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Design, Development, and Evaluation of a Mobile Learning Application for Geography Education

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ABSTRACT

This research focused on the application of the design science research approach in terms of developing GeoLab's mobile learning application for Geography Education in the context of higher education in Indonesia. GeoLab facilitates learning in the field of Geography Education on mobile devices. This application supports learning that can be accessed anywhere in higher education. Even this application provides interactive learning media with a 360-degree video display using Virtual Reality, Augmented Reality, and Mixed Reality features. The first part of this paper describes the analysis, design, and implementation of activities related to GeoLab's development. In addition, this study discussed the characteristics and scope of GeoLab's compliance with the nature and ideas of design science research. We evaluated GeoLab' in real learning, and an experiment was conducted with 126 second-year undergraduate students at a university in Indonesia. This study evaluates the feasibility, effectiveness, and ability of GeoLab' in Geography Education. We conducted a Usability Testing test on GeoLab applications'. The purpose of this Usability Testing is to assess the capabilities of GeoLab applications. Testing using Usability Testing, one of the Usability measurement tools, is the USE Questionnaire, which is divided into three main parameters, namely Usefulness, Satisfaction, and Ease of Use. The results of this study show that the GeoLab application can be considered easy to use by users in Geography learning based on the results of Usability Testing using the USE Questionnaire measurement device. This research offers suggestions on how to implement mobile learning that supports learning in the Geography Education curriculum.

1. Introduction

Geography is one of the subjects in the school curriculum, both in Indonesia and other countries. This means that geography content is considered very important for learners, not only in Indonesia but in various countries in the world [1]. Geography helps learners understand their country and other countries in the world [2]. Geography has links with citizenship, economy, history, and environment.

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Various enormous benefits of geography have not been fully realized, considering that geography education in schools is still faced with many problems. Currently, geography lessons are still considered uninteresting [3]. According to him, several factors cause it, namely: (1) geography lessons are often stuck on the cognitive aspect, namely memorizing the names of places, rivers and mountains or other facts; (2) geography is often associated with the science of making only maps; (3) geography only describes human journeys on the surface of the earth; (4) the learning process of geography tends to be verbal, involves less actual facts, uses less concrete media and the latest technology; and (5) less applicability in solving problems that are developing today. These conditions affect students' interest in learning geography [4-5].

Before efforts were made to improve, things like this had also happened to developed countries such as America and Britain. The results of Battersby and Biddulph's research show that Geography Education there also tends to be repetitive and unfocused [6]. This condition will make the position of geography education in schools less and less taken into account. In fact, Lumby [6] and Siswanto [7] suggests that if a subject is considered boring and irrelevant by students and not important enough by policymakers, then eventually, the subject will lose its school place. Lack of motivation of learners to learn geography can occur due to a lack of utilization of media and learning resources as well as varied and interesting methods.

The limited variety of methods and utilization of learning media in schools will certainly make geography learning activities not run optimally. The continuous use of the lecture method makes geography lessons tend to be verbalistic and distances students from the real world around them. However, one of the objectives of learning geography is to make students have knowledge and understanding of the place where they live [8-10]. Suggests that it is very important to build basic concepts of depiction and spatial planning by first using a picture of a recognizable environment in which children live and move, such as classrooms, school environments, and homes, before moving on to a broader and distant picture of the environment that is not recognized by them.

The geography subject matter offers knowledge about space with its various forms and processes occurring in it, both physical and socio-cultural [11-15]. Knowledge about diverse landscapes in different locations with various uniqueness and processes that occur in them is very interesting to learn. Something that is needed by students who are being attracted by new information or things [16]. However, unfortunately, the lessons are considered less interesting for many learners.

The development of information and communication technology is important, such as smartphones, especially for education [17-30]. It has opened up great opportunities for teachers and students to use it as a learning tool [31-38]. Students today can access widely and openly various platforms, such as mobile and web-based applications, which can be utilized for blended learning [39-44]. Wireless technology and mobile devices will continue to evolve all the time. This technology has become the center of attention in every aspect of our society, especially in the fields of Education, Economy, Trade, and Transportation [40-42]. The constant use of mobile devices such as smartphones and tablets for Geography Education continues to attract interest from researchers and educators [45-59]. Such interest is driven by the availability of mobile devices, relatively low costs, availability of technology infrastructure, and student interest [58, 60-61]. Today's learners can carry and use mobile devices anytime and anywhere to support learning [32-40]. From the results of our preliminary survey, Geography Education students want to learn and have a learning experience through mobile device support. Based on research Ariansyah [61], the projected number of mobile device ownership in Indonesian society increases every year. Research Suciati *et al.,* [62], Syafrina [63], Rianto [64] and Daeng *et al.,* [65] on a survey of mobile device and laptop ownership among teachers and students at universities in Indonesia indicates that 91% of teachers and 95% of students use mobile devices [62-65]. Based on the results of the study, it illustrates an opportunity to optimize

students to take advantage of the devices they have in the learning process. Although learning through mobile devices is considered useful, learners' perceptions and experiences will determine the success of these technological interventions [12].

Based on this, it is necessary to innovate in geography learning. Learning methods that tend to be classical and that have been widely done must be combined with methods that provide more space for students to develop their potential. The role of the teacher is to encourage and motivate students to seek and utilize various learning resources. The use of learning media in the form of smartphones can be used as an effective learning resource for students [32, 40]. In this connection, the GeoLab Application ' provides interactive learning media with a 360-degree video display using Virtual Reality, Augmented Reality, and Mixed Reality features that can be used as learning media and learning resources to recognize and understand geographical conditions or the environment around students.

In this study, we have applied the proposed framework (DSR-Design Science Research) to develop the latest mobile learning, called 'GeoLab', used in the context of Indonesian higher education. DSR has been widely applied in information systems and educational technology research and this method is particularly suitable for mobile learning [66, 69-68, 72-74].

