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Integration of Immersive Virtual Reality in History Learning: Improving Understanding through MilleaLab-Based Virtual Museums in Elementary Schools

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Abstract:
This study was motivated by elementary school students' limited understanding of history due to the visual limitations of conventional media. The study aimed to analyze improvements in students' understanding of history after using the MilleaLab-based Interactive Virtual Museum developed by the researcher. Using a quantitative approach, this study involved 5 students in a small-scale pilot test and 21 students in a large-scale pilot test at SDN Pagung I. Data were collected through observation, interviews, tests, and documentation, then analyzed both qualitatively and quantitatively. The results showed significant changes in students' conceptual understanding. Before the intervention, students experienced fundamental difficulties in identifying historical figures, analyzing cause-and-effect relationships between events, and retelling history in their own words. After the implementation of the immersive virtual reality medium, students were able to master the indicators of explaining and recounting historical events in a coherent manner, although a small number of students still made errors regarding specific dates. The effectiveness of this medium is reinforced by significant quantitative improvements, as evidenced by an increase in the average score from 59.3 (pretest) to 86.2 (posttest), a significant T-test result, and an N-Gain of 0.69 (moderate category). The implementation of immersive Virtual Reality based on MilleaLab has proven effective as an innovative learning medium for comprehensively improving historical understanding in elementary schools.

Keywords: Virtual Reality, MilleaLab, History Education, Elementary School

Introduction

Over time, science and technology continue to develop. Technology that has been developed to date has entered the digital realm. Every industry in Indonesia has begun to use technology to improve their performance, including in the field of education (Manongga, 2022). Education is defined as the process of gaining knowledge or understanding of certain and specific objects in an organized manner in an individual learning system to achieve learning goals (Sari et al, 2022). In the era of increasingly rapid technological development, education must also be able to adjust developments to improve the quality of education, especially in the learning process Agustina et al, 2022) The use of technology in the learning process will provide a more interactive learning experience and increase students' understanding of the material taught.

The existence of history learning in elementary schools is one of the important parts of the education system because it forms children's understanding of national identity, cultural values, and past events that play a role in the development of a sense of nationalism in students (Pratiwi et al, 2023). In addition, history learning is expected to play a role in training students' attitudes, morals, and behaviors in daily life. However, history learning in elementary school often experiences challenges such as history is often considered uninteresting and boring by students, history materials presented are often in the form of long texts and the lack of visualization and the use of ancient learning methods make students have difficulties in understanding concepts in abstract historical materials (Pratiwi et al, 2023) . Comprehension is one of the main indicators that determine the success of learning. Comprehension is a structured way of explaining, interpreting, translating or expressing in their own style or way after knowing and remembering their meaning in real life (Muta'aliyah & 2018, n.d.) . Therefore, it is important to know the improvement of students' understanding in learning history because it is related to nationalist attitudes, moral attitudes and students' behavior in daily life. Therefore, educators must be smart in arranging learning so that students can absorb the knowledge taught easily (Rohmawati , 2014) . Unfortunately, there are still many students who have difficulty in achieving understanding in learning. Students' comprehension ability can be influenced by several factors, one of which is the learning medium.

In today's digital era, it is certainly very easy to apply media in classroom learning. The use of learning media is beneficial for students' understanding of difficult subjects. While audio-visual media, such as learning videos, provide more concrete and real-life examples of subject matter, visual media, such as pictures and illustrations, help students visualize the concepts they are learning. (Ilmah et al., 2025)

Based on the history learning interviews, the history material in grade VI of SDN Pagung I is the low learning outcomes of students who are below the KKTP (75). This is due to several main factors, ranging from the difficulty of students in memorizing the names of heroes, dates, and foreign terms which have an impact on low understanding of the material and the lack of instilling the value of nationalism. This obstacle is exacerbated by the impact of learning during the pandemic which makes basic comprehension skills in the lower class not fully complete when they reach the high grade. And students have a high interest in digital learning media compared to conventional media.

