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Research paper

Interactive Learning Media Development Based on Android Assisted by Google Sites on Building Static Calculation Element in 2nd Depok National Vocational High School

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ABSTRACT

Background: This study aims to develop interactive learning media based on android assisted by Google Sites on building static calculation element class X SMK N 2 Depok and to determine the feasibility of the media in terms of material and media aspects.
Methods: The research is Research and Development (R&D) method using waterfall model development. The stage of waterfall model are analysis, design, coding, testing, and maintenance. Data is collected using interviews, questionnaires, and device usage. Feasibility data analysis using category range analysis.
Results: The results of this research according to the stages (1) the analysis stage reveals problems with learning methods and models that are not yet sufficient for students to learn according to the independent learning curriculum. The software used is Adobe Illustrator and assisted by Google Sites with an android smartphone v4.1 has a minimum of 1GB of RAM and 1GB of free memory. (2) The design stage uses UML planning and storyboards. UML diagrams include use case, activity, class, and sequence. (3) The coding stage is assisted by Google Sites using Markup Language HTML and Website Appsgeyser. (4) The testing phase is carried out on material and media aspects according to ISO 25010. (5) The maintenance stage involves improving the appearance and explanation of the questions.
Conclusion: Based on the test results it is concluded that the media developed is feasible to use.

INTRODUCTION

The challenges and opportunities of Industry 5.0 encourage innovation in education. Technological developments make it easier to communicate, access and create something. The existence of technological developments can improve the learning process in education. As stated by Maritsa et al. (2021) technology can be utilized in the form of interactive devices that facilitate interaction in the classroom, thus improving the quality of education. Sukoco et al.

(2014) define learning as a communication process between educators and students aimed at conveying certain messages. The learning system at school refers to the latest curriculum, namely the independent learning curriculum. The hope of implementing this curriculum is that students understanding will be deeper, more relevant, and interactive. In addition, through this curriculum students are given the freedom to make choices with the direction of educators. This curriculum has different characteristics from the previous curriculum. the latest curriculum is K13 does not provide detailed basic competencies for each subject, thus requiring the teacher's expertise in organizing the delivery of material in accordance with the learning outcomes in the curriculum.

Indonesia has several levels of formal education, namely early childhood education, primary education, secondary education and higher education. Each education has its own rules and policies, especially secondary education which is divided into Vocational High Schools (VHS), Senior High Schools (SHS), and Madrasah Aliyah (MA). Vocational High School is the only formal education that prepares students primarily to work in certain fields. This is explained in Law No. 20 on the National Education System that vocational education is education that prepares students to be able to work in a particular field. Government Regulation No 66 of 2010 explains that Vocational Secondary Education is a formal education pathway at the secondary level that continues basic education, prioritizing the development of students' abilities for the implementation of certain types of education. SMK N 2 Depok is one of the formal education at the secondary school level that has a Building Information Modelling Design expertise program.

Building Information Modelling Design is an expertise program at SMK N 2 Depok that continuously develops to meet the competency standards required by the changing times and demands of the industry. The program prepares students to master various building plans, which involve components such as structural calculations, construction management, building design, measurement using tools, and other relevant skills. In that lesson, there are various aspects related to structure such as elements, factors influencing structure, loading, and forces within the structure so that students can analyse and consider matters related to the structure (Putra & Hariyanto, 2021). One of the fundamental topics that students must learn is structural calculation, which used to be called engineering mechanics but now referred to as building statics calculation in the current curriculum (Pratama, 2022) (Pratama, 2020). This element covers the study of building structures, including force balance calculation and bar forces calculation on simple frames as the basis for building construction work.

