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ANDROID-BASED VIRTUAL LABORATORY DEVELOPMENT (CASE STUDY OF CLASS XI OF SMA IN BANDAR LAMPUNG)

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Article Info	Abstract
	This study aims to develop an android-based virtual laboratory e-module learning media in class XI thermodynamics material which aims to determine the process of developing e-modules, determine the feasibility of e-modules and determine the response of educators and students to the e-modules developed. The type of research is Research and Development (R&D). This research refers to the ADDIE model procedure. The results of the research carried out that the development of an android-based virtual laboratory e-module on thermodynamic material assessments from material experts and media experts obtained a very feasible category with 90% validation percentage of material experts, and 88% of media experts. The questionnaires given by the response of educators and participants to the developed e-module were 90%, small group trials received 92% and field trials scored 92%. This shows that the android-based virtual laboratory e-module on class XI thermodynamics material that has been developed is very feasible and interesting to use as a learning medium.

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INTRODUCTION

The development of science, technology and communication is very helpful in producing learning media. Various interactive learning media have been created and applied by many schools and educational institutions. Likewise, experimental activities can be replaced through interactive simulation media. Through this interactive simulation learning media, experimental activities can be done by students[1].

Computer technology can be used to support the implementation of physics practicum, both for understanding concepts, collecting data, as well as presenting and processing data. In addition, computers can also be used to modify experiments and display complete experiments in a virtual form called the Virtual Laboratory. Students can carry out experimental activities using virtual laboratories. Virtual laboratory or what is often also referred to as virtual simulation is a form of the laboratory with observation or experiment activities using software that is run on a computer[2].

The virtual laboratory has the advantage that it can be used to explain abstract concepts that cannot be explained verbally. The use of a virtual laboratory also does not require a long preparation because the teacher does not need to prepare the tools and materials needed in the experiment. One of the virtual laboratories that are widely used in the field of education and research is the PhET (Physics Education Technology) simulation created by the science community through the PhET Project at the University of Colorado, USA. This simulation is interactive and can be downloaded for free and can be accessed online and offline[3].

The use of android-based virtual laboratory media has many advantages including: 1) Very easy to operate; 2) Has an attractive design and the material presented is easy to understand; 3) There are practice questions by Basic Competencies (KD)/ Core Competencies (KI) and creative thinking

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indicators; 4) There is a virtual laboratory that can be used equipped with tools and materials to carry out simulation or experimental activities as in a real laboratory; 5) Very practical and can be operated anywhere at any time; 6) Does not depend on the existence of a data network, because it can be operated offline[4].

Based on a questionnaire to students, they said that they did not like physics because it was difficult to understand and the learning process seemed to be monotonous and not interactive using only Powerpoint media delivered with lectures so students felt bored and lazy to study physics because the material was difficult to understand. . Students also said that it was easier for them to understand physics material if it not only explained the theory but was applied through practical methods. In addition, students also said that the learning media they like are practical and interactive learning media that make students enthusiastic to learn which not only contains theory but also contains learning simulation videos that are interesting and easy for students to understand as well as simulations that are easy to understand. can help students learn more easily and can understand the material. Then students have never been given learning media[5].

The formulation of the problem in this study is as follows; 1) How to develop android-based virtual laboratory media on class XI thermodynamics material; 2) What is the feasibility of android-based virtual laboratory media on class XI thermodynamics material. Based on the validation results from media experts, material experts, and linguists, as well as student respondents[6].

Based on the above background, the objectives of this study are as follows: 1) To know how to develop android-based virtual laboratory media on class XI thermodynamics material; 2) Knowing the feasibility of android-based virtual laboratory media on class XI thermodynamics material based on validation from media experts, material experts, and linguists, as well as student respondents[7].

METHOD

Place and Time of Development Research:

First, Place of Research Development This research and development was carried out at SMAN 10 Bandar Lampung, SMAN 14 Bandar Lampung, and SMAN 16 Bandar Lampung to determine the feasibility of an android-based virtual laboratory as a physics learning medium that was developed. The three schools became the research sample because these schools were located in Bandar Lampung. In addition, the school still uses conventional learning media and is less attractive, while attracting students' interest in learning requires interesting learning media. So that researchers experience interesting and interactive learning media that need to be applied in learning at school. The learning media that the researcher applies is an Android-based Virtual Laboratory (Virtual Laboratory) which can be accessed via a Smartphone[8].

