

# Mobile Laboratory for Mathematics: Enhancing Mathematical Understanding in Junior High School Students Through Case-Method-Based Virtual Approach

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## ABSTRACT

The laboratory is a place for students to solve cases in learning. The existence of a laboratory is needed in the learning process because it can increase students' curiosity, creativity and understanding in learning. However, not all schools have math and human resources laboratories, especially for junior high school students in the city of Medan. The purpose of this study was to design a case-method-based mobile virtual mathematics laboratory for junior high school students to improve mathematical understanding, design case-method-based junior high school mathematics textbooks, see the feasibility and effectiveness of learning using the EDDIE development method which was carried out in 5 stages (*Analysis, Design, Develop, Implement, and Evaluate*). The research results said that based on the analysis of the needs of the researchers to obtain information that the mobile virtual mathematics laboratory is a laboratory needed to assist the learning process that is packaged in a mobile form with the use of smartphones that are free to use anytime and anywhere with attractive and more interactive visualizations. So that the initial introduction component of the Virtual mathematics laboratory mobile program can be categorized as Very Good. Overall, the virtual mathematics laboratory mobile products are concluded to be very good or very feasible to use. The development of the Virtual mathematics laboratory mobile has produced a quality prototype. Therefore the development of the Mobile Virtual mathematics laboratory needs to be followed up by developing a number of applications or a number of questions with even more cases so that students can become more proficient in working on case-based problems or the case method. Innovation *Virtual math lab mobile* is an innovative product with programming-based application software that can be used as a patent at TKT 7.

**Keywords:** Mobile, Laboratory, Virtual, Case\_Methode, Understanding\_Mathematics.

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## INTRODUCTION

Technology is present and is a part of human life today, it is as if humans cannot function without technology such as cellphones, tablets, computers which are the means of production of today's modern technology. Various aspects of daily life, from working, shopping, studying to searching for information, are all done with the help of technology. In a short time, technology became much needed and dominated the market, users increased and even made it impossible for people to live without technology (adelweis, 2021).

One result of advances in technology is the internet. The Internet is one of the new communication media. The internet, which is a product of communication technology, has been developing for decades, but until now its existence is increasingly needed by almost all people in the world. All information can be easily obtained by internet anytime and anywhere as long as there is a connection (Anita, 2018).

From the explanation above, it can be seen that technology and the educational process cannot be separated because they are already an interrelated unit, such as the opinion (Handayani, 2019) which states that the role of information and communication technology is indispensable for the smooth running of learning activities. Information and Communication Technology is used as a learning medium as well as a medium of communication between students and lecturers. As a learning medium, students will get lecture material and exercises through the website without the need to meet face to face with the lecturer concerned. The material provided can be in the form of text or video. Although not face to face, communication between students and lecturers does not just go away,

The laboratory is a place for students to solve cases in learning that need to find the truth, a place for students to conduct experiments or trials of what they have learned, the existence of a laboratory is very much needed in the learning process because it can increase students' curiosity, creativity and understanding in learning. To make learning more optimal, it must be supported by facilities and infrastructure. The facility that must exist for the education level is a laboratory. However, not all schools have a mathematics laboratory, especially for the junior high school level in the city of Medan. About 80% of junior high schools do not have a mathematics laboratory.

However, the limitations of this and the results of the analysis carried out in the previous year made the

development of a virtual mathematics mobile practicum an alternative in helping learning activities, especially in junior high schools, apart from the limitations of the laboratory owned by the resource school (laboran) is also a mandatory requirement in a laboratory. . In addition, virtual laboratories can complement the learning process in class where through this mobile laboratory students can study independently and online. This statement is also supported by (Gunawan, et al 2015) by developing a virtual laboratory model suitable for use in physics learning and can be used to improve problem solving skills.

The advantages of using this mobile virtual mathematics laboratory include learning or discussing the material which will be given on a case basis, then it is efficient in the use of time because whenever and wherever students can carry out learning activities, the failure process that is carried out when in the laboratory can be repeated and repeated many times until succeeding and causing failure to be productive, and practicing through mobile is fun.

To streamline mobile learning based on the case-method laboratory with Cases built for discussion derived from real-life practices and authentic, complex, problems that require solving through critical analysis of situations, including key personalities and contexts in which decisions must be made according to (Barnes et al. 1994; Boehrer 1994; Kim et al. 2006). Case-method learning is a discussion learning method, a less popular methodology for educators who have so far succeeded in educating and promoting learning and professional development according to (Christensen et al. 1991; Barnes et al. 1994; Garvin 2003).

Based on previous experience, the researcher wanted to develop a mobile virtual mathematics laboratory based on the case-method for junior high school students as an alternative to assist learning activities. Developing case-method-based virtual laboratory teaching materials that can be accessed mobile. The mobile laboratory will be designed by utilizing the internet network to build the applications needed, the features in it will be designed according to needs, such as the main menu, learning competencies or learning objectives, the problems (cases) given, can also be supported by media assistance and finally practicum worksheets.