Based on observations on Friday, October 21, 2022, in the competency of Building Modeling and Information Design expertise for the statics calculation element of the building, several problems were found during the learning process. According to student statements, this learning has characteristics that are difficult to understand but interesting to learn because of the content of calculations that require more accuracy and understanding. According to Narassati et al. (2021) engineering mechanics is an applied science that requires qualified numerical skills. In addition, there is material that is less precise in meaning and grouping. Teachers try to make learning as interesting as possible by conducting group discussions and providing independent assignments. However, students have not responded well. The teacher packages the material by delivering it using PowerPoint, PDF, and videos utilizing an LCD and interspersed with oral and written explanations using the blackboard. Teaching modules used in this curriculum are not yet available. This problem has another impact, namely, material files that accumulate and are less organized. In addition, the material files seem to be many and separated. The method applied has been directed to be learner-cantered, but students still lack reciprocal responses to the teacher. So, it has not yet achieved the expectations of implementing an independent learning curriculum.

Based on the results of interviews with teachers who teach building statics calculation elements, it is explained that students are considered less confident and less independent in learning. In addition, the impact of the pandemic which lasted long enough, made students' understanding of basic mathematics low, which affected basic calculations. According to (Jamal, 2021) online learning can reduce the development of students' mindset and affect the productivity of how students learn. This exacerbates students' dependence on the direction and provision of material from the teacher, has not created conditions for students to learn independently, and students become bored quickly due to monotonous teaching methods (Pratama, 2019). Inappropriate methods cause students to have difficulty in understanding the calculation material. Problems related to the learning process affect the achievement of student competencies. The results of the formative assessment of the third material found 50% of students had scores still below the Minimum Completion Criteria (KKM) of 75.

Students explained that media is needed that can assist in learning. Media with systematic characteristics are able to collect material in a structured manner along with examples and practice questions so that it can be used as a source and reference for learning in class and independently. Behind the problems faced, students have high motivation and desire to learn.

The classroom atmosphere will also be orderly and comfortable if the teacher can use learning media that can encourage students to ask questions, observe, find facts and concepts by thinking for themselves (Titania & Widodo, 2018). Seeing these problems in reality, learning media can be improved and developed in accordance with the development of technological facilities referring to the expectations of an independent learning curriculum (Sumardjo, 2020). This utilization can have a positive impact on technological development and be a solution to the problem of learning media. The creation of interactive learning media can attract students' attention to learning. Through this media can create a better mutual response from students and teachers. Learners can follow learning actively and independently to achieve learning objectives.

The development of technology is increasingly sophisticated and attached to human life. This greatly impacts the development of learning media in education. Media utilization is expected to foster a more meaningful learning atmosphere and experience and increase student participation (Baharuddin, 2018). Student interest in learning is influenced by the methods and media used. Teachers as facilitators in learning must develop and innovate interesting learning media. Learning resources can be packaged in a more attractive and accessible form. One of the tools that can be utilized for media is digital media in the form of smartphones (Pratama, 2022). Forms of learning technology displayed on mobile devices can be in the form of e-books, games, and simulations (Raharjo & Pitaloka, 2020). This is explained by Herlandy et al. (2019) that the use of cell phones as learning media through mobile devices or can also be called mobile learning. Using mobile devices allows students to not only stay in one place, students can access something as long as there is internet from anywhere and anytime without space and time restrictions (Basori et al., 2018) (Hasanah, 2021). Riyan (2021) explains that Android is an operating system widely used due to its user-friendly features that are easily understood by users. The use of technology is also not only in the form of communication tools, but websites can also be utilized in educational development, one of which is Google. Google has many features that can be accessed and utilized to support the learning process. Google Sites is one of the applications provided by Google. So that this help application can be utilized as an interactive learning media maker. Therefore, media that facilitates learning by providing simple and easy access, of course, with an attractive appearance, can be realized.

