as 17% stated that it was good. Meanwhile, only 3% of respondents stated that the 3D Virtual Reality Tour media was in the fairly good category. Then, no respondents chose the very poor and poor categories for the media's suitability. The total number of overall scores carried out on 38 respondents was 239, with an average score of 4.8 and a percentage of 80% in the very good category.

Discussion

The implementation of the 3D Virtual Reality (VR) Tour of the Siak Sri Indrapura Palace based on the Teasys application shows that the use of immersive technology in local history learning significantly increases student engagement and understanding. The results of the media feasibility test in both small and large groups obtained an average rating of 4.8 (80% in the very good category), which reflects a positive response to the quality of the display, interactivity, and audio-visual aspects. This finding is consistent with the results of a meta-analysis showing that the use of VR in an educational context increases motivation and learning activity compared to conventional methods.[9]

The main advantage of VR media is its ability to create presence, namely the feeling of being in a real location, which has an impact on increasing the depth of understanding of historical

[9] Z. Merchant et al., "Virtual Reality in Education: A Meta-Analysis and Review of the Literature," *Computers & Education* 70 (2014): 29–40, https://doi.org/10.1016/j.compedu.2013.07.033.

concepts.[10] The 360° panorama feature complete with audio elements and interactive descriptions facilitates independent exploration of the spaces of the Siak Sri Indrapura Palace, allowing students to freely observe architectural details and historical artifacts. This immersive experience aligns with the findings of Jensen and Konradsen[11] who stated that VR strengthens students' long-term memory and critical thinking skills.

A needs analysis of 38 students revealed an average score of 3.4 (65% "Strong Need") for innovative learning media, reflecting the limitations of conventional media such as presentation slides and lectures in providing an immersive learning experience. Makransky and Lilleholt[12] asserted that VR media can overcome cognitive and emotional barriers in conventional learning by providing a real visual context, so that students can experience the cultural and historical context of the Siak Palace that is difficult to achieve through textbooks or two-dimensional images.

The media development process included needs analysis, content design, and product testing using the Waterfall model, which has proven effective in managing sequential stages with quality control at each stage. Although some studies recommend an iterative approach like Agile for responsiveness to early feedback,[13] the Waterfall model in this study successfully produced a final product that met learning media standards.

In both small and large group trials, visual presentation received the highest ratings, followed by audio quality and interactivity. These findings support Schneider et al.,[14] who demonstrated that VR graphic quality significantly contributes to user engagement and satisfaction. The addition of historical narrative audio elements to each palace room enhanced the multisensory experience and supported holistic information processing.[15]

Despite its proven effectiveness, there are challenges related to the cost and availability of 360° VR devices in some regions, consistent with Radianti et al.'s[16] findings on institutional budget

[10] J. Radianti et al., "A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda," *Computers & Education* 147 (2020): 103778, https://doi.org/10.1016/j.compedu.2019.103778.

[11] L. Jensen and F. Konradsen, "A Review of the Use of Virtual Reality Head-Mounted Displays in Education and Training," *Education and Information Technologies* 23 (2018): 1515–29, https://doi.org/10.1007/s10639-017-9676-0.

[12] G. Makransky and L. Lilleholt, "A Structural Equation Modeling Investigation of the Emotional Value of Immersive Virtual Reality in Education," *Educational Technology Research and Development* 66 (2018): 1141–64, https://doi.org/10.1007/s11423-018-9630-7.

[13] M. Slater and M. V. Sanchez-Vives, "Enhancing Our Lives with Immersive Virtual Reality," *Frontiers in Robotics and AI* 3 (2016): 74, https://doi.org/10.3389/frobt.2016.00074.

[14] B. Schneider, "The Role of Graphical Fidelity in Virtual Reality Engagement," *International Journal of Human–Computer Studies* 152 (2021): 102–23, https://doi.org/10.1016/j.ijhcs.2021.102623.

[15] M. Slater and M. Usoh, "Body Ownership and Presence in Immersive Virtual Environments," *Artificial Life and Virtual Reality* 7, no. 8 (1994): 106–8.

[16] Radianti et al., "A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda."

constraints in VR adoption. Furthermore, varying levels of digital literacy among teachers and students necessitate technical training for optimal use of VR media. Therefore, providing tutorials and accompanying modules is highly recommended to ensure inclusive and sustainable adoption.[17]

Further development could enrich the content with gamification elements such as interactive quizzes, exploration missions, and role-playing scenarios, which have been shown to increase motivation and cognitive engagement in VR-based learning.[18] Furthermore, utilizing WebXR technology and optimizing it for mobile devices could expand media access without requiring special headsets, making it more practical and culturally friendly.

Overall, the Theeasys-based 3D VR Tour of the Siak Sri Indrapura Palace has proven to be an effective, innovative, and engaging resource for learning about local history. In addition to facilitating factual understanding of cultural heritage, this medium fosters a love and awareness of history among the younger generation. Cross-disciplinary collaboration with information technology experts, historians, and instructional designers is highly recommended to enrich the content, enhance interactivity, and adapt the medium to the needs of the national curriculum.

CONCLUSION

DevelopmentThe Siak Sri Indrapura Palace 3D Virtual Reality Tour, based on the Teasys application, is perfect for learning and deepening local history. This 3D Virtual Reality Tour offers convenience and innovation that can replace direct visits to historical sites, making learning more effective and efficient. The 3D Virtual Reality Tour covers the entire palace collection, including rooms, paintings, photographs, statues, and weapons. This makes learning history more engaging with diverse materials and images. The development of this media demonstrates that history learning can be adapted to the latest technological developments, such as the use of Virtual Reality (VR). It's time to learn history no longer using classical approaches, but rather using innovative and enjoyable media. The 3D Virtual Reality Tour offers just that.

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