Geografika Journal (Geografi Lingkungan Lahan Basah)
Vol. 5, No. 2 - December 2024
Geography Study Program, Lambung Mangkurat University

DEVELOPMENT OF VIRTUAL LABORATORY BASED ON MOBILE LEARNING IN BROMO TENGGER SEMERU NATIONAL PARK AREA

Abdul Bashith[1*], Saiful Amin[2], Muchammad Akbar Kurniawan[3], Sari Dewi[4]
[1,2,3] Social Studies Education Study Program, Maulana Malik Ibrahim State Islamic University of Malang, Malang, Indonesia
[4] Doctoral Program in Social Studies Education, Surabaya State University, Surabaya, Indonesia
[*]Correspondent Email: bbash98@pips.uin-malang.ac.id

Received 2024-12-20 | **Revision** 2024-12-25 | **Accepted** 2024-12-31
Geography Study Program, Lambung Mangkurat University

Abstract: Mobile learning-based digital field laboratories have not been widely developed in the learning process. Currently, the development of mobile learning-based virtual laboratories needs to be done to assist learning both online and offline. This study aims to explain the process of developing mobile learning-based virtual laboratories and also discuss the effect of using mobile learning-based virtual laboratories on student learning outcomes. This study uses the Borg & Gall Research and Development (R&D) model. The suitability of the product has been tested by expert validators on media and learning materials. Product effectiveness data has been tested on students using normality tests, homogeneity tests and independent sample t-tests. The increase in Gain score in the experimental group using mobile learning-based virtual laboratories was 39.04 (from 46.22 to 85.26), while the control group without a virtual laboratory increased by 25.70 (from 42.37 to 68.07). The results of the study indicate that 1) mobile learning-based virtual laboratories are feasible to use in learning with a very effective category and 2) the use of mobile learning-based virtual laboratories is effective in improving student learning outcomes in the topic of Economic Behavior of the Tengger Mountain Slope Community. This research has a positive impact on the development of knowledge of social studies education students in utilizing virtual laboratories based on mobile learning. Suggestions for further research are that the results of the development of mobile learning-based learning media products should be distributed through the app market.

Keywords: Development, Virtual Laboratory, Mobile Learning, TNBTS Area

INTRODUCTION

Field laboratories are an important learning platform for a university. The implementation of the "Tridharma" of higher education cannot be carried out properly without the existence of a field laboratory. Learning, research, and community service activities need to be supported by field laboratory facilities as a place to implement the learning process that combines theory and practice (Astina, Sapto, & Ruja, 2016). Field laboratories can be used as a supporting facility to improve students' scientific abilities through practical and inquiry activities as well as seeking and collecting information in understanding social and environmental knowledge. Several research results show the urgency of field laboratories in increasing students' enthusiasm for learning and supporting their thinking skills. Bashith, Amin, and Mkumbachi (2022) showed from their research results that the physical, social, economic, and cultural potential on the slopes of Mount Tengger strongly supports being used as a field laboratory for Social Studies Education with a suitable guidebook for use. This is reinforced by the results of interviews and confirmation with several students as conveyed by Dyah Ulan Ningrum (2023), a student representative who stated that the Social Studies Education

field laboratory is very interesting to use in learning and makes it easier to understand the material and learning competency achievements set out in the semester learning plan (RPS).

Field laboratories are in accordance with the characteristics of social science education. Social science education is a discipline that combines economics, history, geography, and sociology. Practical social science education is more appropriate in studying social problems (Sumaatmadja, 1996). The Last Supper (2001) explains that social science education is a discipline that does not stand alone. The Last Supper (2001) adding social science education is a simplification of the social sciences that are studied and researched. Social studies education in learning is based on social sciences that study society and its relationship to the environment (Darsono & Achmad, 2017). The purpose of learning social science education is further explained, namely developing the ability to provide solutions to social problems in society.

Field laboratories are vital media in social studies learning to synchronize theory and real-life facts. Based on the character of social problems that require direct solutions in real-life situations. The function and benefits of field laboratories are only as a place for scientific research, measurement, experimentation, and scientific training related to science (Friady, 2018).