Based on the explanation provided, effective and efficient learning media is needed to accommodate changes in student learning patterns in the post-pandemic period, particularly

for building statics calculation material. The learning media should be interactive and visually appealing to generate students' enthusiasm and interest in learning. Smartphone applications are preferred due to their practicality and accessibility. With the use of explanations, images, videos, and practice questions, the presented material will be more engaging and structured, making it easier for students to comprehend. The development of this media aims to meet the expectations of the independent learning curriculum. Thus, this research is crucial to enhance the quality of learning, especially in the subject of building statics calculation elements, by developing interactive learning media based on Android with the support of Google Sites. Based on the problem statement above, the research objectives are described as follows:

1. To develop an interactive learning media based on Android and supported by Google Sites for the elements of structural calculations in SMK N 2 Depok.
2. To determine the feasibility of the interactive learning media based on Android and supported by Google Sites for the elements of structural calculations in SMK N 2 Depok.

METHODS

This research belongs to the type of Research and Development (R&D) that focuses on developing application-based interactive learning media. The resulting product is a building statics calculation element application that can be installed on Android devices for the Building Information Modeling Design expertise program. The study was conducted at SMK N 2 Depok, involving students and teachers who teach building statics calculation elements of Building Information Modeling Design competency, as well as material and media experts.

The object of this research is an interactive learning media implemented in the form of an application that can be downloaded on Android devices. The learning media contains the learning outcomes of structural elements of buildings, calculation of force equilibrium in building structures, and calculation of forces in simple frameworks as the basis for construction work calculations.

The development model used in this research is the Waterfall or linear sequential model, which consists of stages such as analysis, design, code, test, and maintenance (Pressman, 2015). This method and model were chosen because the media to be developed in the form of software that has a medium level of complexity system based on the needs of the actual situation so that the process and results of making the product are easily understood by users

and developers. Through this model, it is intended to produce products in the form of interactive learning media on the Android platform with the help of Google Sites.

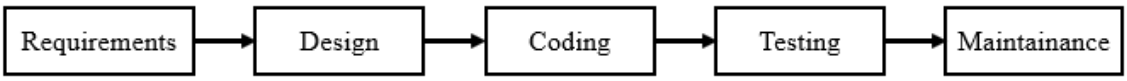

Figure 1. Stages of the waterfall model

1. Analysis

The analysis stage is carried out to define the needs required in developing interactive-based learning media on the android platform. Through this stage, interviews with teachers, questionnaires filled out by students, and observations are carried out. In this stage, there are several components that are carried out, among others:

a. Problem analysis

This analysis is carried out by conducting interviews, observations, and distributing questionnaires to find out the problems related to the obstacles in learning the calculation elements of building statics.

b. Analysis of learning element achievements

Based on the independent curriculum, learning the calculation element of building statics is a part of the Basics of Construction. The calculation element of building statics has the learning objectives of understanding structural elements, calculating the balance of forces on building structures, and calculating the force of the trunk on a simple frame.

c. Potential analysis

Based on the results of the observations made, the analysis of the potential for learning and schools is related to the availability of wifi network access for learning, the regulation of the use of smartphone devices, and the operator signal network coverage at school.

d. Media functional requirements analysis

Based on the previous analysis, the necessary requirements are obtained so that the development of application-based media can be planned.

2. Design

Design is a phase to plan software such as content components, software interfaces, and coding procedures. The design stage utilizes system design planning in the form of Unified Modeling Language (UML) and interface design. UML diagrams are use case diagrams, activity diagrams, class diagrams, and sequence diagrams. The four diagrams represent three main areas, namely structural, dynamic, and model management, which represent aspects in the translation system requirements to be developed (A.S. & Shalahuddin, 2015). While the display design uses a storyboard.

3. Code

The result of the coding stage is the implementation of the application interface design layout from the UML diagram. The design of android-based learning applications uses the help of Google Sites. Making the website uses Markup Language in the form of HTML that describes the appearance (CSS) and functionality or behavior on the website (JavaScript).

