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PAPER

Si-VirPraJa: Using an Immersive Technology to Learn Prehistoric Sites in Indonesia

Bayu Kurniawan[1](✉), Rajendra Prasad Shrestha[2], Mohamed Jefferi bin Haji Mat Lazim[3], Azmi bin Abd Hamid[3], Hariyono[1], Wahyu Djoko Sulistyo[1], Nugraheni Warih Utami[1], Fitri Wahyuni[1]

[1]Universitas Negeri Malang, Malang, Indonesia

[2]Asian Institute of Technology, Pathum Thani, Thailand

[3]Institut Pendidikan Guru Kampus Ipoh, Tanjung Rambutan, Malaysia

bayu.kurniawan.fis@um.ac.id

ABSTRACT

Nowadays, studying prehistoric sites in Indonesia has become convenient because of the touch of technology. We no longer need to spend money, time, and energy to visiting the sites in person. Virtual Reality (VR) is the commonly used immersive technology for virtualizing prehistoric sites. Cutting-edge research is utilizing Virtual Reality (VR) technology to construct virtual environments of prehistoric sites, allowing people to learn and enjoy them with flexibility. However, in the context of learning, its use is still quite limited due to general features. Therefore, it is necessary to develop applications with more complete and interactive learning features. The aim of this study is to develop a web-based Si-VirPraJa (Prehistoric Virtual Site) application. We employed research and development (R&D) to achieve the objectives of the research. Furthermore, we used the ADDIE development model, which includes analysis, design, development, implementation, and evaluation. We initiated the research by conducting a needs analysis study of the Si-VirPraJa App as expected by students and teachers. The needs analysis results formed the foundation for designing the application's initial stage. Learning media experts tested it and provided assessments, suggestions, and comments. The Si-VirPraJa app, refined based on assessment results, suggestions, and comments from media experts, is implemented in a trial class to gather feedback from students and teachers. The findings suggested that students need a virtual tour-based application to study prehistoric sites in Indonesia. This necessary application must also include multiple features that facilitate learning. The findings from validation tests conducted by experts and trials class that the Si-VirPraJa application is viable for use as a learning media. The impact of using this application for learning is evident in students' enhanced self-learning ability, improved comprehension of the material, and the generation of engaging and meaningful learning experiences.

KEYWORDS

Si-VirPraja, virtual reality, immersive, prehistoric

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1 INTRODUCTION

The prehistoric era is a fascinating and significant topic that should be taught to students. They can gain knowledge about the origins of humans, changes in the environment, as well as cultural and technological progressions. In Indonesia, there are numerous prehistoric sites discovered and spread across different regions, dating back to the Paleolithic era [1]–[4], Mesolithic [5]–[10], Neolithic [11]–[13], Megalithic [14]–[18], and the Metal Ages [19]–[21]. However, accessing the location of these ancient sites seems to be quite challenging [22]. Most locations are desolate, far from settlements, and situated in the limestone hills [23]. This condition significantly hinders students from directly studying prehistory at the site. It necessitates time, effort, and financial resources to visit the location for a valuable learning experience. Students turn to alternative methods like videos, internet images, and books, but these have their limitations. Meanwhile, inaccessible prehistoric sites can only be examined with extensive preparation. As a result, there is less interest among students in learning about prehistoric sites. Hence, a solution is required to facilitate the study of prehistoric sites for every student and audience, regardless of location or time constraints.

The best solution to this problem is undoubtedly integrating it with technology. Integrating technology can allow people to study prehistoric sites without physically visiting the sites. In recent years, many studies have focused on virtualizing prehistoric sites. For example, in North Africa, digitization techniques were used to document and analyze images of carvings found at prehistoric sites. This effort aims to create extensive archives that can be studied by local communities [24]. Additionally, researchers have tried to create a virtual tour of the late Iron Age prehistoric site at Ulaca Oppidum in Spain [25]. More recently, an application based on Virtual Reality (VR) has been developed, which allows interactive access to a 6000-year-old Neolithic cemetery in Lenzburg [26]. In fact, virtual technology has even been used to reconstruct an unrecognizable Paleolithic cave [27].