The social science field laboratory was developed as a very potential practicum place to support students to have experience, insight, and special skills, so that students can become professionals in the field of social sciences. The field laboratory is very important because it has a purpose in the application of contextual learning. This means that the material studied in learning cannot be separated from the knowledge possessed, so that there is a relationship between one and the other. The relationship between knowledge in the classroom and phenomena in the environment (Nurhadi et al., 2004). Contextual learning has 7 components, namely constructivism, asking, inquiry, learning community, modeling, reflection, and meaningful assessment (Trianto, 2007).

This research is a follow-up study of the development of field laboratories conducted by Bashith & Amin (2020). The results of the study indicate that the slopes of Mount Tengger, Malang Regency are suitable for use as a field laboratory for social science education. The physical, social, economic, and cultural potential of the research object on the slopes of Mount Tengger supports outdoor learning, especially social studies learning. All potentials, both physical and social, are very complex on the slopes of Mount Tengger. This is evidenced by the many tourism developments that are used as references by the community, both as places of recreation and learning. The results of other studies conducted byThe Redeemer (2018)strengthens the argument that tourism in TN-BTS (Bromo Tengger Semeru National Park) has many impacts on economic, social and environmental aspects.

This is further strengthened by research Wahono et al. (2017) which identifies the potential of districts around the TN-BTS area as having great potential in the form of tourist villages, waterfalls, natural scenery in the form of mountains, and lakes. Based on the results of previous studies, it can be concluded that the Tengger Mountains area of Malang Regency is suitable for use as a social science field laboratory.

Research challenges undertaken by Bashith & Amin (2020), is how to present a field laboratory into the classroom. The suggestion in his research is to develop a virtual field laboratory, which can be used in the classroom. The function of this virtual field laboratory is to present information in the field laboratory area to the class. The goal is for students to be able to explore information through virtual before they identify problems and analyze the problem-solving process in the field.

A rational effort that can be done is to develop a field laboratory based on mobile learning. Mobile learning is one of the digital learning media that helps students' learning experience through available features, such as audio, video, animation,

images, and text (Behera, 2013). The menu function on mobile learning media is very helpful in learning both online and offline so that learning becomes easy and smooth.

The use of mobile learning in the development of field laboratories is based on the idea that it can improve learning outcomes. Empirically, the results of the study Handayani & Suharyanto (2016) shows that the use of android-based mobile learning as a learning medium can improve learning outcomes. Furthermore, research byAmin et al. (2022) shows that mobile learning based on the integration of science-Islam can improve student learning outcomes in the hydrosphere material. Furthermore, the advantages of mobile learning are also stated by the findings Prastiyono et al. (2021) that the use of mobile learning combined with e-learning and outdoor study can improve learning outcomes. Cobcroft, Towers, Smith, & Bruns (2008) in his research shows the opportunities and challenges of mobile learning. The Last Supper (2019) and Sarrab, Elbasisr, & Alnaeli on the effectiveness of mobile learning.Handayani & Suharyanto (2016), Mabruri, Ahmadi, & Suminar (2019), And Oyelere, Suhonen, Wajiga, & Sutinen (2018) about the development of Android-based mobile learning media.

Product development studies on field laboratory development have been conducted byRatnawati et al. (2017), Citra & Sarmita (2016), Astina et al. (2016), Hissoh (2016), Hartono (2014), and Bashith et al. (2022). Regarding the development of virtual laboratories carried out by several researchers such as (Adi, Suratno, & Iqbal, 2016; Elisa, Wiratmaja, Nugraha, & Dantes, 2020; Jaya, 2012; Kholifa & Suswanti, 2019; Koretsky, Amatore, Barnes, & Kimura, 2008; Kusumaningsih, Iswahyudi, & Susanti, 2014; Oidov, Tortogtokh, & Purevdagva, 2012; Sirajudin, Suratno, & Pamuti, 2021; Tuysüz, 2010; Wahyuni & Atun, 2019; Wijayanto, Rizal, Subekti, & Novianti, 2018; Wulandari, Harlita, & Nurmiyati, 2020) However, research that develops a mobile learning-based social studies field laboratory does not yet exist, so it needs to be done. In addition to product development, in this study, an experimental test is needed to determine the effect of using a mobile learning-based virtual laboratory on student learning outcomes.