4. Test

Products that have been developed in the form of learning media applications will be validated by material experts, media experts, and users. Material testing is carried out by material experts. While media testing is based on display and system assessment based on ISO 25010. According to David in (Chiva Olivia Bilah, 2019), there are four aspects of software testing, namely functional suitability, compatibility, usability, and performance efficiency.

a. Functional suitability

Functional suitability is the ability of software to provide functions according to user needs. Testing the aspect of functional suitability uses black-box testing. The testing instrument consists of function indicators and action steps or activities used to test the suitability of functions within the application.

b. Compatibility

According to Ghaffur (2017), compatibility is the ability of two or more software components to exchange information and perform functions when the application is running on software. Co-existence testing will be conducted directly using Android devices and testing on various operating systems with different types of devices.

c. Usability

Testing the usability aspect of the application uses the System Usability Scale (SUS) as the measurement instrument. This is based on the statement that the System Usability

Scale (SUS) is a questionnaire that can be used to measure the usability of computer systems from the subjective perspective of users (Brooke, 2020).

d. Performance efficiency

Performance testing is used to assess memory and CPU usage under various conditions to determine the quality of the developed software's performance. tests will be conducted on CPU and memory usage using a tool called CPU Monitor as a performance testing application.

5. Maintenance

The last stage, namely maintenance, is carried out to repair or maintain applications that are developed periodically. This stage also refers to suggestions and comments given by users.

RESULTS AND DISCUSSION

The research adopts the Waterfall or Linear Sequential Model, which consists of five stages: analysis, design, coding, testing, and maintenance. The research aims to develop Android-based interactive learning media for the calculation element of building statics, using Google Sites as an assistant. The following section explains the analysis stage of the research.

1. Analysis stage

a. Problem analysis

The problems in learning the calculation of building statics at SMK N 2 Depok were identified through observations, interviews, and questionnaires, as follows:

1) The utilization of technology to assist learning has not been optimized.
2) The learning media available does not fulfill the expectations of an independent learning curriculum.
3) Building statics calculation material requires accuracy, calculation basis, and deeper understanding. Some materials have errors in meaning and grouping.
4) Due to the long-lasting pandemic, students' understanding of basic mathematics has decreased, resulting in low confidence in problem-solving and learning.
5) The current learning method is still teacher-centered and monotonous, making students overly reliant on the teacher's explanations and directions.
6) The module materials and video explanations used as learning media have not encouraged students to be more active in independent learning.

7) Students' scores on simple rod force calculation material, which forms the basis of construction work calculations, are still below the KKM by 50%.

b. Analysis of learning achievement elements

Based on the independent learning curriculum and its application at school, the material given for calculations on certain static structures is limited to two-dimensional beams and trusses with calculation steps using the equilibrium method of the gusset point and Cremona. Therefore, the material for the calculation elements of building statics in the interactive learning media based on Android, assisted by Google Sites, is formulated as follows:

1) Topic 1: Structural Elements, which contains definitions, classifications, and types of structural elements.
2) Topic 2: Forces, Supports, Loads, and Internal Forces, which contains definitions, types, and calculation steps.
3) Topic 3: Truss, which contains the definition, classification, and calculation steps of a truss.

c. Potential analysis

Based on observations of learning and school regulations, the following potentials for developing application-based learning media have been identified

1) All students have smartphones that they can use for communication and learning.
2) Students can use smartphones while at school with the time limit set by each teacher.
3) SMK N 2 Depok has good wifi access and operator signal coverage.

d. Media functional requirements analysis

Based on the previous analysis, the media will be developed in the form of applications with the following assistance:

1) Adobe Illustrator will be used to design buttons or images in the media.
2) Google Sites will be used to develop learning media layouts.

Meanwhile, the minimum smartphone specifications to run the interactive learning media application for building statics calculation elements are Android v4.1 with a minimum of 1GB RAM and 1GB of free memory.

2. Design stage

The development of this media learning includes the design of Unified Modeling Language (UML) and interface display. This stage is carried out to describe the planning of the application

to be developed in the form of a real system and display. The media will be developed using Google Sites with a GUI (Graphical User Interface).