Based on observations, it shows that the learning process is still dominated by conventional lecture methods. Educators have not optimally innovated using learning media or utilizing digital facilities that are actually available in schools, such as *chromebooks*, *smart boards*, and projectors. As a result, students tend to be less attentive, less enthusiastic, and have difficulty in meeting indicators of achieving high-level

competencies such as telling, distinguishing, and showing the cause and effect of historical events. In fact, initial assessments show that the majority of students have visual and auditory learning styles.

From the problems that occurred at SDN Pagung I, the researcher argued that students need a solution for a media that suits their needs, is interactive, can provide new experiences, and can develop the ability to understand abstract history learning so that learning outcomes can improve. In addition, students in grade VI have more interest in digital learning media than conventional ones. From the initial diagnostic analysis, it is known that the average learning style of students is *visual* and *auditory* which makes it easier for them to understand with illustrations that can be in the form of pictures or videos during learning. This is in accordance with their vulnerable age, namely at the age of 11-12 years they are at the concrete operational stage. According to Jean Piaget' *s opinion, the concrete* operational stage of students can be taught to think logically, but still need the help of real objects or illustrations to understand something. At this concrete operational stage, it can be seen through the characteristics, namely that students are more interested in understanding and being interested in the existence of illustrations that are real in the learning process. (Rahmah, 2023)

The application of media with interesting visualization content with animation and interactivity with students such as *virtual* media can be a solution that has the potential to overcome the problems that occur at SDN Pagung I. Like the MilleLab-Based Virtual Museum Media, an application made to help the learning process, especially in the digital age, this learning media is similar to playing games individually or in groups (Arifin & Legion , 2025). In making this media, it combines several media such as short videos containing heroes' struggles, hero images, infographic and audio texts, and *quizzes* that can show understanding of students and avatars that make the media more real. This interactive virtual museum media has several features and in the use of this application can be opened with 3 modes and can use VR glasses for more real applications.

The previous research was conducted by Febiyana Anggraini, et al. with the research title "Development of Virtual Reality (VR)-Based Learning Media using the Millealab Application in Science Subjects of the Jenang State Elementary School Class 05" (Anggraini et al., 2025). From the results of the research, learning using *virtual reality* based on Millealab is quite effective in improving student learning outcomes in the science subject of Indonesiaku Kaya Budaya. The difference between this research and the research that has been conducted lies in the variables of research and methods used. The research conducted by Febiyana Anggraini focuses on determining the ability to understand the material before and after the application of Virtual Reality-based learning media and to determine the effectiveness of Virtual Reality-based learning media in improving the comprehension ability of elementary school students. In addition, the previous research method used R&D. while in this study it focused on learning history using quantitative methods.

Therefore, with this study, it aims to find out the increase in students' understanding of historical material in elementary school after using MilleaLab-Based Virtual Museum Media as a learning medium. The selection of history learning in this study is due to the large number of reading texts in books and the lack of visualization makes it difficult for students to understand abstract historical material. In addition, learning that refers only to textbooks makes history learning in elementary school often considered boring. With the use of MilleaLab-Based Virtual Museum Media, students can understand the history meter of the struggle of heroes more deeply with videos, students can play an active role in the use of media and be able to provide new and enjoyable

experiences in learning. So that the existence of this media is expected to be a new innovation in history learning that is more interactive and innovative to achieve learning goals.

Methods

The research method used in this study is quantitative with *the One Group Pretest Posttest* research design. The design was chosen because there was only one experimental class group and no control group, so this design was used. Before the *treatment* was implemented, students in this design took a *pretest* to determine their basic abilities. After receiving *the treatment* in the form of media, the participants took a *posttest* to see if their comprehension skills improved. This is done because the observed changes are closely related to the design applied, the effectiveness of the *treatment* can be measured more precisely through the comparison of *prettest* and *posttest results*.

Data was collected through observation, interviews, tests, and documentation, then analyzed qualitatively and quantitatively. The population in this study was all grades VI at SDN Pagung I which was held from September 2025 to May 2026. In this study, the *random sampling method* of all grade VI students at SDN Pagung I was used which totaled 26. At the time of the trial, students were divided into two groups, namely 5 students in a small-scale trial and 21 students in a large-scale trial. The data analysis techniques applied included descriptive analysis, normality testing, and t-test (hypothesis test) to determine whether there was a significant difference by going through pretest and posttest results after treatment was given.