DSR is a holistic research method with a dual purpose. First, develop specific solutions (artifacts) to solve a problem and meet needs or requirements related to the real environment. In our case, the real environment is Geography Education in Indonesian higher education. GeoLab' application is designed to support teacher activities by using blended learning methods to teach large groups of students in Geography Education. The real purpose of this study is to improve optimizing the functionality and ownership of students' mobile devices to promote Geography learning through mobile devices. Second, DSR should expand the existing knowledge base relevant to the field of research [66]. As far as we are concerned, scientific investments are mainly related to good practices and are based on our experience in designing, developing, and evaluating GeoLab' applications, following design principles. The purpose of this special study is to describe the design and implementation of GeoLab mobile learning application activities to reflect the development of GeoLab' based on DSR principles, as well as analyze assessment evaluations conducted by Indonesian university Geography Education students who use GeoLab' for learning activities. We will also evaluate their assessment of GeoLab'. This research will answer the following problem formulation: How to test the GeoLab application using the Usability Use Questionnaire for Geography education students at universities in Indonesia?

To answer the formulation of the research problem, we conducted a Usability Testing test on the GeoLab application'. The participants of this test are second-year Geography Education students taking Lithosphere learning courses at the Universitas Pendidikan Indonesia, Bandung, Indonesia. GeoLab' is used as a technological intervention to manage learning and support student experience and engagement in learning.

There are several studies on mobile learning in Indonesia, but most of them are theoretical studies and feasibility studies on mobile learning [75-82]. We are not aware of any similar research on the full implementation and evaluation of mobile learning for Geography Education in the Indonesian context. So, in our opinion, this is the first study in Indonesia that examines the experience of undergraduate Geography Education students who learn through mobile learning applications. Our results are the first to describe students' experiences and/or perceptions of assessment in using GeoLab' in a real learning setting.

2. Literature Study

2.1 The Relevance of Mobile Learning in Indonesia

The development of ICT device technology such as mobile devices currently provides great opportunities to be utilized in the world of education and learning processes [35, 37, 79, 83-85]. With the development of information and communication technology today in Indonesia, people, in general, have commonly used mobile devices, including teachers and students carrying mobile devices that have a variety of function systems, in addition to those that are mainly for communicating over long distances but also have other functions such as computing power, multimedia, internet, and portability [86-88]. The existing functional capabilities of mobile devices can be used as tools and learning media and affect the condition of students [58, 89-92]. Since the advent of mobile learning in the world, several researchers have attempted to define the term. Early definitions of mobile learning were the use of mobile phones portably and having a computing system to support learning [93-98]. Based on the development of mobile learning, there is also a definition related to mobile learning, which is an application of portable mobile computing devices, such as mobile phones, tablets, smartphones, and e-readers, to access learning resources, collaborate, communicate, and share learning experiences. However, mobile learning is not only the use of mobile devices to support learning but also involves all activities that occur between teachers, students, learning environments, learning theories, and learning support from anywhere, anyone, and anytime [35-38, 96, 99-105].

Using mobile devices in learning are such as relatively small size, use of unlimited flexible mobility, relatively easy use of applications, ability to provide new opportunities to update the learning environment in different forms, able to provide new experiences in learning, such as user engagement with mobile devices through the assumption that students can learn anytime and anywhere constant even informal learning includes traditional online learning and can provide dynamic development of skills and knowledge through peer training [104, 106-113]. In addition to supporting face-to-face learning, mobile learning made in it with the inclusion of appropriate knowledge material can also stimulate research and discoveries related to the adjustment of learning and teaching approaches based on the existing knowledge material on the mobile device, such as social learning approaches [58, 114-116], inquiry-based learning [115, 117-118], blended learning [119], flipped learning [120-121], online distance learning [122], game-based learning [123-124], cooperative learning [125-126], collaborative learning [127], competition-based learning [128], active learning [129-130], and exploratory learning [131-132]. Therefore, learning using mobile devices has the prospect of developing innovations in the world of education, especially in aspects of teaching methods. Such technologies can also create a cascade effect on learners' performance, thereby not only helping to understand a particular subject but also facilitating the development of skills such as problem-solving, teamwork, communication, creativity, innovation, and soft skills. Mobile applications designed for learning are only valid for the short term because the flexibility offered by the application must adapt to the curriculum of the educational institution and its pedagogic needs [133]. Therefore, mobile learning should include a wider range of student learning activities, not limiting students to determining the location and learning environment. Mobile learning should influence formal and non-formal learning for the transfer of knowledge and skills [135-136].

2.2 Mobile Learning in Geography Education

Mobile learning in Geography Education is something that has developed in the implementation of Geography teaching. The application of mobile learning in Geography Education can increase motivation to learn, improve the student learning experience, and provide more real simulations of learning opportunities using mobile devices, improving student performance, pedagogic experience, and learning achievement [137-140].

The positive effect of mobile learning was doubled: (1) student engagement in mobile technology supported observation during their scientific investigations, and (2) student engagement in mobile technology supported manipulation during their scientific investigations [110, 141-143]. Translating the positive impact of mobile learning in Geography Education will result in improved learning, positive perceptions, and rewarding experiences. It is difficult for individuals to study some cases of Geography Education material; mobile learning as a new pedagogical method offers an opportunity to minimize such difficulties. However, mobile learning solutions in Geography Education should be designed to support meaningful learning and provide motivation for students to adopt such solutions [58, 144-145]. Table 1 shows some examples of mobile learning solutions in Geography Education from the literature that also inspired our work with GeoLab' applications.