In this application, the planned content or content needed is learning objectives, learning topics, PTS and PAS practice questions, ask the teacher, glossary, developer library, instructions for use, and developer profile. This is planned as follows.

a. Unified Modelling Language (UML) design

1) Use case diagram

The use case diagram design provides an explanation in the form of a diagram to describe the relationship between the user and the system and the developer with the system. In this media there are users, namely students and teachers and developers. Both can access the features provided in the system that has been developed.

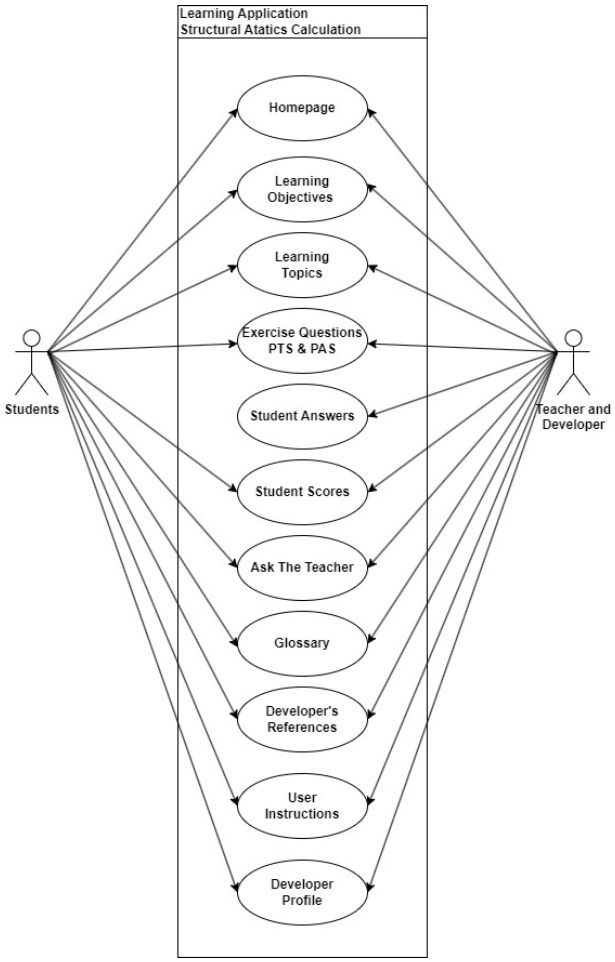

Figure 2. Use case diagram

2) Sequence diagram

Sequence diagram planning is done to explain the system process for each function in the application by describing the relationship between objects or use-cases. Each function will describe the running objects and continue the messages sent between interrelated objects. This system is planned in a structured manner for each function so that it can facilitate users in finding the desired menu.

3) Class diagram

The design of the class diagram serves to explain the system structure in the application in the form of classes in the system. Grouping consists of seven classes including teachers, users, student activities learning topics, practice questions, assessment of exercise results, and questions and answers. Each of these groups has a name, a list of attributes, and a list of methods or operations. These components explain the needs and form of operations that will be carried out from the system.