The use of virtual field laboratories based on mobile learning in social studies learning makes learning easy, exciting, and enjoyable. This virtual laboratory learning media based on mobile learning is easy to apply, exciting in the menu display, and enjoyable in the presentation of features, images, and displays. Through easy, exciting, and enjoyable learning, learning competency achievements can be optimized. Thus, the use of virtual laboratories based on mobile learning can improve student learning outcomes. This study aims to develop a virtual laboratory based on mobile learning and determine its feasibility; 2) determine the effect of using a virtual laboratory based on mobile learning on learning outcomes.

LITERATURE REVIEW

1. Virtual Laboratory

A virtual laboratory is either 1) a place set aside for science experiments or testing and research, or 2) a time in school when students can do lab work. A virtual laboratory is an interactive space where people can make and run fake tests; it's like a playground for experiments. It has a simulation program that depends on the topic, experimental units called objects that contain data files, tools that can be used on the objects, and reference books (Haryoko & Jaya, 2014).

Virtual laboratory is a system that can be used to support the conventional practicum system. This virtual laboratory is usually called Virtual Laboratory (V-Lab). The existence of this virtual laboratory can provide an opportunity for students in particular to do practicums either through or without internet access so that students do not need to be present to take part in practicums in the laboratory room (Jaya, 2012; Muhajarah & Sulthon, 2020). This is effective learning because you can learn

actively by yourself without the help of an instructor or assistant like the system that runs. With a web-based display format, it is quite helpful for students to be able to follow the practicum independently (Bonok, 2023). Virtual labs facilitate educational activities through diverse formats, ranging from plain web pages containing video and text to dynamic interfaces featuring complex environments, collaborative creation, video on demand, virtual meetings, and numerous additional functionalities (Haryoko & Jaya, 2014).

2. Mobile Learning

Mobile learning is a transition from subordinate electronic learning methods to independent learning and is being widely studied. Mobile learning can be defined as a mobile device that functions as a mediator in the teaching and learning process (Behera, 2013; Traxler & Crompton, 2015). Mobile learning, or m-learning, represents a contemporary educational approach that enables students to engage in learning at any time and from any location.

M-Learning is a unique learning because learners can access learning materials, directions and applications related to learning, anytime and anywhere via telecommunication devices such as mobile phones, smartphones and tablets (Basak, Wotto, & Bélanger, 2018). Mobile learning is learning that is done using computing devices including smartphones, personal digital assistants (PDAs), and similar handheld devices (Behera, 2013).

Mobile learning is based on the premise that learning can be done anywhere and at any time (Chen & Chen, 2022). Has a wide coverage because it uses a commercial cellular network. Can be integrated with various e-learning systems, academic systems and instant messaging systems. Mobile learning is a learning model that utilizes information and communication technology. In this learning concept, mobile learning brings the benefits of the availability of teaching materials that can be accessed at any time and attractive visualization of the material.

The technology utilised for mobile learning include handheld devices such as personal digital assistants (PDAs), mobile phones, smartphones, MP3 and MP4 players, different portable multimedia players, gaming consoles, ultramobile PCs, micro notebooks or netbooks, and GPS systems, among others (Darmawan, 2016). One of the basic considerations for developing mobile-based teaching media is the flexibility in accessing information anytime and anywhere (Calimag, Miguel, Conde, & Aquino, 2014). In addition, the Android operating system used by most smartphones is open source, which allows the source code on Android to be read by developers to customize various application features accordingly (Judge & Sumbawati, 2015).

Android-based mobile smartphone technology has the ability to enhance learning effectiveness by actively engaging students in educational activities (Cobcroft et al., 2008). Another advantage of using mobile-based teaching media is that the price is relatively cheaper than Personal Computers (PCs) or laptops, with a cheaper price, smartphones have almost the same advantages as PCs, namely being able to display multimedia elements in the form of text, video, sound, animation, entertainment and others. The disadvantages of smartphones based on Android mobile in learning are: limited image resolution, battery life, and less support for several types of files to be operated (Aripin, 2018).