Second, Time of Research Development This research was carried out in three senior high schools located in the domicile of Bandar Lampung, especially in class XI students in the even semester of the 2022 school year.

B. Research Design Development The approach and method of this research is an interactive approach to research and development methods (R & D) which has been adopted In the research and development of the Borg & Gall Model which has been modified by Sugiyono, ten stages of development are needed. produce a final product that is ready to be implemented, namely (1) potential problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product trial, (7) revision product, (8) use trial, (9) final product revision, (10) mass production. This research and development developed a product in the form of an android-based virtual laboratory containing thermodynamic material for 11th-grade students in semester 2. The development steps used in this study were seven of ten development steps. This study only uses seven steps of the development stage because the formulation of the problem from this research can be answered only by using the seven steps of the development stage48. The seven stages that researchers mean are as follows[9]:
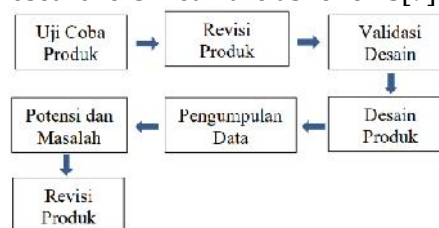
Development Research Procedure 1. Preliminary Research At this stage the researcher determines the problems that exist in the school where the research is carried out, to find out the problems being faced, the researchers carry out several activities in obtaining data as sources for research are as follows:

a. Needs Analysis

Needs analysis can be done to raise and determines the basic problems faced in the physics learning process by distributing questionnaires to students that have been made by researchers and interviews with teachers, to obtain research data as samples to support research that in schools it is necessary to develop a virtual laboratory (virtual laboratory) based on android as a medium physics learning that will be developed by researchers. The needs questionnaire that has been distributed is also used to collect information related to how to implement physics learning in the classroom using the available learning media[10].

b. Field Survey

Based on field surveys that have been carried out in several schools, namely SMAN 10 Bandar Lampung, SMAN 14 Bandar Lampung, and SMAN 16 Bandar Lampung. At this stage, observations have been made with physics subject teachers to find out the process of learning activities in schools, including the curriculum used, learning methods, and learning media used by teachers. This stage aims to obtain a means of information about conditions, facts at school, and problems about learning physics in schools so that data is needed to develop android-based physics learning media[11].

2. Media Development Planning

After conducting a needs analysis and field survey in schools, the next researcher went to the stage of implementing the design of an android-based virtual laboratory development as a physics learning medium to improve the mastery of science concepts for class XI students in thermodynamics learning. The design of this learning media uses several relevant journal sources[12].

Product specifications are developed according to the needs of the school as seen from the data from questionnaires and interviews to obtain the product developed, then data collection is carried out by testing the operation of the learning media making devices in the form of hardware (software) and software[13].

The product specification developed in this research is an android-based Virtual Laboratory (Virtual Laboratory) that can be accessed through applications with Thermodynamics material for students at the XI high school level. An android-based virtual laboratory that has sections or menu features in it[14], namely:

a. Screen menu display that displays several menu features including standard competency features, basic competencies, indicators, material features, laboratory menus, and evaluation menus.

b. The next feature in the menu features competency standards, basic competencies, and indicators is a more detailed description of competency standards, basic competencies, indicators and learning objectives.

c. The next feature in the material menu feature is material which then when we click select will access complete with visual images and learning videos.

d. The next feature is the laboratory menu feature, when we are selected, we will access the laboratory selection page, each equipped with laboratory tools and materials that can be used to carry out practicum as well as in a real laboratory.

e. The next feature is an evaluation feature in which there is a page for filling in self-identity before working on science concept mastery questions and a score page that will appear automatically on the dashboard when students complete all questions.

f. The next feature there is a profile icon when we select it will access the profile page of the media developer which contains the developer's identity.

g. Then how to operate is quite simple, namely by first installing a virtual laboratory application on an Android smartphone. If the application is installed then we can operate the application. This android-based virtual laboratory media

can be accessed offline and online for this virtual laboratory application.

The subjects of the development research trial were students of class XII MIPA Senior High School from 3 schools located in Bandar Lampung, where each school was taken one class to be used as a research sample which was obtained by about 60 students.