Results and Discussion

Before the research is carried out, it is necessary to have a validation process for the instruments needed to analyze learning conditions in schools. This validation must be carried out because to assess the questions or content in the instrument it is able to describe the aspects to be measured. The instrument is validated to an expert validator, namely a lecturer. The instrument is used in two stages, namely the analysis stage before being given a trentment in the form of *a pretest question instrument,* learning style, interview instrument and observation instrument. The second stage of the trial after being given treatment is in the form of a posttest question instrument and a student response instrument. The indicators used in *the posttest pretest* instrument based on Bloom's taxonomy include the skills of knowing heroes, analyzing events and reflecting in life.

The first stage of analysis, this stage is carried out with the aim of finding out the needs and characteristics of grade VI students related to history learning through observation, interviews, and initial diagnostic activities such as initial tests and learning styles. The researcher conducted observations and interviews in grade VI of SDN Pagung I on September 20, 2025. Then the researcher carried out an initial diagnostic test on grade VI students The test contains questions arranged based on *the bloom taxonomy* as a reference for students' cognitive success and initial diagnostics to find out the learning style of students who focus on the way they learn in class such as the way they remember, understand explanations and attitudes while learning (Auliyah et al, 2023). The test was carried out on October 4, 2025 which aimed to determine the initial understanding and characteristics of students. Based on the results of the analysis, the researcher can conclude that grade VI students at SDN Pagung I need learning media in the form of interactive media that can attract students' interest and attention so that they are more focused and can make it easier to understand the material. SDN Pagung I has quite complete facilities, one of which is the internet which is easily accessible. In addition,

from the analysis of student character, it can be found that students are easier to understand and more interested in learning if given real illustrations. This can be found by the researcher during learning, during which many students have difficulties when understanding the material, especially in important events such as wars and meetings that create historical events. In addition, the researcher also conducts initial diagnostics to find out the learning style of students, from the results of the assessment, it can be seen that the average student has *a visual* and *auditory learning style*.

The second stage *of treatment,* in this study, aims to test the effectiveness and practicality of virtual museum media products in a real learning environment. The implementation activity was carried out on May 22-23, 2026 at SDN Pagung I. The research subjects in this stage involved class VI students with a total of 26 selected based on *one group of pretest-posttest samples* which aimed to find out the learning outcomes of students before and after the use of media and to determine the improvement of students' understanding. The implementation process was carried out in three main stages: first, the researcher gave an initial test (*pretest*) to the subjects to measure the initial condition before the treatment was given. Second, the researcher implemented interactive virtual museum media as a teaching medium in learning activities for 2 JP or 70 minutes in one meeting. Third, the researcher provides a final test (*posttest*) to measure the subject's achievement after using the product.

Descriptive Analysis

Descriptive analysis was carried out to provide an overview of the results data *Pretest* and *Posttest* students. With this analysis, it can be known how much the value increase between *Pretest* and *Posts*. The descriptive analysis contains several aspects, namely the average value, standard deviation, highest and lowest values before maupen after being given treatment. The results of this descriptive analysis are as follows:

Table 1, Pretest-Posttest *Descriptive Analysis*

Descriptive Statistics

	N	Minimum	Maximum	Red	Std. Deviation
Pretest	26	35	85	58.46	14.337
Posttest	26	70	100	86.15	8.638
Valid N (listwise)	26				

Based on the results of the analysis above, it shows that of the 26 students who are the subjects of the research. At the time of giving *the pretest,* the results were the lowest score obtained at 35, the highest score was 85 and the average score was 58.46. Meanwhile, when giving the posttest, the result was the lowest score of 70. The highest score was 100 and got an average of 86.15. Based on the descriptive analysis, it can be seen that between the prestest score and the posttest score, there was an increase in the value results after the use of MilleaLab-Based Virtual Museum Media.