RESEARCH METHODS

1. Product Development Research and Feasibility Testing Design

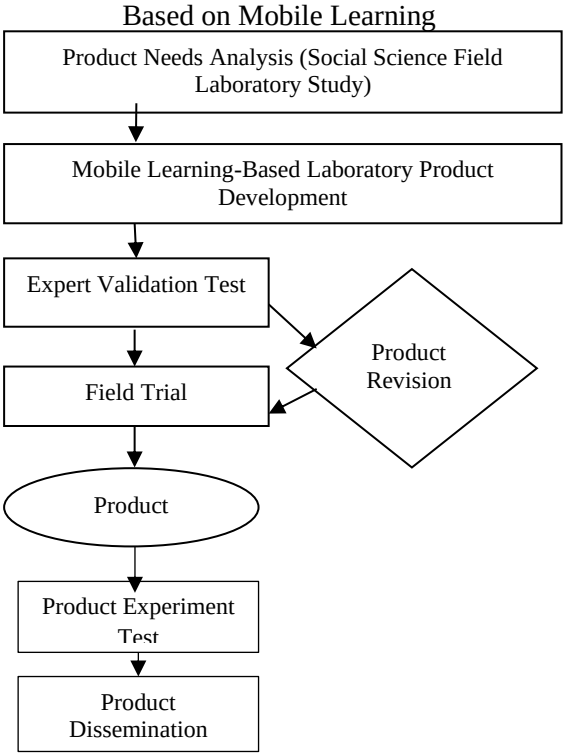
This type of research is Research and Development (R&D). This research aims to produce field laboratory media products based on mobile learning, so researchers use the Borg & Gall development model (Gall, Gall, & Borg, 2006). The reason for using the Borg & Gall model is because it is a good model in developing and validating educational products, one of which is learning media.

The development stages according to Borg & Gall in this study are simplified into 8 steps (Figure 1), namely 1) conducting preliminary research; 2) developing the product; 3) conducting product validation; 4) conducting limited trials; 5) revising; 6) making the final product; and 7) conducting trials; and 8) socializing the product (Gall et al., 2006).

The feasibility of mobile learning field laboratory media is known through the results of responses and decisions from the validator. The validation stage is carried out by each expert, namely social studies learning experts, mobile learning media and design experts, and field laboratory design experts, as well as limited trials to lecturers and students.

Teachers and children were used as test subjects for the product. The purpose of this action was to 1) find out what people thought about using mobile learning field laboratories, 2) find out how they affected and matched up with other things, and 3) find problems with the use of mobile learning field laboratories. Some tests were done on students from the UIN Maulana Malik Ibrahim Malang Department of Social Studies Education.

Figure 1. Field Laboratory Research Stage Based on Mobile Learning



All data obtained are grouped into two, namely qualitative data and quantitative data. Qualitative data were obtained from reviews of social studies learning experts, mobile learning design and media experts, and field laboratory design experts. Quantitative data were obtained through questionnaire responses from students and lecturers during limited trials.

Questionnaires, interview guides, and papers were used to gather information for this study. The following tools were used to collect data for initial evaluation: 1) Going over the validator's work again using discussion sheets, questionnaires, and observation sheets; 2) Judging the quality of the work again using observation and interview sheets; and 3) Judging the scope of the material again using a literature review (including books, laws, and scientific papers).

Used to process data from expert reviews of social studies learning experts, mobile learning media and design experts, and field laboratory design experts, as well as limited trials to lecturers and students. This data is in the form of input, responses, criticisms, and suggestions for improvement contained in questionnaires, discussions, and interview sheets.

The results of this qualitative analysis are then used to revise mobile learning-based laboratory products. Descriptive statistical analysis is used to manage the data obtained in the form of criteria score analysis using a Likert scale. This analysis is used to process data obtained through small group trials and field trials to students as well as the results of suggestions and improvements from experts.