Table 1
Related Mobile Learning Solutions in Geography Education

Solution	Title	Result	Ref.
Learning Media Based on GIS	Development of an Android-based smartphone application to support geography learning using a geographic information system	The study shows that students are motivated to use technology for geography learning and use mobile devices for long-term learning by using geographic information systems	[142]
VirTEd	Development of an Android-based smartphone application to support learning in the field of tourism education, such as Tourism Geography, hospitals, tourism service businesses, and gastronomy	The platform provides students with experience in learning tourism geography	[146]
M-Guiding app	Development of an Android-based smartphone application to support learning to guide geopark tourist sites	This study presents a mobile tool that facilitates the engagement of students, teachers, and educators in determining the location and path of tourist destinations through applications and contains interpretations related to edu tournaments in geoparks.	[147]
COMPASS	Development of an Android-based smartphone application to support learning to guide tourist sites	This study presents a mobile tool that facilitates students' experiential engagement in determining the location of tourist destinations through applications.	[148]
Mobile Tourism	Development of an Android-based smartphone application to support learning tour guidance	The study shows that students are motivated to use technology for learning and using mobile devices for long-term learning.	[149]
M Traveling	Development of an Android-based smartphone application to support learning to guide tourist sites	The platform provides students with experience in learning travel management.	[150]
Social Media Marketing	In social media marketing, students can run and see visualizations of the implementation of Geography marketing.	The study presents a mobile tool that facilitates students' active involvement in travel promotion through apps.	[151]

From the table, it can be seen that several mobile learning solutions have been developed in Geography Education to support independent learning as well as support the implementation of computational learning [148-151]. However, existing solutions have not been designed for the context of higher education in Indonesia. The mobile learning solution, GeoLab', has been specifically designed to address the problem of poor engagement in teaching large numbers of students in computing classes in the context of undergraduate in Geography Education at universities in Indonesia. In addition, there is a need to continuously design new and inclusive mobile learning platforms based on scientifically proven theories and emerging frameworks such as DSRs. Assessment of mobile learning applications is very necessary to test the level of usability, satisfaction as well as usefulness, and usability is an important factor in the development of mobile learning applications [152-153].

3. Method

3.1 Design science research framework

Design Science Research (DSR) is a procedure carried out systematically to solve problems, design applications, design applications, implement applications, evaluate application design, contribute to research, and communicate with the scientific community [6, 66, 71, 154-155]. DSR begins with a problem to find a solution or improvement [6, 154, 156]. This study aims to design Android-based mobile learning media as a solution to meet the needs and needs of Geography Education in the context of higher education in Indonesia.

This study used a DSR framework adapted from [2, 66]. This framework is then used to develop GeoLab' applications for learning media. The framework includes five stages: explicating the problem, outlining the artifact and defining the requirement, designing and developing the artifact, demonstrating the artifact, and evaluating the artifact. Next, we use the abbreviation EODDE to refer to the framework. The EODDE framework consists of the following activities: describing the problem, outlining the application and defining requirements, designing and developing the application, demonstrating the application, and finally, evaluating the application (see Figure 1). All DSR process activities can contribute to knowledge related to a particular field of study.

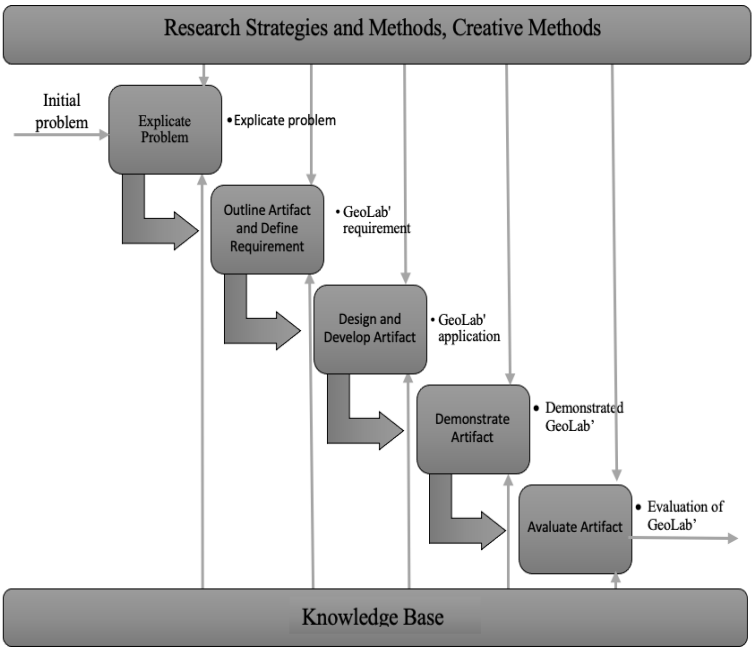


Fig. 1. Design science research framework adapted from [66]

The first activity in the EODDE framework is to explain the problem, which means clearly explaining the problem behind the DSR process and showing that the problem is important to solve [58]. The problems expressed must also be of general interest. The basic cause of the problem must be identified and analyzed. The main purpose of the first phase is to explain the initial problem, put the problem into practice where it arises, shape the problem appropriately, and activate the importance of the problem.

The second activity in the EODDE series is to describe the application and define the requirements of the application. The purpose of this second activity is to define the needs and expectations of using applications in providing solutions to problems [73].

In the third activity, designing and developing an application, the goal is to explain how the application is designed to address the following problems of defining the functions in the application and the components of building the construction of the application.

In the fourth activity, namely, demonstration, explaining the appearance of menus or tabs related to application functions in solving problems.

In the fifth activity regarding evaluation, application testing is carried out to investigate and evaluate how application usage is performing. Formative evaluation and summary evaluation methods can be used to gather feedback and correct deficiencies in the app's usage and performance. At the same time, summary evaluation is used to measure the impact of the solution [157].