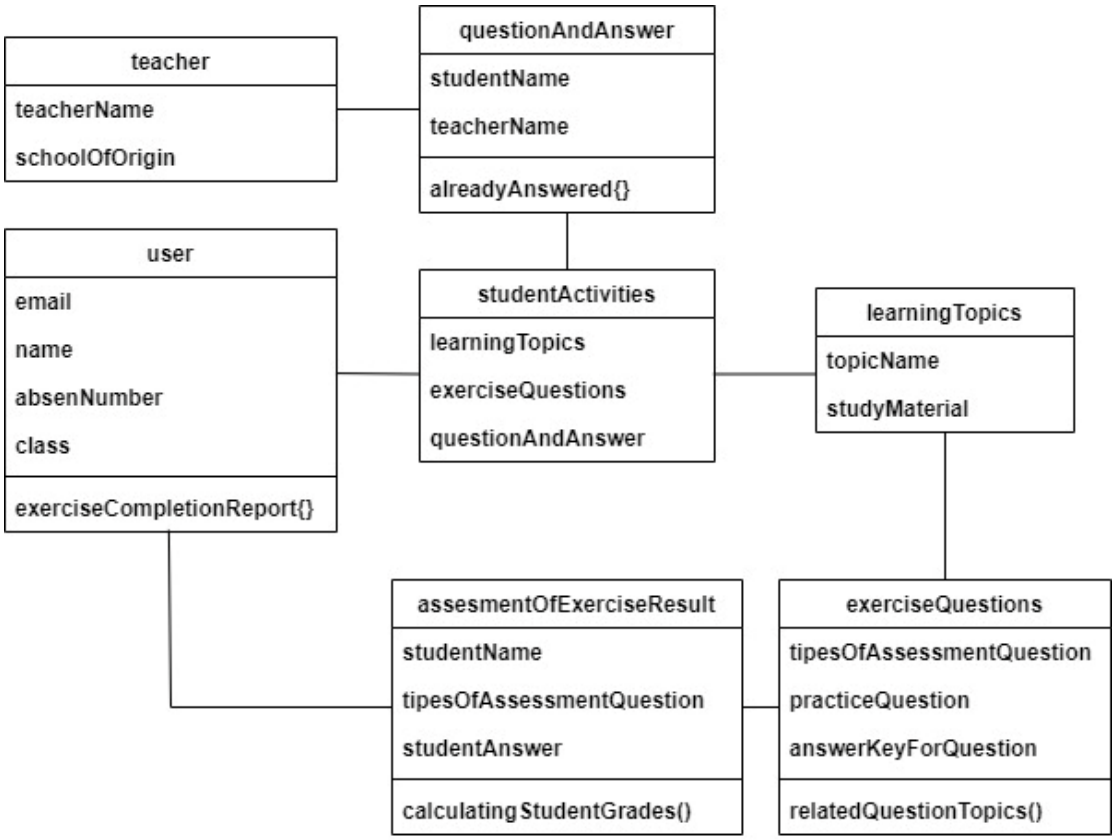

Figure 3. Class diagram

4) Activity diagram

The design of the activity diagram serves to describe the flow of the system process as a whole from the initial launching process or the process of opening to closing the application. This diagram will inform the activities that can be done along with the system process in response to the selection of icons or buttons selected by the user.

b. User Interface Design

The interface design stage involves creating a systematic and practical display design to meet learning needs. This design is based on the UML design stage and is presented as a storyboard, which explains the shape of the display, name, and content materials.