The percentage formula for each subject's answer is as follows:(Arikunto, 2002).

$$\text{Persentase (\%)} = \frac{\sum(\text{Skor Total})}{\text{N} \times \text{n} \times \text{Nilai Maksimum}} \times 100\%$$

Information:
N = Number of respondents
n = Number of questionnaire items

To be able to provide meaning and make decisions, the following provisions are used.

Table 1. Percentage Score Criteria

Percentage (%)	Qualification	Results
≥ 86	Very effective	Worthy
≥ 71 – < 86	Effective	Worthy
≥ 56 – < 71	Quite Effective	Not feasible
≥ 41 – < 56	Less effective	Not feasible
< 41	Ineffective	Not feasible

Source:Arikunto (2003)

2. Experimental Research Stage

The design in this study is a quasi-experiment because the researcher cannot fully control the two groups studied, so that the changes that occur are not entirely due to the influence of the treatment. The form of quasi-experimental design in this study is a pretest-posttest control group design as in table 2 below.

Table 2. Pretest-Posttest Control Group Design

Group	Pretest	Treatment	Post
Test	O 1	X	O 2
Control	O 3	-	O 4

Source:Campbell & Stanley (1973); Sugiyono (2011)

Information:

O 1 : *Pretest*for experimental class
O 2 : *Posttest*for experimental class
X : Learning with virtual laboratory media in experimental classes
O 3 : *Pretest*for control class
O 4 : *Posttest*for control class
\- : Learning without using virtual laboratory media in the control class

The subjects of the experimental research were students of the Social Studies Education Department of UIN Maulana Malik Ibrahim Malang in the 2023/2024 academic year. The subject determination technique was carried out by purposive sampling, subjects were taken based on the characteristics of the same cognitive abilities based on the average value of learning outcomes. Furthermore, two classes were obtained, each as an experimental and control class.

The assessment instrument for student learning outcomes uses a written test. The form is an essay consisting of 5 questions. The test questions refer to the learning indicators of the material on the Economic Behavior of the Tengger Mountain Slope Community. Before being used for data collection, the test questions were first tested for validity using the product moment correlation technique and their reliability tested using Cronbach's Alpha (Purwanto, 2005).

Data analysis using parametric inferential statistics. This analysis is used to determine the effect of the use of mobile learning-based field laboratories on student learning outcomes in the experimental and control groups. Statistical analysis uses normality tests, homogeneity tests, and independent sample t-tests to determine the effect between unrelated independent variables. The use of independent sample t tests assisted by SPSS 22.0 for Windows with a significance level of 0.05. The decisions taken are based on hypothesis testing of the acquisition of learning outcome score data. Hypothesis testing in this study is as follows.

H0 : There is no difference in student learning outcomes before and after using mobile learning-based field laboratory media in learning.
H1 : There is a difference in student learning outcomes before and after using mobile learning-based field laboratory media in learning.

The criteria are as follows: if sig. ≥ 0.05 then H0 is accepted. And if Sig. < 0.05 then H0 is rejected.

RESULTS AND DISCUSSION

1. Development and Feasibility of Mobile Learning-Based Virtual Laboratory Products

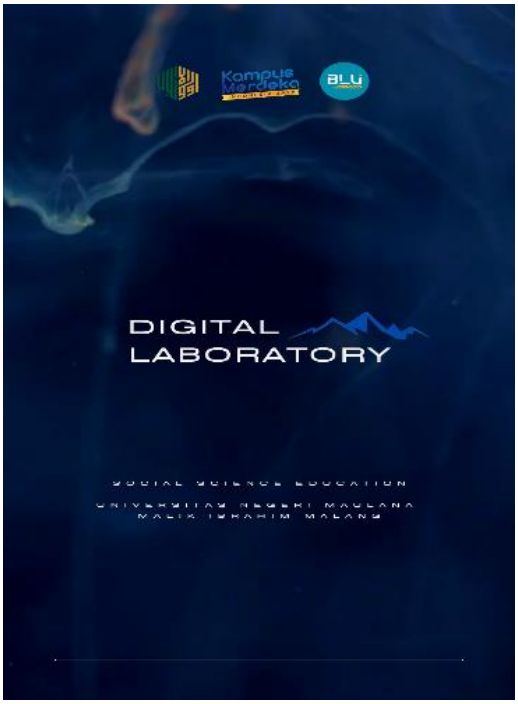
The process of developing a virtual laboratory product based on mobile learning follows the stages as conveyed by Borg & Gall which consists of 8 steps, starting with preliminary research activities in the field that have been carried out in previous