Previous studies have indeed demonstrated fascinating advancements in the examination of prehistoric sites combined with technology. However, there are still significant gaps that require further investigation. Previous research has not yet proven the effectiveness of these features in enhancing the learning experience, as most developed applications remain limited to general educational platforms. Therefore, it is imperative to create an application that incorporates interactive and captivating virtual reality (VR) features, while also being easily accessible and equipped with teaching materials, multimedia, quizzes, and opportunities for independent learning reflections. The objective of this research is to develop a website-based application Si-VirPraJa (Prehistoric Virtual Site).

2 LITERATURE REVIEW

2.1 Virtualize of prehistoric sites

Technology allows humans to remove distance, cost and time, and makes everything more flexible [28]. Likewise for people who want to study prehistoric sites that may require effort and money to get to their location. Now there is no need to worry anymore because technology is very developed. The desired site environments

have been digitized into the virtual space [29]. This greatly allows one to feel as if one is in the desired location. This technology is also known as virtual reality (VR) [30], [31], and by using a 360° panoramic camera, the experience feels more real [32], [33]. Prehistoric site virtualization technologies have also emerged currently. In Indonesia, the government has developed a virtualization of the Sangiran ancient human museum [34], [35]. This technology is very helpful for educating the public about the life of ancient humans in Indonesia.

3 METHOD

3.1 Research design

The purpose of this research is to develop a web-based Si-VirPraJa (Prehistoric Virtual Site) App. To achieve this, the research follows a Research & Development (R&D) approach using the ADDIE model (analysis, design, development, implementation, evaluation). The analysis phase involves gathering data on the learning needs of users, particularly students. Based on the findings, the initial design of the application, including its appearance, features, and content, is determined. The draft of Si-VirPraJa App is then tested by learning media experts, whose assessments, suggestions, and comments are crucial for improving the application before further testing. To evaluate its suitability, a small-scale trial is conducted involving 5 teachers who use the Si-VirPraJa application. Ultimately, the data from the trial serves as the basis for determining whether the Si-VirPraJa application is suitable for use or not.

3.2 Data collection

The data to be collected at this stage are: 1) needs analysis data, 2) validation test data, and 3) product trial data. Needs analysis data is obtained based on indicators: 1) obstacles to studying historical sites directly in the field (NA-1), 2) required alternative solutions (NA-2), 3) required platform (NA-3), 4) features required features (NA-4), and 5) desired type of learning activity (NA-5). We have sent a needs analysis questionnaire to 263 students from history majors in various parts of Indonesia. We also selected 2 experts in the field of learning media to carry out validation tests on the initial product of the Si-VirPraJa application. The indicators that will be assessed include: 1) apps appearance, 2) easy-to-use, and 3) visual communication. In the trial phase, we have invited 5 lecturers to use the Si-VirPraJa application. Based on the experiences of the respondents, the data from the trial results were obtained, which consisted of several indicators, namely Interface, utilizable apps, content, language, and learning impact.

3.3 Data analysis

The data that has been obtained at the stage of needs analysis, validation test, and testing are analyzed by descriptive statistical analysis techniques. The data from the analysis is then visualized using relevant diagrams so that it can be read properly.