Research instruments are used to make it easier for researchers to get research data samples, in research. In this study, researchers used several research instruments, including the following:

The questionnaire sheet through the google form was filled out by students of class XI MIPA as many as 90 students in the early stages of the study found responses or opinions regarding the learning media they currently use tend to be boring and less interesting in learning and also very limited use of space and time. Based on the results of the pre-research questionnaire, the researchers decided to develop an android-based virtual laboratory learning media.

Product testing is an important part of development research that is carried out after the product design is complete. Product trials are intended to collect data that can be used as a basis for obtaining the level of effectiveness, efficiency and or attractiveness of the resulting product. Product trials were carried out through small group trials and field trials.

Small group trials were conducted on 10 class XI students at SMA N 10 Bandar Lampung, SMA N 14 Bandar Lampung, and SMA N 16 Bandar Lampung. have been seen using a questionnaire.

Field trials will be conducted on class XI students at SMA N 10 Bandar Lampung, SMA N 14 Bandar Lampung, and SMA N 16 Bandar Lampung. Students are asked to provide input about the products they have seen using a questionnaire.

Data analysis of non-test instruments in this study used quantitative data analysis techniques. The type of data obtained from the results of this study is qualitative data which is analyzed using quantitative data, in the form of numerical data and interpreted in the form of words. The non-test instrument is in the form of a questionnaire using a Likert scale. The Likert scale is used to measure attitudes, opinions, and perceptions of a person or group about a social phenomenon.

This study used a scale of 1 to 5, with the lowest score of 1 and the highest score of 5. With a Likert scale, the variables to be measured are translated into variable indicators. Then the indicator is used as a starting point for

compiling instrument items which can be in the form of statements or questions

The final value of an item is the percentage of the average value of the indicator from all validator answers. The formula for calculating the average value of the indicator is as follows50:

$$x = \frac{\Sigma x i}{n}$$

Keterangan:

$\bar{x}$ = Nilai rata-rata perindikator

$\Sigma x i$ = Jumlah total nilai jawaban dari responden

n = Banyaknya responden

Tabel 3.2 Kriteria Validasi

Interval	Kriteria
$80\% < x \le 100\%$	Sangat Layak
$60\% < x \le 80\%$	Layak
$40\% < x \le 60\%$	Cukup Layak
$20\% < x \le 40\%$	Tidak Layak
$0\% < x \le 20\%$	Sangat Tidak Layak

RESULTS AND DISCUSSION

Pre-research by distributing questionnaires to high school students in class XI in Lampung Province. In addition, pre-research is also carried out on educators who teach in high school. Pre-study was carried out via google form. Given that the implementation is during a pandemic data collection is carried out semi-online. The results show that the learning activities in the classroom have used learning media. However, students understanding of science subjects, especially physics is still relatively low because most of them still find it difficult. the result of pre-study with educators is that student's interest in science subjects physics is a subject that can be said to be difficult. Even though educators have used learning media such as

PowerPoint, learning videos, textbooks and so on.

1. Product Design Results

Making an android-based virtual laboratory using Modular software and assisted by PhET Simulations. Software is used to design visual images in the virtual laboratory E-Module. Then Kondular is a website that is used to create virtual laboratory applications. Meanwhile, PhET Simulations is one of the computational media that provides animations of physics, biology, and science which are made in the form of a website.

Design Validation Results

The android-based virtual laboratory that was developed then passed the validation stage process. This validation process has the aim of measuring the feasibility of this virtual laboratory module. The type of validation in this development research includes material and media validation. The validation involved 6 expert lecturers including 3 material expert lecturers and 3 media expert lecturers.

a. Material Expert Validation

Conducted by 3 material expert lecturers namely Mrs Sri Latifah, M.Sc, Mr Antomi Saregar, M.Pd., M.Si, and Mr Ajo Dian Yusandika, M.Sc. The categories measured were presentation, content quality, and language appropriateness. The results of the material validation can be seen in table 4.1 below. Table 4.1 Results of Material Expert Validation Phase I No Aspect Percentage Category 1. Presentation 77.2% Eligible 2. Content Quality 78.2% Eligible 3. Language Feasibility 76.70%

Eligible Based on the table presented, it can be seen that the presentation aspect obtained a percentage score of 79.2%, the content quality aspect obtained a percentage score of 80%, and the language feasibility aspect obtained a percentage score of 76.70%. The average result of the three aspects above obtained a percentage score of 79.60%.