research in 2020. This research is followed up and developed with a product presentation that adapts to the needs of the development of digital era information technology in the form of a virtual laboratory based on mobile learningimg. Additional data mining was carried out by dividing the area into 3 parts, namely the lower, middle, and upper areas of the slopes of Mount Tengger.

In each area, information was mined regarding the location of the region, physical conditions, and socio-economic conditions of interesting objects that are suitable for virtualized social studies learning. Main Menu Page (picture 2).

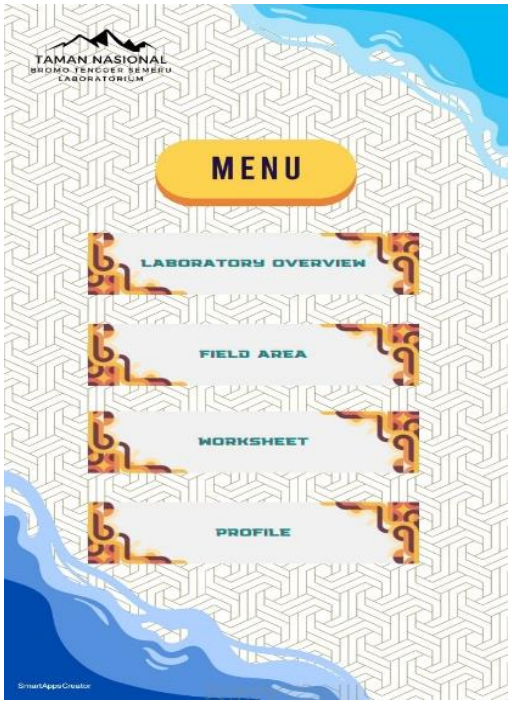
The first page takes students to the main page with the available menus. The menus above are used by students to support the learning process