3.2 GeoLab' Design and Development

3.2.1 Explaining the Problem Behind GeoLab'

The practical challenge that motivates the development of GeoLab' application is the lack of direct involvement and interaction between teachers and students due to the large number of students in the class of the Geography Education undergraduate program in the context of Indonesian higher education [158]. Practically speaking, in developing countries like Indonesia, there are a lot of students enrolled in public universities. Often, teachers are faced with the challenge of giving attention to hundreds of students in undergraduate programs. The large number of students has created many problems that occur in the implementation of learning, for example, problems such as less interaction between students and teachers, lack of multimedia interactive learning media, poor management of learning activities, achievement of ineffective instructional goals involving a high level of cognitive skills, such as analysis, synthesis, and application; poor morale, motivation, and self-esteem among learners and teachers; and limited opportunities for individual feedback and student assessment [159]. Although this problem is common in developing countries, it can be of general concern.

We conduct a preliminary study of the problem explicitly using the following methods. First, to determine the problem, consultations begin with stakeholders, namely the Indonesian Ministry of Education and Culture, through offline and online discussions, questionnaires, and teacher interviews. We also investigated the readiness of Indonesian higher education Geography Education undergraduate program students to adopt mobile learning, their preferences for using specific mobile learning devices and mobile learning solutions for Geography learning training courses, and their opinions regarding the suitability of mobile learning to study Geography Education-related subjects. Next, we conducted a systematic literature review to identify existing research solutions and results regarding mobile mobile learning in Geography Education [139]. The systematic review explores perspectives on integrating mobile learning into Geographic Education, such as the

application, progression, and design of mobile learning solutions, which subsequently inspired the refinement of requirements and, ultimately, the design and development of GeoLab's systems.

The opportunity to acquire mobile devices in Indonesia is relatively easy compared to other ICT devices, such as laptops, making it an important consideration when developing a mobile-based learning platform because it is more practical [160]. Therefore, these conditions are important to use and utilize for the learning process. We also want to design and develop a GeoLab system to support blended learning, which combines learning using computer technology or mobile devices with conventional learning in the classroom. In blended learning, students can learn through online media and conventional learning, allowing teachers to deliver material to more students.

Currently, the learning environment in Geography Education in Indonesian higher education is dominated by conventional/face-to-face learning methods where teachers and students must be in one location. However, this method has been considered successful in recent decades but cannot provide ICT experiences such as using mobile learning-based learning for students. The reconceptualization of learning that emphasizes the importance of mobility, cooperation, and communication, especially in the mobile age, must now be patented. Therefore, it is very relevant and up-to-date to identify technologies that can support mobile learning.

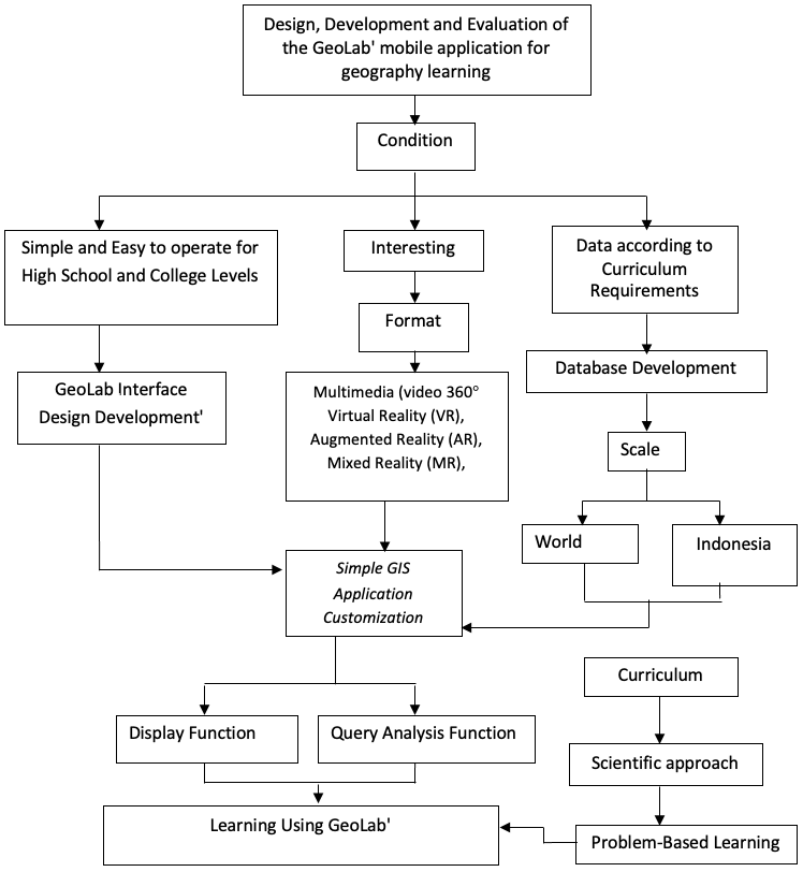
3.2.2 Explanation of Solutions and Forms of Needs

GeoLab's primary function is the ability to support the learning engagement of many students at any Abdurrahman *et al.,* [129], learning in large classrooms is one source of decreased student activity and teacher interaction with students. A blended learning approach is considered one option to minimize the impact of large classrooms and improve learner performance [135, 160-161]. One way to support student engagement in mobile learning is to use mobile communication functions like chat, email, push notifications, discussion forums, apps, and interactive self-practice materials [131]. All these functions are available in GeoLab', another requirement fulfilled by GeoLab' is to utilize the capabilities of mobile devices as technology in supporting learning activities anywhere and anytime. For example, GeoLab' supports the availability of materials or teaching materials in various formats, the availability of interactive learning media and multimedia is supported by 360° video, Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), 3D games and the use of device features, such as cellular data, Bluetooth, Wi-Fi, and GPS. As conveyed, mobility, social networks, and context awareness are important functions for 21st-century learners [5, 58]. Other requirements mobile learning meets are opportunities for blended learning consisting of mobile learning-based activities, large classroom teaching and small group laboratories, and assessment evaluation aspects [50, 162]. Thus, GeoLab' supports students to access learning materials in various formats such as .doc, .pdf, ppt, 360° videos, Virtual Reality (VR), Augmented Reality