The validation results are declared feasible to use but there are suggestions for improvement. Result of Validation of Material Expert Phase II No Aspect Percentage Category 1. Presentation 90.2% Very Eligible 2. Content Quality 95.62%. Very Eligible 3. Language Eligibility 90.70% Very Eligible. Based on the table above, the presentation aspect obtained a percentage score of 90.2%, the content quality aspect obtained a percentage score of 95.62%, and the language feasibility aspect obtained a percentage score of 90.70%. The average result of the three aspects obtained a percentage score of 92.17%.

b. Media Expert Validation

Conducted by 3 media expert lecturers namely Mr Hendri Noperi, M.Pd., M.Sc., Mirs Vandan Wiliyanti, M.Sc., and Muhammad Ridho Syarlisjiswan, M.Pd. The categories measured were e-module display design, e-module content design and ease of use. The results of the material validation can be seen below Media Expert Validation Results Phase I No Aspect Percentage Category 1. E-Modul Display Design 79.2% Eligible 2. E-Module Content Design 80% Eligible 3. Ease of Use 76.70% Eligible 71 Based on the table presented, it can be seen the acquisition of e-display design aspects -modules get a percentage score of 79.2%, the e-module content design aspect gets a percentage score of 80%, and the ease of use aspect gets a percentage score of 76.70%. The average result of the three aspects obtained a percentage score of 85.70%.

The validation results are declared feasible to use but there are suggestions for improvement. The following table presents the results of the validation after revision. Table 4.2 Results of Media Expert Validation Phase II No Aspect Percentage e Category 1. E-module Display Design 90.2% Very Feasible 2. E-Module Content Design 95.70% Very Eligible 3. Ease of Use 90.70% Very Eligible Based on the table What is presented shows the acquisition of the e-

module display design aspect obtaining a percentage score of 90.2%, the e-module content design aspect obtaining a percentage score of 95.70%, and the ease of use of 90.70%. The average result of the three aspects obtained a percentage score of 92.4%.

2. Product Trial

Small Group Product Trial

Small group trial consisting of 20 students from SMAN 10 Bandar Lampung, SMAN 14 Bandar Lampung and SMAN 16 Bandar Lampung. Where it is used as a sample of student responses to identify the initial problems that exist in the e-module before being tested on a larger scale with a simple random sampling technique. Response results 78 90% 94% 92% 0% 20% 40% 60% 80% 100% Feasibility of Teaching Materials Strengths of Materials Presentation Techniques Student Response Results Small Groups of students in small group trials are presented in table 4.11 and Figure 4.12 as follows: Table 4.8 Small Group Assessment Results No Research Aspects Percentage Criteria 1. Feasibility of teaching materials 90% Very Interesting 2. Strength of material 94% Very Interesting 3 Presentation techniques 92% Very Attractive Average Total Aspect 92% Very Interesting.

Field Trial

The effectiveness of the product being tested in the field from the developed model is seen in the results of product testing on students of class XI MIPA at SMAN 10 Bandar Lampung, SMAN 14 Bandar Lampung, and SMAN 16 Bandar Lampung. The field trial consisted of 60 students from class XI MIPA at SMAN 10 Bandar Lampung, SMAN 14 Bandar Lampung, and SMAN 16 Bandar Lampung in the even semester with the student response instrument sheet consisting of 3 aspects. Table 4.12 Field Assessment Results No Research Aspects Percentage Criteria 1. Presentation 89%

Very Attractive 2. Language and Communication 90% Very Attractive 3 Benefits 92% Very Attractive Average Total Aspect 90.33% Very Attractive.

Educator Response

The results of the educator assessment were carried out on three physics subject educators at SMAN 10 Bandar Lampung, SMAN 14 Bandar Lampung, and SMAN 16 Bandar Lampung. The following are the results of the educator's assessment: 81 90% 92% 92% 0% 20% 40% 60% 80% 100% Feasibility of Teaching Materials Material Strength Presentation Techniques Educator Response Test Results Table 4.13 Percentage of Educator Response Test Recapitulation Results No Aspect Research Percentage Criteria 1. Application Appearance 90% Very Attractive 2. Ease of Use 92.2% Very Attractive 3 Application Specifications 92% Very Attractive Average Total Aspect 92.3% Very Attractive.