4 FINDINGS

4.1 The need analysis of Si-VirPraJa apps

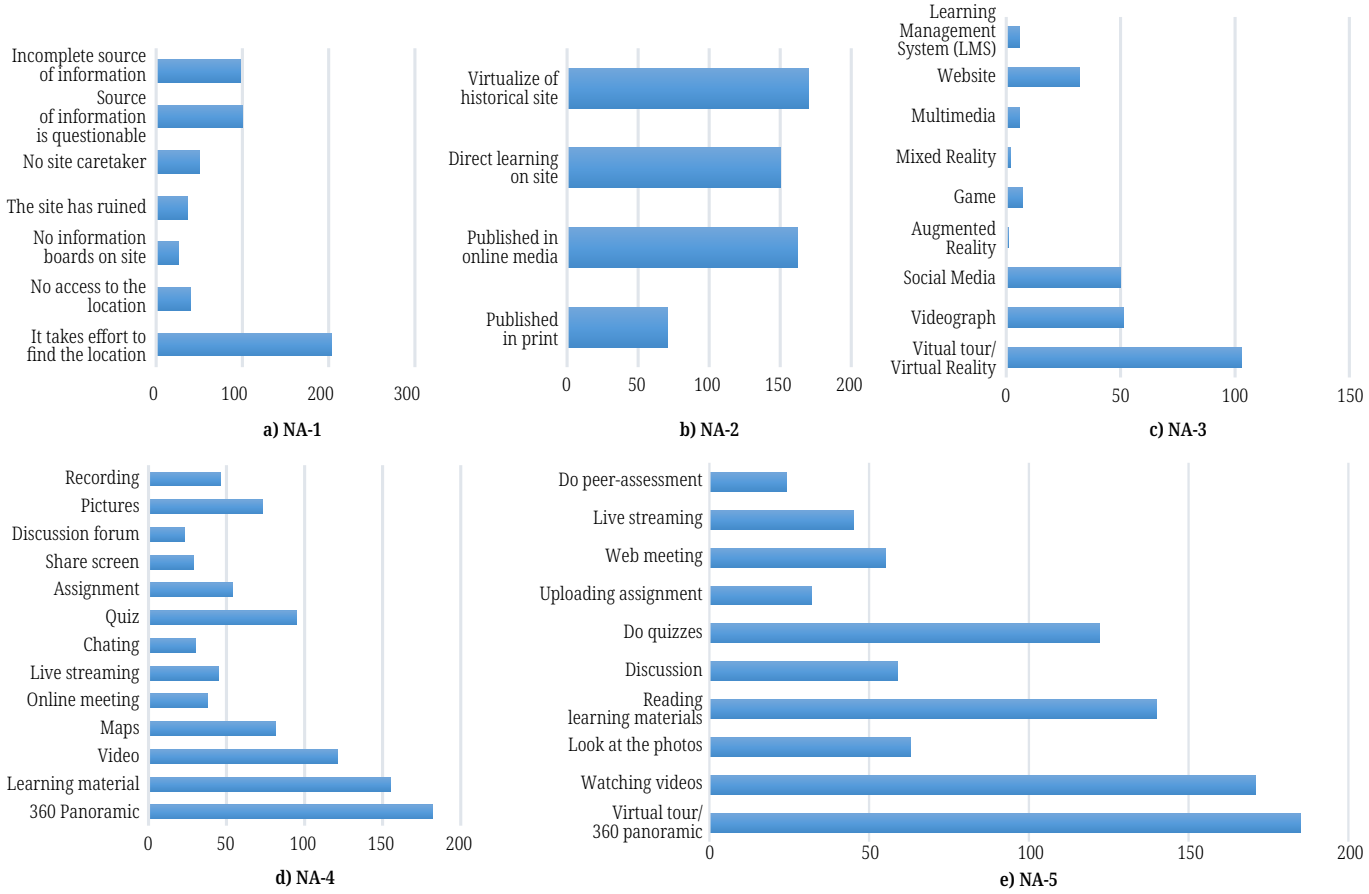


Fig. 1. Needs analysis data sets of Si-VirPraJa app

Based on the needs analysis data (see Figure 1) we found that the difficulty of students in studying prehistoric sites is that the location is very far, and it takes more effort to get to the site (203 times) (NA-1). The solution chosen by the students to solve this problem was that they wanted the site to be virtualized (170 times) and some still chose to go to the site location (150 times) (NA-2). To virtualize prehistoric sites, students want the application platform in the form of virtual tours/virtual reality (appears 103 times) (NA-3). Students want features that must be embedded in the Si-VirPraJa application in the form of 360-deg panoramas (182 times selected), learning materials (155 times selected), videos (121 times selected), quizzes (95 selected times) and maps (81 selected times) (NA-4). The learning activities in the application they want are virtual tours (185 times selected), watching videos (171 times selected), reading information material (140 times selected) and answering quiz questions (122 selected times) (NA-5).