3.2.3 GeoLab' Application Development Design

GeoLab' is a mobile learning application that contains Geography Education learning material related to physical Geography elements (Lithosphere, Hydrosphere, and Atmosphere). GeoLab' can be used for blended learning, collaboration, social networking, and assessment evaluation because the application is already connected to a mobile server subsystem to share data among all mobile devices connected to the server. GeoLab's physical structure consists of GeoLab's learning center administration, Users, databases, and Servers. GeoLab' learning center administration is at the heart of the entire running of the system. In the GeoLab application, there are seven menus/tabs/windows consisting of Home, Instructions, Salindia, 360°-based Geography learning videos with Virtual Reality

(VR), Augmented Reality (AR), Mixed Reality (MR) display features, Application Instructions, Modules/teaching materials, quizzes as a learning evaluation process, discussion forums/notifications (Credit) and Log Out (See Figure 2).



F**ig. 2.** Geolab material design framework drawing

3.2.4 GeoLab System Implementation'

The programming languages, software, and tools that we use to implement this application are as follows:

(1) Hardware (See Table 2)
(2) Software (See Table 3)

Table 2
Hardware

Tools	**Specifications**
Laptop Asus X550V	15.6 Inch, Windows 10, Intel(R) core(TM) i7-7799HQ CPU @ 2.80 GHz 2.81 GHz, 1TB Hard Drive, 8GB ofDDr SDRAM.
Personal Computer	Microsoft Windows 10 (OS), 2.20 GHz Intel Duo Processor, 500GB hard drive, 4GB of RAM
Mobile Oppo A5	Android 9.0 Pie, 6.5 inch (720x1600) Screen, Memory 3GB
Samsung Galaxy Tablet	Android 9.0 pie, 8 inch (1280x800) Screen, Memory 3GB
Insta 360 oner camera	

Table 3
Software

Tools	Specifications
Programming tools	(i) Android SDK is an operating system for Linux-based mobile devices that includes operating systems, middleware, and applications
	(ii) Unified Modeling Language (UML) is a standard modeling language for software development and object-oriented systems. UML provides a visual modeling language that is useful for developers in creating blueprints from programs to be created
	(iii) MySQL is an RDBMS (Relational Database Management System) product that is very popular in Linux environments but is also available on Windows
Graphics tools	(i) Blender is used for modeling, rendering, and 3D animation in addition to blender can be used in video editing, video effects, image retouching, and game development
	(ii) PTGui is an affordable commercial merging tool for creating panoramic images of large landscapes taken with a 360-degree camera. PTGui is a panoramic stitching software for Windows and Mac OSX. This software was developed as a graphical user interface for Panorama Tools
	(iii) Adobe Illustrator is a leading vector graphics editor program, developed and marketed by Adobe Systems. Illustrator CC is the latest version of this program, the twentieth generation of Illustrator products.
	(iv) Adobe Premiere Pro is a non-linear based video editing program from Adobe Systems.
Sound Tools	Audacity
Document and Present tools	Microsoft Office 2013

The first working version of GeoLab' was an Android-based mobile app. As described in the design phase, the entire system consists of clients (Android-powered mobile devices), GeoLab's learning center administration, Users, databases, and Servers. To ensure system portability, efficiency, and maintenance, we build each subsystem using different software technologies. Subsystems are connected using dynamic link libraries. After developing the app, we ran it separately on the emulator and the actual device to confirm the functionality of the different units. Then, we install the application on a real mobile device for debugging. Testing conducted on 6.6-inch Samsung Galaxy A34 5G and 8-inch Samsung Galaxy Tablet. Applications are implemented through rigorous tuning and iteration, as defined by the DSR. The DSR framework for GeoLab' is illustrated in Figure 3. GeoLab' app is available on Google Play Store. This app can be downloaded for free.

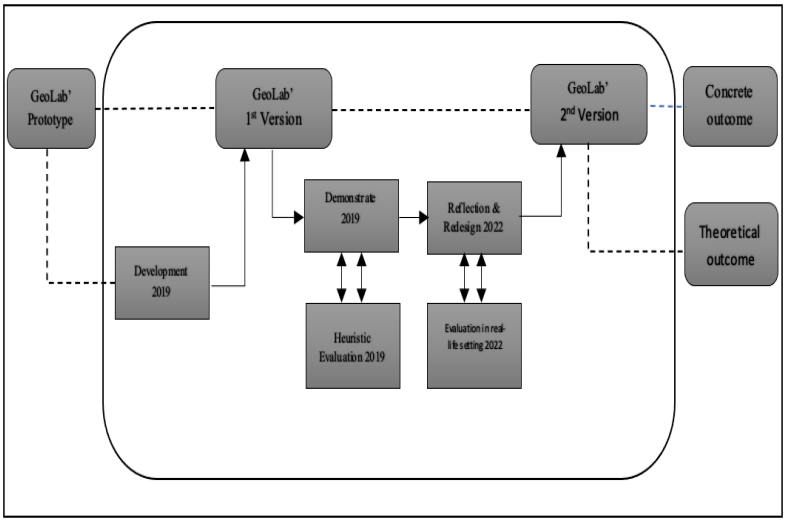


Fig. 3. Summary of the GeoLab' DSR process

3.2.5 GeoLab' Application Demonstration'

GeoLab's main screen contains eight tabs for performing learning activities. Both instructors and students are welcomed with seven menus/tabs/windows consisting of Home, Hints, Salindia, 360°-based Geography learning videos with Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) display features, Application Instructions, Modules/teaching materials, quizzes as a learning evaluation process, discussion forums/notifications (Credits) and Log Out. Figure 4 describes a screenshot of the home screen.