Normality Test

The normality test is carried out before the test *Paired Sample T-test* Useful as a prerequisite test. The normality test is a research method to determine whether the distribution of the collected data is normal. The researcher used IBM SPSS Statistics 29.0 to conduct a normality test on the data. The normality test of the sample data in this study uses one of the test analysis methods *Shapiro-Wilk* at the significance level $\alpha = 0.05$

because the number of samples evaluated in this study is less than 50. If the significance value is greater than 0.05 the data distribution is considered normal. On the other hand, if the significance value is less than 0.05, the data is considered abnormally distributed. The following are the results of the normality calculation using the test *Shapiro-Wilk:*

Table 2. *Shapiro-Wilk Normality Test*

Tests of Normality			
	Shapiro-Wilk		
	Statistic	df	Sig.
BEFORE	.985	26	.351
AFTER	.935	26	.109
*. This is a lower bound of the true significance			
a. Lilliefors Significance Correction			

Based on the *Shapiro-Wilk* Normality Test, it can be seen that the number of students is 26 with a significance value for *Pretest* data of 0.351 and for *Posttest* data of 0.109. From the two data, it can be seen that the significance value is greater than the significance level of 0.05, so it can be concluded that *the pretest* and *posttest* data are distributed normally. After the results of the normality test are declared normal, then *the paired sample T-test* can be carried out.

Paired *Sample T-Test*

The T test used in this study is the *paired sample T-test.* The paired sample t-test is one of the tests used to evaluate the effectiveness of an action which is characterized by the difference in the average before the action and after the action is given (Rahmani et al, 2025). The subject used for this T test is grade VI students at SDN Pagung I with a total of 26. With testing *Paired sample t-test* as follows: 1) H0 i.e. There is no significant difference (0.05) between before and after using the developed product. 2) H_1 i.e. There is a significant difference (0.05) between before and after using the developed product. The decision making in this sample test is if $-t_{Count}$ < -ttable or tcal > - ttable Then H0 is rejected and H1 is accepted. Below, are the test results *Paired Sample T-test* using SPSS 29.0*:*

Table 3. T Test Pretest *and* Posttest *Data*

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Red	Std. Devi Ation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-Tailed)
Pair 1	Pretest - Posttest	-27.69231	7.77570	1.52494	-30.83298	-24.55163	-18.160	25	<,001

Based on the results of the T paired sample T test above, that the negative value of tcount indicates that the average score *Pretest* higher than the average score *Pretest*, with an average difference of 27.69231 and a confidence level of 95% (α = 0.05), which is indicated by a range of confidence intervals between -30.83298 to 24.55163. Since the value of Sig. (2-tailed) = 0.001< 0.005, this result falls into the category of "very significant" or "very high" thus, it can be concluded that there is a significant difference

between the scores *Pretest* and *Posttest* after being given treatment. This shows that the use of MilleaLab-based virtual museum media is effective in improving students' understanding as seen from students' learning outcomes.

Analysis

Based on the results of the research, before the use of media, students experienced difficulties in understanding history learning, especially in the history material of the various resistances taught. This can be seen from the lack of achievement of understanding indicators such as the ability to explain, retell and interpret. From the results of *the pretest*, it is known that students have not mastered the indicator of explaining, especially in the indicator of telling. This can be seen from the answer to the multiple-choice question of students with the average student being unable to recognize the name of the hero and the event that occurred, and in the description question students are not able to explain such as the cause of the war or the cause of an important event, while in the indicator of telling students are not able to tell an event such as the Padri War, the formulation of the youth oath, the Javanese War in their own language. After treatment, namely the use of interactive virtual museum media, students' understanding has increased, students can recognize the names of characters and events that occurred, students can explain a cause of the event, students can tell an event in sequence, but in writing the date there are some students who are still wrong.

The improvement of students' learning understanding can be influenced by internal factors and external factors. Internal factors are factors in students such as the physical condition of students, intelligence, attitudes, interests, and motivation. External factors are factors that come from outside such as the school environment, learning strategies, learning methods, learning models, learning media (Ilmah et al., 2025b) . One of the factors for understanding learning is learning media, with the existence of interactive virtual museum media providing new experiences in learning and interesting visuals with learning pictures and videos so that students not only read the material, but also understand the material through illustrations.