Discussion

This development research was carried out in 5 steps. The stages of the research steps using the ADDIE model. The research steps consist of analysis, design, development, implementation, and evaluation. Based on the results of the potential, problems and information data collection, it was found that educators have not made maximum use of electronic teaching materials in physics learning and students also feel bored and have difficulty understanding physics material, this is because the teaching materials used are not yet fully effective for students. where educators are still fixated on conventional media. Students want interesting and interactive teaching materials that can contain material, images, videos, simulations and animations and require independent teaching materials that can be used anywhere and anytime. This is due to the demands of rapid technological developments. Technological developments allow students to be able to solve problems

independently. Thus, a design was made to develop an android-based virtual laboratory e-module. The next stage is a product design and design validation where the researcher designs the product design and then validates the next stage of design revision under the direction of the material expert validator and media expert. The results of the validation carried out include the following:

Material Expert Validation Results Stages of material experts are validated by two or three physics education lecturers.

Table 4.2 Material Expert Validation Results

No	Aspect	Percentage	Category
1	Presentation	90.2%	Very Worthy
2	Content Quality	95.62%	Very Worthy
3	Language Eligibility	90.70%	Very Worthy

The material expert's assessment consists of several aspects, namely the acquisition of the presentation aspect and a percentage score of 90.2%, the content quality aspect obtaining a percentage score of 95.62%, and the language feasibility aspect obtaining a percentage score of 90.70%. The average results of the three aspects obtained a percentage score of 92.17%, with the "Very Eligible" category, thus e-modules are suitable for use as teaching materials.

1. Media Expert Validation Results Stages of media experts were validated by three physics education lecturers.
2. Table 4.2 Material Expert Validation Results

No	Aspect	Percentage	Category
1	Appearance	90.2%	Very Worthy
2	Content Design	95.70%	Very Worthy
3	Ease of Use	90.70%	Very Worthy

The media expert's assessment consisted of several aspects, namely the virtual laboratory e-module display design obtained a 90.2% percentage score, the e-module content design aspect obtained a 95.70% percentage score and 90.70% ease of use. The average result of the three aspects obtained a percentage score of 92.2%. So it is known that the highest assessment results on the product are in the design aspect of the e-module content and ease of use, this is because the e-module content design aspect and the ease of use of the evaluation indicators on the e-module have good appeal and the e-module operation is very easy. Meanwhile, in the design aspect of the e-module display, the virtual laboratory received the smallest rating because the e-module display aspect was less appropriate, and less clear so the e-module display aspect got the lowest score of 84. From this, we can know that the e-module product is suitable for use as teaching material.

Small Group Trial This small group trial was conducted on a limited number of students, the student trial was conducted on 15 students from three schools in class XI MIPA where data collection using a questionnaire was carried out offline. The questionnaire used includes several aspects, namely the feasibility of teaching materials, aspects of material strength, and aspects of presentation techniques.

Figure 4.10 Small Group Student Response Results

As for the average assessment, the score for the average number of percentages on the results of small group product trials is 92% with the "Very

Interesting" criteria.

Field Group Trial This field trial was conducted on 60 students from three schools in class XI MIPA where data was collected using an offline questionnaire. The questionnaire used includes several aspects, namely the feasibility of teaching materials, the strength of materials, and presentation techniques..
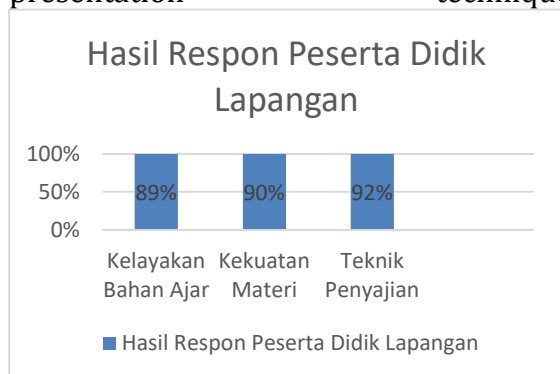

Figure 4.11 Student Response Results in the field

The average score obtained by the assessment score is the average number of percentages on the results of field trials of 92% with the criteria of "Very Interesting". After revising the product, the Android-based virtual laboratory e-module has been developed and has been tested for both feasibility and attractiveness. So that the Android-based virtual laboratory e-module is declared very feasible, and very interesting, so it can be used in learning activities at school.

CONCLUSION

The conclusions of this research and development are described as follows:

The development of an Android-based virtual laboratory e-module on class XI thermodynamics material is valid and very feasible to use based on the assessment of material experts and media experts can be used as one of the teaching materials for educators and students.

The development of an Android-based virtual laboratory e -module on class XI thermodynamics material obtained very interesting results and was very suitable for use in teaching materials.

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