The Lithosphere tab is an explanation of geography digital learning materials that explain the outermost crust of the earth, which is composed of tectonic plates that are very difficult to move. This Lithosphere tab displays a three-dimensional view and virtual tour of the lithosphere and its information attributes that explain geography digital learning materials. Furthermore, the Atmosphere Tab explains geography digital learning materials about the Earth's Atmosphere or the layer of gas surrounding it, from its surface to deep space. The Atmosphere's height is 0 km above ground level and 560 km above the earth's surface. This Atmosphere tab displays a 3D view and virtual tour of the Atmosphere along with its information attributes that explain geography digital learning materials. The Hydrosphere tab explains geography digital learning materials that explain the Hydrosphere or the water layer on the earth's surface. This Hydrosphere tab displays a three-dimensional view and virtual tour of the Hydrosphere and its information attributes that explain geography digital learning materials. The biosphere tab explains geography digital learning materials that explain the number of ecosystems throughout the earth. The biosphere is also called a zone of life on Earth, a closed and largely automated system. This Biosphere tab displays a three-dimensional view and virtual tour of the biosphere along with information attributes that explain geography digital learning materials. The Anthroposphere tab explains geography digital learning materials that explain the human layer, the central theme among the spheres. Because the study of geography is a central theme, geographical studies are often called anthropocentric. This Anthroposphere tab displays a three-dimensional view and virtual tour of the Anthroposphere along with its information attributes that explain geography digital learning materials. And finally, the Map Tab displays a picture of the earth's surface in Indonesia.

The lithospheric dynamics tab supports users with the function of displaying any material that can be studied or displayed, ranging from modules, geography learning videos, VR, AR, and MR related to lithospheric dynamics shown in Figure 5, figure 6 shows three-dimensional impressions of lithospheric phenomena and there are labels as supporting information in the picture. Figure 7 shows a screenshot of 360° Virtual Reality (VR), Mixed Reality (MR), and Augmented Reality Videos related to geography phenomena. Figure 8 shows the working system of Virtual Reality (VR) and Mixed Reality (MR) modes. Figure 9. contains related application instructions. Figure 10 displays the module (this feature presents teaching material information about the Geography material and simulation center that can be accessed by users in which there is a complete description that will help in learning so that it can make it easier for users to get information) The originality of our solution lies in the fact that GeoLab' system is all-encompassing to support multi-student blended learning while providing opportunities for assessment, multimedia, collaboration, and social networking. Model of the entire GeoLab system' using a UML use case diagram. Actors (lecturers, students, and administrators) are shown interacting with system functions.

Fig. 4. Home screen

Fig. 5. Lithosphere dynamics tab display

Fig. 6. 360° and 3D Image Display

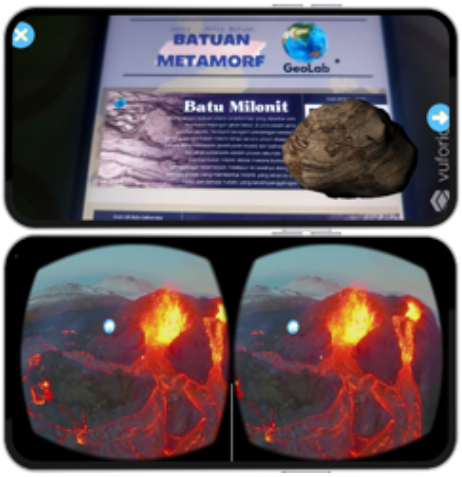


Fig. 7. 360° Virtual Reality (VR), Mixed Reality (MR), and Augmented Reality Video Display

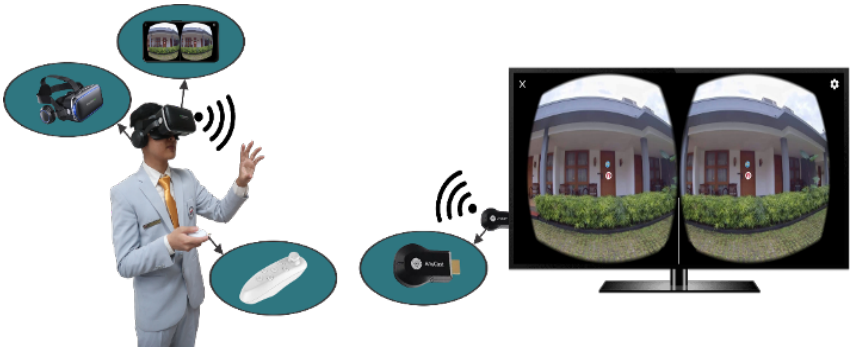


Fig. 8. Virtual Reality (VR) and Mixed Reality (MR) mode illustration

Fig. 9. Application Instructions for Use

Fig. 10. Module

3.2.6 Evaluation Testing using GeoLab's Usability Testing'

To evaluate the feasibility, effectiveness, and capability of GeoLab' in Geography Education, we conducted a 'Usability Testing' test on GeoLab applications. This Usability Testing aims to assess the capabilities of GeoLab' applications. Testing using Usability Testing One of the Usability measurement devices is the USE Questionnaire, which is divided into three main parameters, namely Usefulness, Satisfaction, and Ease of Use [2]. Here's the explanation: 1. Usefulness: The extent to which an application allows the user to achieve its purpose and is an assessment of the user's willingness to use it. 2. Satisfaction: How users feel when using the product, Feedback on the product design, or response to the overall product design. 3. Ease of use Measures the extent to which the user can operate the system. Testing is only one stage in testing GeoLab applications on students by testing the Application Usability Testing Task as follows (See Table 4):