Picture 1. Main Menu Page



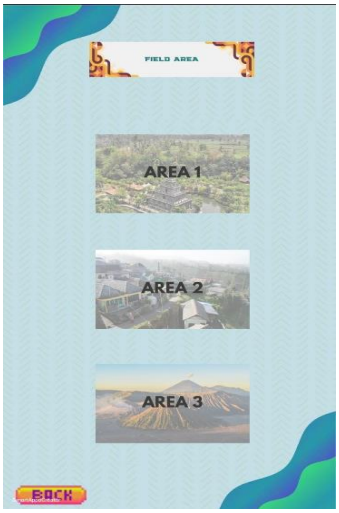
Source: Processed data, 2023

Picture 2. Menu Page



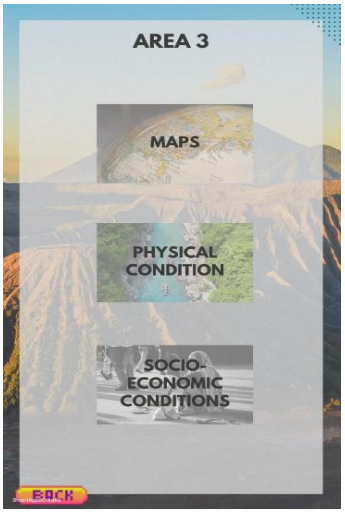
Source: Processed data, 2023

Picture 3. Field Area Page



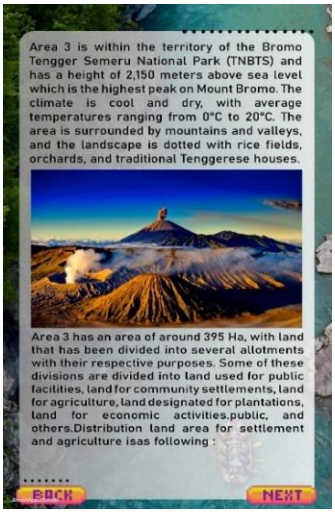
Source: Processed data, 2023

Picture 4. Menu Fields



Source: Processed data, 2023

Picture 5. Example of Explanation of Physical Conditions in Area 3



Source: Processed data, 2023

Profile Menu Page (figure 3). The page offers details regarding the laboratory overview, field area, worksheets, and profiles related to development media. Field Area (Figures 4, 5, and 6). Contains multiple sub-chapters that elucidate sections 1, 2, and 3. The area menu contains sub-chapters pertaining to the location, physical conditions, and socio-economic activities of the region. A questionnaire instrument with various questions has been used to obtain answers and perceptions from each validator and respondent.

The field laboratory has 16 questions for social studies learning experts (material experts), 16 questions for learning media experts, and 18 questions for students. The results of all validators and respondents on the field laboratory media are shown in table 3 below.

Table 3. Respondent Assessment Results

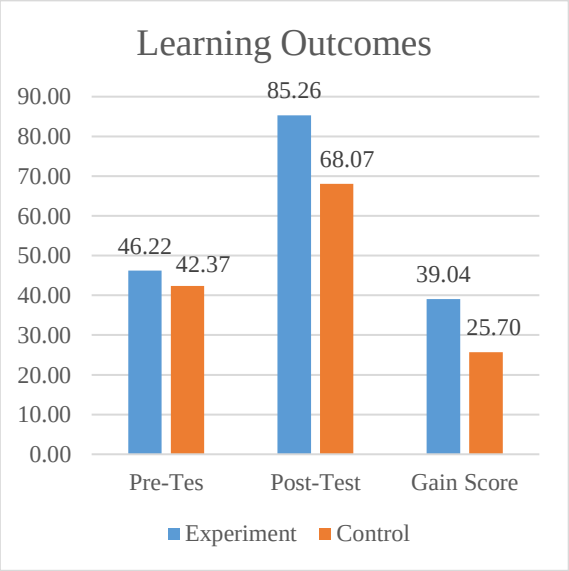
Respondents	Percentage (%)	Qualification	Conclusion
Subject Matter Expert	89.73	Very effective	Worthy
Media Expert	92.10	Very effective	Worthy
Student	84.39	Effective	Worthy
Average	88.74	Very effective	Worthy

As seen in Table 3, the results of the digital field laboratory test assessment were 88.74%. This indicates that the development product is in the very effective category and does not require revision, so it can be concluded that the Bromo-Tengger-Semeru National Park Virtual Laboratory has met the eligibility standards for use in social science learning.

2. The Influence of Mobile Learning-Based Virtual Laboratory Media on Learning Outcomes

The assessment of learning outcomes was administered prior to and following the product trial to evaluate the extent of student comprehension of the information. Figure 7 illustrates the comparison of learning outcomes between the experimental and control groups. Figure 7 illustrates that the gain score of learning outcomes in the experimental group utilising a mobile learning-based virtual laboratory rose by 39.04, from 46.22 to 85.26. Furthermore, the gain score of the learning outcomes of the control group without a virtual laboratory based on mobile learning increased by 25.70 from 42.37 to 68.07. The gain score indicates an increase in learning outcomes. Thus, the field laboratory media has been able to improve student learning outcomes.

Picture 6. Learning Outcomes Topic Economic Behavior of the Tengger Mountain Slope Community



Next, the effectiveness of the product is tested using an independent sample t-test by testing normality and homogeneity first. The following are the results of the normality test shown in table 4.

Table 4. Results of Learning Outcome Data Normality Test

	Kolmogorov-Smirnov a		
	statistics	df	sig.
Experiment	.122	27	.200
Control	.140	27	.189

The findings of the normality test of the experimental class learning outcome data scores are shown in Table 2 as sig. = 0.200 < α = 0.05 and sig. = 0.189 > α = 0.05 for the control class. The experimental and control class learning outcome data can be concluded to be normally distributed based on these significant values.