4.2 The Si-VirPraJa apps validation test results

The validity test was carried out to determine whether the prototype of the Si-VirPraJa application that had been developed based on the results of the analysis

of student needs was feasible or not. Learning media experts will assess and provide criticism and suggestions to improve this application. We have appointed two learning media experts who will assess several aspects, namely apps appearance, easy-to-use, visual communication (Figure 2) and learning impact (Figure 3).

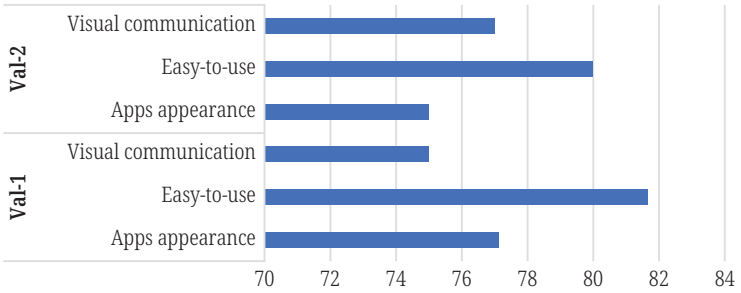
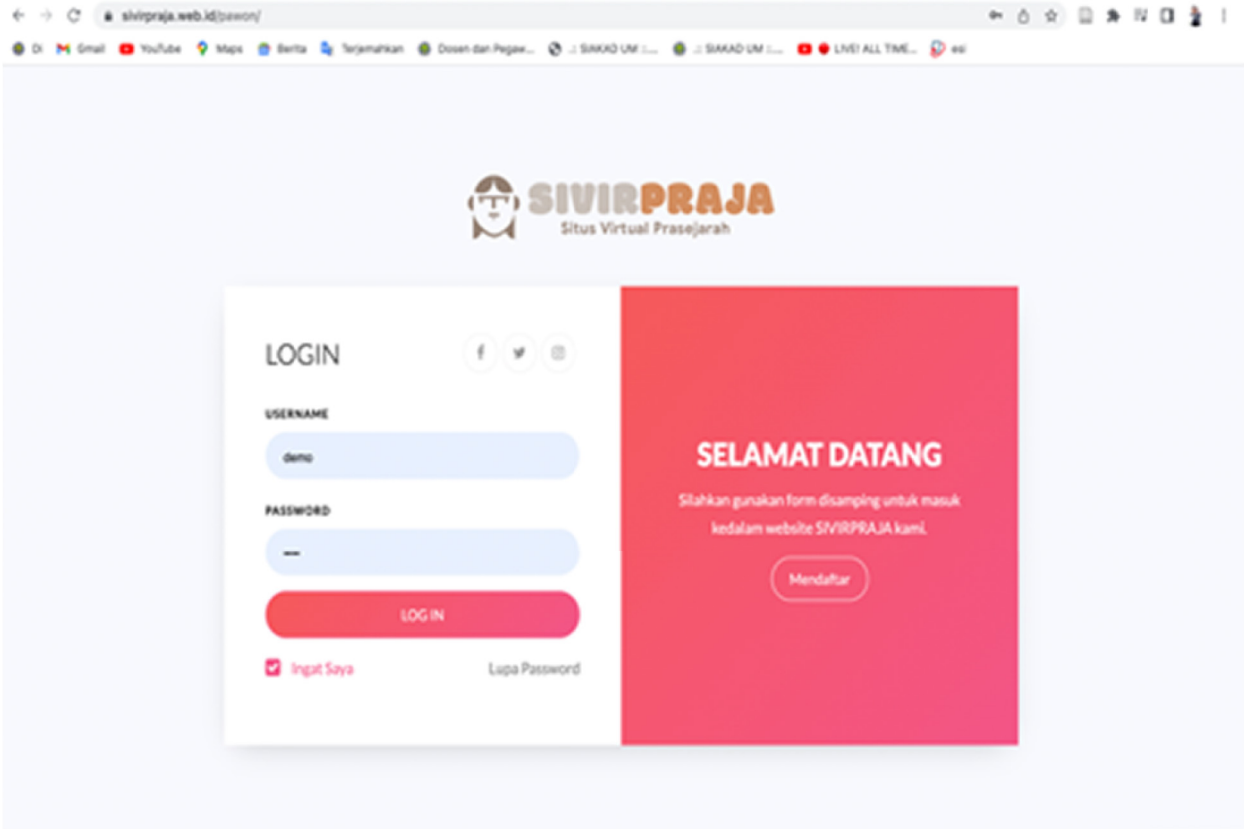