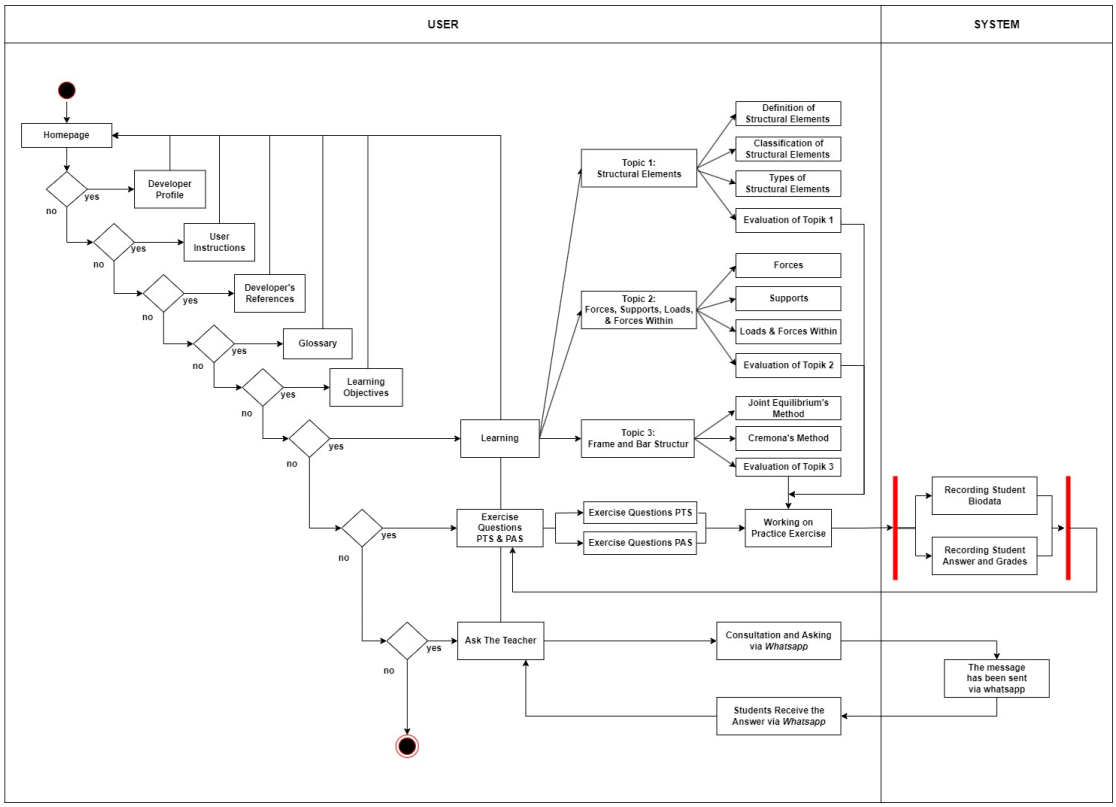

Figure 4. Activity Diagram

3. Code Stage

The coding stage contains the results of media design planning implemented in the form of an android aplication. The design of an android-based learning application uses the help of Google Sites which contains text, images, evaluations, and others. Making the website uses Markup Language in the form of HTML that describes the appearance (CSS) and functionality or

behavior on the website (JavaScript). This is used to produce a more dynamic website development. The result of the design and code stage is the implementation of the application's user interface design. The following are the results of the implementation of the design and code stages made.

4. Testing Stage

Products that have been developed in the form of applications are validated by material experts, media experts, and users. Material testing is carried out by material experts. While media testing is based on display and system assessment based on ISO 25010. These tests are functional suitability, compatibility, usability, and performance efficiency.

a. Material testing

Material testing was carried out by material expert lecturers. Testing was done twice with the same instrument. The results of the first stage of testing obtained assessment results with an average score of 4.01. The total number of scores obtained was 105 out of 26 questions with a feasibility percentage of 82, 95%. While the results of the second assessment obtained an average score of 4.39. The total number of scores obtained was 112 out of 26 questions with a feasibility percentage of 87.88% in the "Feasible" category. The increase in scores occurred in all aspects of the assessment instrument.

Table 1.
Material expert analysis results

Assessment Aspect	Total Score	Average	(%)
Knowledge dimension	41	4,1	82
Material organization	14	4,667	93,334
Supporting material presentation	29	4,142	82,857
Instructional	28	4,667	93,334
Amount	$\Sigma x = 105$	$\bar{x} = 4,39$	$\bar{x} = 87,88$

b. Media testing of interface aspects

Testing the interface aspect was carried out twice by making improvements. The results of the assessment from the media expert lecturer obtained an average score of 4.151. The total number of scores obtained is 103 out of 25 questions with a feasibility percentage of 83.02%. While the second stage assessment obtained an average score of 4.745. The total number of scores obtained was 118 out of 25 questions with a feasibility percentage of 94.9% so that it fell into the "Appropriate" category. The percentage of eligibility has increased because there are improvements that have been made based on suggestions and comments from media experts. The increase in scores occurred in all aspects of the assessment instrument.