This research is supported by research conducted by Salsabila Laily Amalina, et al entitled "*Development Of Augmented Reality E-Booklet To Improve Students' Learning Outcomes On Earth Structure Material*" in the study discusses the development of VR media in the form of E-Books which proves that learning using virtual-based media can improve students' understanding and learning outcomes in elementary schools (Amalina et al., 2025) . In addition, the use of virtual media as a learning medium is based on the theory of cognitivism which focuses on cognitive development where the knowledge and active role of students in building knowledge are influenced by understanding and interaction with their environment, in other words the theory of cognitivism is a theory that is more concerned with the meaningful learning process of the learning outcomes (Rahmah, 2022) . From this theory, it can be concluded that learning is not only about the interaction between educators and students, but is the process of students in building their own understanding through their knowledge and learning environment.

The use of MilleLab-based virtual museum media in learning makes students more actively involved in the learning process in their classroom because information is provided in a more effective and interesting way, they seem more enthusiastic and eager to learn and understand the material independently. The learning process is more effective and efficient which has a positive impact, namely increasing understanding.

In addition, the availability of audio that contains a brief explanation of each material can help students understand the material in a simpler way. With audio, students only read the available infographics, but also get a brief summary of the audio. After using interactive virtual museum media, students' scores increased from not achieving to achieving or meeting the Learning Goal Achievement Criteria (KKTP) with this showing an increase in students' learning understanding. So the achievement of KKTP illustrates how interactive virtual museum media significantly improves students' understanding.

The improvement of students' understanding can also be seen from the scores obtained from *the pretest* and *posttest.* Before further analysis, the pretest and posttest data were first tested for normality using *the Shapiro-Wilk test*, this test is used if the number of samples is less than 50 respondents (Rahmani et al, 2025). From the results of the normality test conducted by the researcher found that the significance values for *the pretest* and *posttest* showed that the data was distributed normally.

The results of *the Paired Sample T-Test* obtained results of a significant increase between *the results of the pretest* and *posttest* after the application of interactive virtual museum media Because the value of Sig. (2-tailed) = 0.001< 0.005, this result is included in the category of "very significant" or "very high" thus, it can be concluded that the use of interactive virtual museum media is effective in improving students' understanding as seen from the students' learning outcomes.

Based on the results of the description analysis, the results of *the posttest* score after the use of virtual museum media showed a significant increase compared to *the pretest* score, which indicates that interactive virtual museum media is effective in improving students' understanding and learning achievement. This is evidenced by the average *pretest* score of 58.46 which increased to 86.15 at the time of *the posttest*. So with the results of this discovery, interactive virtual museum media based on millealab can improve students' understanding.

These results show an increase in students' understanding of historical materials after using interactive virtual museum media in history learning. Thus, the media developed, namely interactive virtual museum media, can be concluded to be effective in increasing students' understanding of history learning of historical materials of various resistances.

Conclusion

Based on the findings of the research, it can be concluded that MilleaLab-Based Virtual Museum Media as a teaching medium can be an efficient choice in teaching basic school history. The use of this facility has been proven to increase students' enthusiasm and interest in learning, making it easier for them to understand the material, especially for grade VI students who enter the concrete operational stage. Before the use of media, students experienced difficulties in understanding history learning, especially in the history material of the various resistances taught. This can be seen from the lack of achievement of understanding indicators such as the ability to explain, retell and interpret. After treatment, namely the use of interactive virtual museum media, students' understanding has increased, students can recognize the names of characters and events that occurred, students can explain a cause of events, students can tell an event in order, but in writing the date, there are some students who are still wrong.

This research has limitations. First, this research was only carried out in one location, namely one of the elementary schools in Kediri Regency. The limitations of this area cause the research findings to not be generalized widely into other contexts or to different regions. Second, the number of samples used still has limitations, so the findings

obtained may not fully describe a group of students with similar characteristics. Based on these limitations, it is suggested that further research can expand the scope of the location and the number of samples so that the research results can be generalized more widely. Follow-up research is also expected to do its best when choosing an application or platform to be used for development to conduct a more in-depth study or research so that it does not experience difficulties during the trial stage and does not take longer.

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