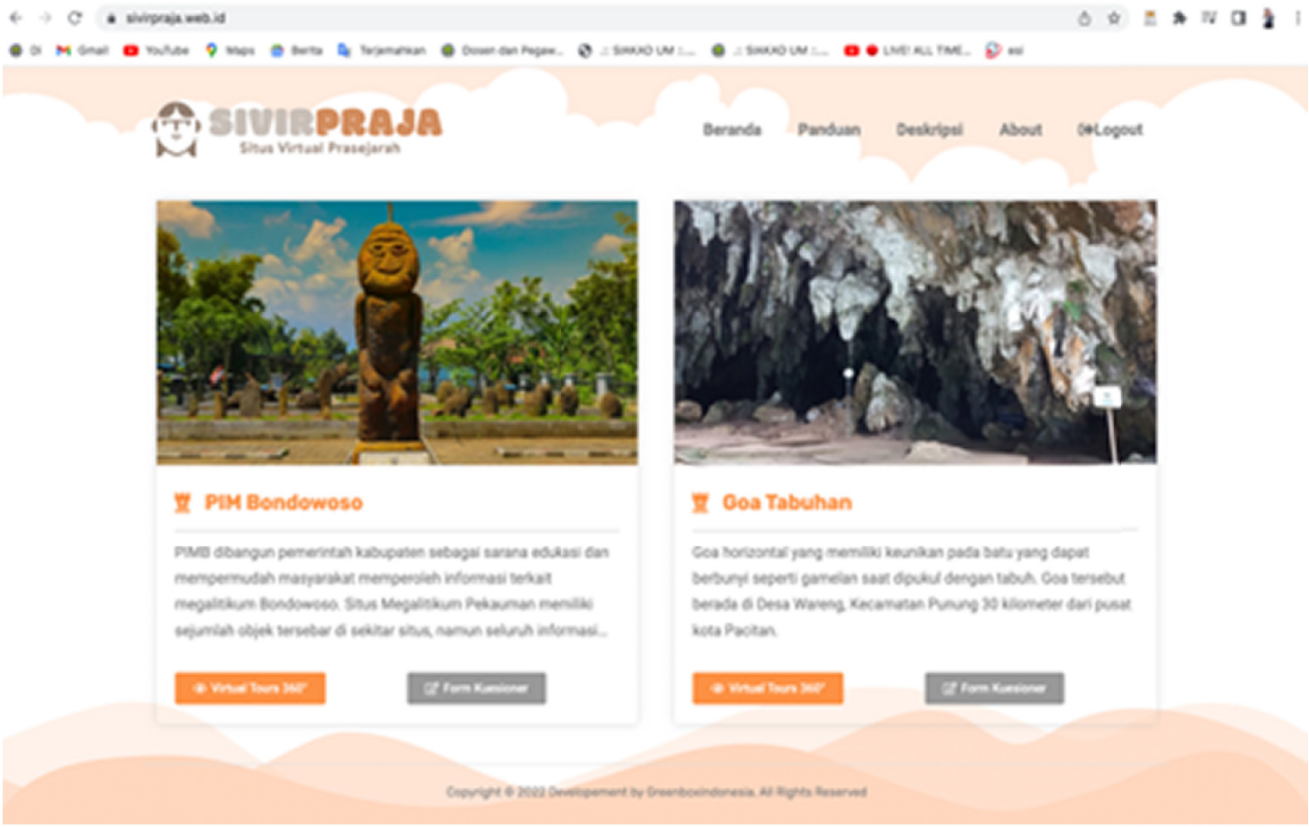
Fig. 2. The results of Si-VirPraJa validation test