Table 2.
Results of Media Expert Analysis of Interface Aspects

Assessment Aspect	Total Score	Average	(%)
Ease of Use	14	4,667	93,33
Beauty or Aesthetic	66	4,714	94,29
Media Integrity	15	5	100
Technical Quality	23	4,6	92
Amount	Σx = 118	$\bar{x}$ = 4,75	$\bar{x}$ = 94,9

c. Functional suitability aspect media testing

Testing the functional suitability aspect uses the black box testing method. The application is assessed based on the function of the system according to user needs. Testing this aspect obtained the results of an assessment from a media expert lecturer for the functional suitability aspect has an average score of 4.85. The total number of scores obtained was 428 out of 88 activities assessed with a feasibility percentage of 97.14% in the "Feasible" category. The assessment was carried out twice with the same score. This eligibility percentage shows the success and suitability of the system in the application.

d. Media testing usability aspects

Usability testing was conducted using the System Usability Scale (SUS) developed by (Brooke, 2020). The SUS consists of 10 statements with five-point Likert scale responses. The testing involved 60 users, including X DPIB class students and teachers who teach learning outcomes. The test results yielded an average score of 83%. Based on this score, it can be concluded that the developed media has excellent usability with a grade A rating.

Table 3.
Media Expert Analysis Results Usability Aspect

Respondent	(%)	Grade	Rating
60	83	A	Excellent

e. Compatibility aspect media testing

Compatibility aspect testing has two types of testing, namely co-existence which tests the success of the application when run simultaneously with other applications and testing on different device specifications. Co-existence testing gets a feasibility result of 100% in the "Worthy" category. In addition, testing was also carried out on devices with different android versions, processors, and RAM. All devices successfully loaded the

application so that it obtained a feasibility percentage of 100%. Therefore, the android application tested in this aspect achieved 100% feasibility in the "Feasible" category.

f. Media testing in the aspect of performance efficiency

Performance efficiency testing consists of time behaviour testing, which includes measuring the response time of launching the application, CPU usage, and memory usage. The testing of time behaviour shows that the application was successfully launched on several devices with the same internet source, with an average launch time of 2.526 seconds in the "Very Satisfied" category. The CPU usage was found to have an average result of 16.3% during one hour of use, and the memory usage was 22 MB during the last three hours of use. Throughout the test, the application and device did not experience any problems or memory leaks, and the application ran smoothly.

5. Maintenance stage

The maintenance stage is carried out to improve and maintain the appearance and system. These improvements come from user responses, namely students and teachers of building statics calculation elements after trying to use this application. The suggestions given are in the form of improvements to the homepage display and explanation of the questions to be more detailed.

CONCLUSION

Based on the results and discussion based on the stages, it can be concluded (1) the analysis stage identified the problem of learning methods and models that have not been fully developed and have not met students' expectations in implementing an independent learning curriculum. Learning outcomes are adjusted to the applicable curriculum and material restrictions of the school. Students have smartphones that can be used in accordance with regulations, and there is internet network access while at school. The software used is Adobe Illustrator, assisted by Google Sites, with a minimum smartphone requirement of android v4.1, 1GB RAM, and 1GB free memory. (2) The design stage uses Google Sites and Website Appsgeyser for assistance. The design stage involves UML diagrams in the form of use cases, sequences, classes, and activities. The display design stage uses a storyboard. (3) The coding stage is carried out using Markup Language in the form of HTML. (4) The testing stage is carried out on material and media aspects. (5) The maintenance stage involves display improvements and question explanations. Material testing by material experts yields a feasibility percentage of

87.88% in the "Feasible" category. Media testing of interface aspects by media experts yields 94.9% in the "Feasible" category. Testing of the functional suitability aspect by media experts yields 97.14% in the "Feasible" category. The compatibility aspect yields 100% feasibility in the "Feasible" category. The usability aspect is rated 83% grade A with an excellent rating, and the performance efficiency aspect has a testing time behavior of 2.526 seconds in the "Very Satisfied" category, as well as CPU and memory usage that meet the standards. Based on the test results, it is concluded that the developed media is suitable for use.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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