Table 4
Application usability testing task

No	Task	Task Experience
1	Open the GeoLab app'	*The* user tries the application and pays attention to the application interface
2	Open Menu	The user try open room design
3	Run Features (Home, Hints, Salindia, 360°-based Geography learning videos with Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Application Instructions, Modules/teaching materials, quizzes	*Users* try interactive features of interactive *maps* such as *rotate* and *zoom*
4	Search for resources with the search	*User* enters the name of the facility in the *search* button
5	Unlock resources via *hotspot* labels	*User* selects Hotspot facility on the *Interactive Tools page*
6	Run Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Application Instructions, Modules/teaching materials, quizzes	*users* try Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Application Instructions, Modules/teaching materials, quizzes
7	Run *a facility* hotspot	*user* selects *hotspot* Facility
8	Try switching pages between *virtual tours*	*user* opens *between menus* and tries to move pages on Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) features
9	Go to ordinances	*User* opens *the Info button* in the main menu to see how to use the application
10	Open module	*The user* sees the material in the module
11	Open quiz	*User* View and Try quiz
12	Open credit	*User* view credit info about the app
13	Go to log out	*User* logout

GeoLab's main screen contains eight tabs for performing learning activities. Both instructors and students are welcomed with seven menus/tabs/windows consisting of Home, Hints, Salindia, 360°-based Geography learning videos with Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) display features, Application Instructions, Modules/teaching materials, quizzes as a learning evaluation process, discussion forums/notifications (Credits) and Log Out. Figure 4 describes a screenshot of the home screen.

3.2.7 Research Instruments

After being given the task above, the questionnaire is given to users who have done the tasks above to get user experience (user experience) of the appearance of the application being tested, namely what users see and feel when doing the given task. The questionnaire contains 16 questions for students representing all three aspects of the use questionnaire, consisting of five question items related to Usefulness, four question items related to satisfaction, and seven question items related to Ease of Use. Each parameter is broken down into a set of statement packets presented to users as questionnaires with a Likert scale. Each question in the questionnaire aims to show the level of usability according to user acceptance, which will be rated on a scale of 5 (See Tables 5 and 6).

Table 5
Application usability testing task

PK	STM	CE	CM	M	BC
Value	100	200	300	400	500

Where, Information are
PK = Questionnaire Questions
STM = Not Very Easy
TM = Not Easy
CM = Easy Enough
M = Easy
SM = Very Easy

Table 6
Aspects of application usability use questionnaire

No	Question	Factor
1	Are 360° images and videos with Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and information displayed easy to understand?	
2	Is the App Guide easy to understand?	
3	Is it easy to access the menu offered?	Usefulness
4	Are the explanatory modules and videos easy to use?	
5	Are the explanatory modules and videos easy to use?	
6	Is it easy with this application to know more about Geography?	
7	Is it easy with this application you can easily get an idea of learning Geography?	Satisfaction
8	Can the application make it easier to get information about learning Geography?	
9	Does this application make it easy to find the location of the facilities you are looking for?	
10	Is the interface in GeoLab' application easy to identify?	
11	Is the app easy to use?	
12	Is the color display in GeoLab' application suitable?	
13	Is the app menu display easy to recognize?	
14	Is the existing written information easy to read?	Ease of use
15	Are symbols, icons, and images easy to understand?	
16	Is the 3D display form displayed easy to understand?	
13	Is the app menu display easy to recognize?	

3.3 Data analysis

A combination of quantitative and qualitative approaches is used in data analysis. The collected data was calculated using the Likert scale based on the answers from the respondents.

4. Results

Research question: how to test GeoLab' application using Usability Use Questionnaire? Based on the results obtained regarding the Usability Use Questionnaire testing using three main parameters, namely Usefulness, Satisfaction, and Ease of Use by 126 students on the GeoLab application, they are as follows.

This measurement of the usefulness parameter measures the extent to which the application allows the user to achieve its goals and assesses their willingness to use it. The average value of usefulness parameter assessment by 126 respondents was 462, with a percentage of 92.4%, which shows that this application is very easy for users. Based on the results of a five-item questionnaire related to the Usefulness parameter in the use of the GeoLab application, it was obtained that this application greatly facilitates users in using the application and greatly facilitates users in achieving a goal related to feature information in the GeoLab application'. The main concern of the respondents is related to the use and purpose of the GeoLab application, namely 360° video with Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) display features information, materials, practices related to Geography learning according to the respondent this feature provides very important information and goals related to learning Geography, then the guide feature in this application can also facilitate the use of the application by Students., respondents' assessment of the menu access offered is considered very easy for users to carry out the functions of the application (See Figure 11).

This Satisfaction parameter is measured by how users feel when using the product or responses to product design and the overall product design. The average value of satisfaction parameter assessment by 100 respondents is 455, with a percentage of 91%, which shows that this application makes it easy for users to provide an application usage experience. Based on the results of the questionnaire of four question items related to this Satisfaction parameter in the use of the GeoLab application, it was obtained that this application makes it very easy for users to learn more about Geography through the 360° video display feature with Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) display features, users also get an overview and information about learning Geography, this application also makes it easier for users to find the location of the facilities they are looking for (See Figure 12).

Measuring ease of use parameters measures how users can operate the system. The average value of ease of use parameter assessment by 100 respondents was 435, with a percentage of 87%, which shows that this application is easy to operate the system by users. Based on the results of a seven-item questionnaire related to the ease of use parameter in the use of the GeoLab application, it was obtained that the application and the interface design of this application can be said to facilitate users in its operation, the color display in the application is considered suitable to be applied to the application, the application display is easy to recognize, writing information is easy to read, symbols, icons, and images are easy to read and understand. The 3D building view is easy to read and understand (See Figure 13).