Based on the results of the validation test by learning media experts, it was found that validator 1 (Val-1) gave an average value of 77.93, while validator 2 (Val-2) gave an average value of 77.33. These two average values are then added up and the average value is 77.63. So, it can be concluded that the SIVIRPRAJA application is in the good category. Criticisms and suggestions from the two validators were then processed to improve the SIVIRPRAJA application before being used for product trials (Figure 3).



a) Si-VirPraJa login interface

Fig. 3. *(Continued)*



b) Home interface of Si-VirPraJa app

c) Virtual tour interface of Si-VirPraJa app

Fig. 3. Interface of Si-VirPraJa app

4.3 The trial test results

The trial process is carried out to find out whether the developed application is suitable for use or not. We determined several aspects of the indicators that were seen in the testing process, including interface, utilizable apps, content, language, and learning impact. At this stage, we have appointed 5 lecturers to be users of the Si-VirPraJa application (see Table 1).

Tabel 1. Results of Si-VirPraJa trial test

Interface	Interface appearance	8.8
	Colors used	8.6
	Pictures display	8.6
	Video display	8.0
	Letters and numbers	8.8
	Dimensions of letters and numbers	8.8
	Average	**8.6**
Utilizable Apps	Website rememberable	10
	The application is accessible through various devices	10
	The application run well	8.4
	The application is fast response	8.8
	Applications can be operated easily	8.6
	All feature working well	8.4
	Average	**9.03**
Content	The data and information are relevant content	9.2
	The data and information content are complete and detailed	7.6
	The pictures content is relevant	8.6
	The video content is relevant	8.2
	The video sound is clearly	8.8
	Average	**8.48**
Language	Used correct words	10
	Grammar is clearly	10
	Use understandable language	10
	Average	**10**

The respondents gave an average score on the Si-VirPraJa application interface of 8.6, utilizable apps (9.03), content (8.48), and language (10). Based on this value, the average obtained is 9.02, where the test results of the Si-VirPraJa application are in the very good category. The learning impact provided by this application is to increase students' self-study ability, help them understand the material, produce interesting and meaningful learning (see Figure 4).