Furthermore, the results of the homogeneity test are shown in Table 5.

Table 5. Results of Homogeneity Test of Learning Outcomes

Levene Statistics	df1	df2	sig.
.542	1	52	.465

The learning outcome data in the experimental and control classes varied consistently, as seen in table 5 with a sig. value = 0.465 > α = 0.05. Based on the test results for both requirements, it can be concluded that the data is usually homogeneous and distributed. To ensure the impact of the IPS digital field laboratory on student learning outcomes, an independent analysis test was conducted using the gain score t-test sample. Table 6 provides a summary of the results of the independent analysis test of the t-test sample.

Table 6.T-Test Results

Class	N	Average	Sig. (2-tailed)
Experiment	27	39.04	.001
Control	27	25.70	

Table 6 shows that the average gain score of the control class is 25.70 while the average gain score of the experimental class is higher, namely 39.04. The sample data of the t-test of the learning outcome score shows the usefulness of sig. = 0.001 = 0.05 in the findings of the independent test.

As a result, it can be stated that there is a variation in learning outcomes before and after the implementation of the social studies digital field laboratory because the H0 hypothesis is rejected and the H1 hypothesis is accepted. The social science digital field laboratory significantly improves student learning outcomes on the topic of Economic Behavior of the Tengger Mountain Slope Community for Social Studies Education.

According to research, the social studies digital field laboratory based on mobile learning has an impact on student learning outcomes because when used it will confront students with real environmental challenges. The act of overcoming these inherent problems cultivates students' capacity for critical and analytical thinking regarding their everyday surroundings (Kurniawan et al., 2022; Nicol, Gakuba, & Habinshuti, 2022; Sari, Angreni, & Salsa, 2022). Students are encouraged to care about issues in their environment through social science digital field laboratories.

Investigating the problems raised in social science digital field laboratory learning while trying to solve them requires direct observation in the field. Students have a more comprehensive and concrete understanding of the problem, which makes it easier to collect data and information to identify and choose solutions (Al-nakhle, 2022).

Digital field laboratory has an impact on improving student learning outcomes on the topic of Economic Behavior of the Tengger Mountain Slope Community. Research by Al- nakhle (2022), Erdogan & Bozkurt (2022) and Sasmito & Sekarsari (2022) indicates that digital field labs enhance learning outcomes and facilitate learning development, corroborating the findings of this study. Students now have more time to search for data and information sources online that cannot be found in the field. As a means to help them find solutions to the problems they face, students' knowledge develops (Haleem, Javaid, Qadri, & Suman, 2022; Manyilizu, 2023).

As a result, the IPS digital field laboratory not only influences the improvement of learning outcomes but also helps students better understand information technology (Sumarmi, Putra, & Tanjung, 2023). Students in social science education are given this opportunity to prepare them to face the demands of information technology developments in the world in the 21st century.

CONCLUSION

The results of this study indicate that 1) a virtual laboratory based on mobile learning is feasible to be used in learning with a very effective category. 2) The use of a virtual laboratory based on mobile learning is effective in improving student learning outcomes in the topic of Economic Behavior of the Tengger Mountain Slope Community.

This study has a positive impact on the development of knowledge of social studies education students in utilizing virtual laboratories based on mobile learning. The results of this study contribute to the implementation of learning in the digital era as a consequence of the development of information technology.

This mobile learning-based virtual laboratory is now undergoing testing in limited learning and application domains, necessitating future development for broader and more familiar commercial applications. Recommendations for future research include: 1) disseminating the outcomes of mobile learning-based educational media products via app marketplaces, and 2) employing a platform that is seamlessly integrated with mobile learning applications for the presentation of student assessment menus and worksheets.

ACKNOWLEDGEMENTS

Gratitude is extended to the Institute for Research and Community Service (LP2M) of the State Islamic University of Maulana Malik Ibrahim Malang for the grant monies allocated for this research. This research was financed by the Ministry of Religious Affairs of the Republic of Indonesia through the 2023 BOPTN Research initiative. DIPA Number: 025.04.2.423812/2023.

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