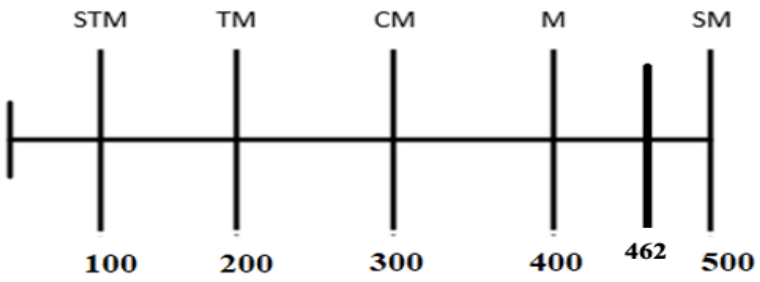


Fig. 11. Average score of usefulness assessment

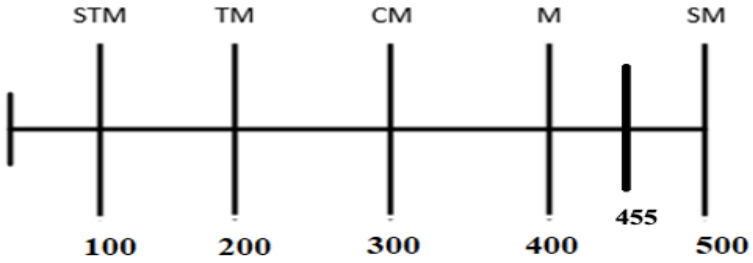


Fig. 12. satisfaction assessment average score

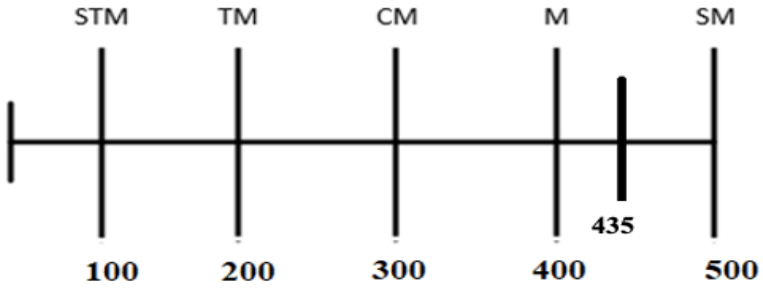


Fig. 13. Average score of ease of assessment

5. Discussion

This study aimed to evaluate GeoLab', a mobile learning application developed specifically for Geography Education in Indonesia. We focus on developing GeoLab' for students' learning experience using mobile learning applications. Student experience using the GeoLab application is needed to ensure the use system runs functionally in Geography Education learning. Therefore, our research investigates the potential offered as a mobile learning solution and ascertains the perception of user judgment towards the app.

The results of this study show that the GeoLab application can be considered easy to use by users in geography learning based on the results of Usability Testing using the USE Questionnaire measurement tool, which divides into three main parameters: Usefulness, Satisfaction, and Ease of Use. Usability, satisfaction, usefulness, and usability are important in developing mobile learning applications. The results we obtained from testing the application by users in the aspect of Usability

(Usefulness) show that the GeoLab application is considered very easy to use, the aspect of satisfaction, as well as usefulness (Satisfaction), is considered very easy and very helpful for users in solving solutions related to Geography learning, and the user aspect (Ease of use) of the application is considered by users easy to operate.

This follows what several researchers conveyed about how to evaluate mobile learning application testing using Usability Testing [152-153]. Evaluation of mobile application testing using Usability Testing shows the usefulness of application functions, effectiveness, and efficiency to application users. The similarity of the evaluation results of the GeoLab application with the results of other application assessments is in the ease of using the application. In contrast, what distinguishes it from other applications is the function and usefulness of the application seen from the content of the application. The application we design has a different focus where the material we display is about learning Geography Education and its usefulness, which is different from previous application research, for example in Van Setten [148], Kenteris *et al.*, [149], da Silva *et al.,* [150] and Gulbahar *et al.,* [151], which is mostly more focused on the general perspective of mobile learning, application adoption, mobile learning implementation feasibility studies, mobile learning challenges, the impact of m-learning, the effect of m-learning on learning performance. Based on the results of other studies also mentioned that the application of mobile learning can improve student learning performance [111, 131]. Although many studies of this type have been conducted, our findings support the expansion of the novelty of mobile learning devices, especially in Geography Education. In addition, the flexibility of using mobile devices allows students to learn anytime and anywhere [96, 100-10, 163]. GeoLab' application provides a learning experience through mobile mobile applications to students. Also, it helps students set and implement learning routines even when they want to study independently.

Nevertheless, more research is needed to ascertain the effect of mobile learning on student learning performance. Furthermore, the experience and attitudes of students who use and assess GeoLab' for Geography Education are considered easy to use as a mobile learning medium. As a result, we conclude that GeoLab' has a positive assessment and has great potential to be used in Geography learning.

6. Conclusion

Based on the achievements of our investigation, we can conclude that the GeoLab application can be considered easy to use by users in geography learning based on the results of Usability Testing using the USE Questionnaire measurement tool, which divides into three main parameters, namely Usefulness, Satisfaction and Ease of Use. Usability, satisfaction, usefulness, and usability are important in developing mobile learning applications. The results we obtained from testing the application by users in the aspect of Usability (Usefulness) show that the GeoLab application is considered very easy to use, the aspect of satisfaction, as well as usefulness (Satisfaction), is considered very easy and very helpful for users in solving solutions related to Geography learning, and the user aspect (Ease of use) of the application is considered by users easy to operate.

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