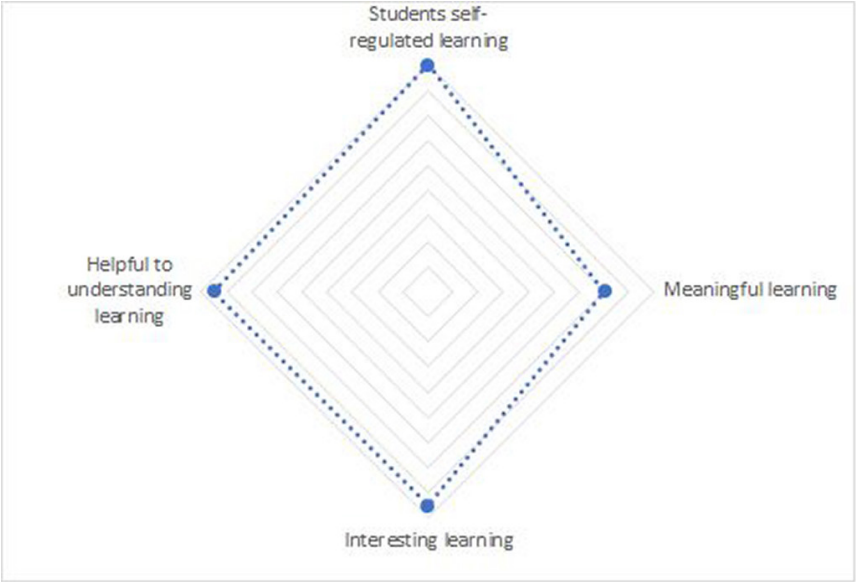


Fig. 4. Learning impact of Si-VirPraJa app

5 DISCUSSION

The current era of learning is very thick with the integration of technology so that the existing innovations aim to accelerate the transfer of knowledge. Field-based lecture activities continue to be virtualized so that they can be more flexible and inexpensive [29], [36]. All aspects are being digitized, including in the field of history. Indonesia has a very rich potential for historical sites, especially the cultural products of the Hindu-Buddhist era. Learning directly on site is the best way even though it's not an easy job to bring students to the field. Our findings show that distance and access to historical sites are the biggest obstacles for students to learn directly. They want learning about historical sites from the Hindu-Buddhist era to be virtual. Recent studies also support this finding as historical, archaeological and museum sites are increasingly leading to integration with virtual platforms [37]–[39]. Another finding states that the latest features related to virtual tours are important points to provide a meaningful learning experience, even though, so far, the use of virtual tours has been more intensively carried out in the tourism sector [40]–[42]. Nevertheless, tourism cannot be separated from cultural heritage so that it enriches digital insight. Other cultural heritages also get a positive impact through virtual heritage [43]–[46], which offers interesting features. In fact, this virtual heritage study is getting deeper in the narrative aspect of social history [47]. In general, the virtualization of historical sites certainly leads to virtual tours, which are the features offered. This is inseparable from the 360 panorama feature which gives real reality to the captured object [48]–[50]. In the future, of course, the virtualization of historical sites will be more sophisticated by offering features that provide a meaningful experience.

6 CONCLUSION

The Si-VirPraJa application was developed based on the needs analysis result conducted on students for learning about prehistoric sites but constrained

by distance. This application is based on a virtual tour equipped with learning features and activities that have an impact on student independence in learning, helping them to understand the material, presenting interesting and meaningful learning. The test results by experts show that the Si-VirPraJa application is in the good category so that it can be tested. Post-validation test of the application showed that this application was in the very good category and deserved to be used massively.

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9 AUTHORS

Bayu Kurniawan is an Indonesian History Educator, one of the lecturers in the Faculty of Social Science, Universitas Negeri Malang. His research interests are education and learning innovation (E-mail: bayu.kurniawan.fis@um.ac.id).

Rajendra Prasad Shrestha is a Professor in the Department of Energy, Environment, and Climate, School of Environment, Resources and Development, Asian Institute of Technology, Thailand. He lectures on Climate Change and Sustainable Development Program (E-mail: rajendra@ait.ac.th).

Mohamed Jefferi bin Haji Mat Lazim is a history lecturer in Institut Pendidikan Guru Kampus Ipoh, Malaysia. His research interests are Malay history and political history (E-mail: jefferi@ipgmipoh.edu.my).

Azmi bin Abd Hamid is a Lecturer in the Institut Pendidikan Guru Kampus Ipoh, Tanjung Rambutan, Malaysia.

Hariyono is a Professor in Department of History Faculty of Social Science, Universitas Negeri Malang. His research interests are political history and education history (E-mail: hariyono.fis@um.ac.id).

Wahyu Djoko Sulistyo is an Indonesian History Educator, one of the lecturers in History Department, Faculty of Social Science, Universitas Negeri Malang. He is interested in educational history and learning innovation (E-mail: wahyu.djoko.fis@um.ac.id).

Nugraheni Warih Utami is education lecturer in Faculty of Education Universitas Negeri Malang. She is majoring in education and guidance counseling (E-mail: nugraheni.warih.fip@um.ac.id).

Fitri Wahyuni is a lecturer at the Faculty of Education, Universitas Negeri Malang, Indonesia. She is majoring in education and guidance counseling (E-mail: fitri.wahyuni.fip@um.ac.id).