## METHOD

The research method used in the process of creating a mobile virtual mathematics laboratory is the development of the ADDIE (Analysis, Design, Develop, Implement, and Evaluate) model developed by Reiser and Mollenda. In the ADDIE development design model, there are five stages of research implementation, namely as follows:



Figure 1. ADDIE Development Model

Through this research, researchers are trying to develop a Virtual Mathematics Laboratory Car product, the resulting product is in the form of a virtual mathematics laboratory application that can be used from anywhere and at any time by students. The research subjects in the development of this Virtual Mathematics Laboratory Car were class VII students of Muhammadiyah 1 Middle School (SMP) Medan, Jalan Demak No.3 Sei Rengas Permata, Medan Area District, Medan City, North Sumatra. The subjects of this study were taken randomly for the control class and the experimental class, each of which consisted of 40 people. This development research conducts validity tests, practicality tests and effectiveness tests. This development research uses the ADDIE model as proposed by Mulyatiningsih (2016). This model can be used for various forms of product development in learning activities such as models, learning strategies, learning methods, media and teaching materials. Validation test using the following criteria:

Table 1. Category Of Validity

Category achievement level
1. 0 – 1.00 Valid
2. < 0 Invalid

Source: Azwar (2014)

Then a practicality test was carried out to see the ease of use Virtual Math Lab Car. Furthermore, the score of the results of the analysis of practicality by teachers and students through the categories presented in the table ....

Table 2. Practical Category

No Achievement Level(%) Category
1. 81 – 100 Very Practical
2. 61 – 80 Practical
3. 41 – 60 Quite Practical
4. 21 – 40 Less Practical
5. 0 – 20 Impractical

Source: Riduwan (2010)

The effectiveness of the Virtual Mathematics Laboratory Car can be seen from the learning outcomes of students in the experimental class and control class. If the increase in student learning outcomes in the experimental class is higher than the control class, then the Virtual Mathematics Laboratory Car can be said to be effective. Furthermore, to test the significance can be done with the t-test which previously had to do the normality test and homogeneity test.

## RESULTS

The research process used in making this virtual mathematics laboratory mobile is through the development of an android application product for a mathematics learning laboratory. The intended android application is software based on operating software that can be accessed using a smartphone (smartphone). Product development is carried out in several stages

### 1. Analysis Phase (Analyze)

At this stage the researcher determines the scope of the study of difficulties in teaching mathematics material due to the lack of lesson hours given for each meeting, the lesson hours are considered insufficient to provide theory and practice of learning mathematics in the hope that students can understand the material presented, this is sometimes ineffective for learning mathematics because to solve different problems the teacher has to explain again, students have not been able to understand the material presented mathematically. Furthermore, judging from the needs analysis based on the questionnaire, data obtained from 80% of students said that a mobile mathematics laboratory was needed to support mathematics learning and 57% of students said that web-based teaching materials that could be accessed by car were also very much needed to assist them in doing so. independent and mobile learning.

Meanwhile, if seen from the sources identified, they include school books, reference books from different publishers to see the range of material, supporting software, and the use of several applications in the form of software to build mobile mathematics laboratories and web-based or electronic teaching materials.

### 2. Design Stage (Design)

After the concept and task analysis stage, it is continued with developing Flowchart and Storyboard of Mobile Virtual Math laboratory products. Flowcharts are made to find out how the product workflow is when it is operated. After the next flowchart is used as the basis for creating Storyboards. The storyboard contains a detailed description of the program which contains the display design and programming. Details of the Mobile Virtual Mathematics laboratory product storyboard can be seen in the flowchart:

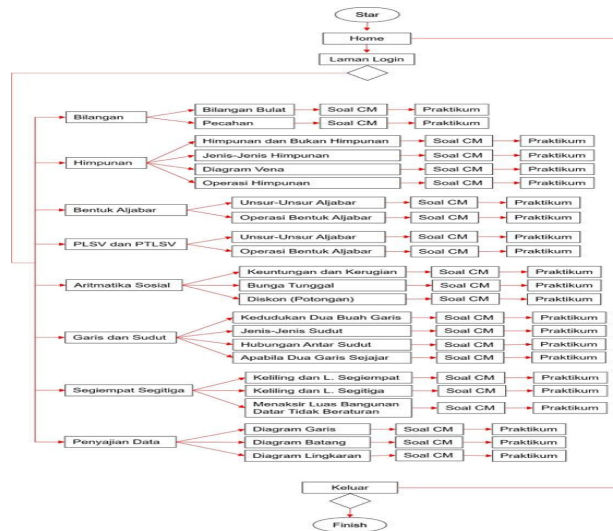


Figure 2. Flowchart Mobile Virtual Math laboratory

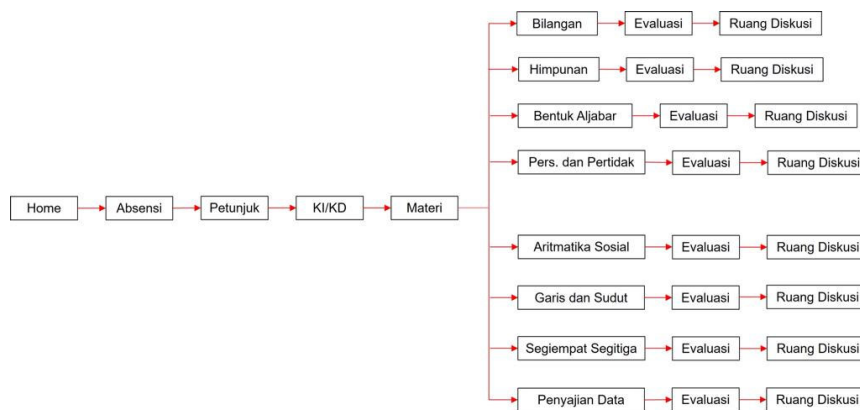


Figure 3. Flowchart of Mathematics Laboratory Teaching Materials

Evaluation at the development stage of this Flowchart is in the form of a Self Evaluation or self-evaluation to find out the process of developing product development activities *Mobile Virtual Mathematics laboratory and web-based teaching materials*. In addition to evaluating this stage, it is also carried out on the material or content contained in the product. The results of this evaluation are used as a basis for developing Mobile Virtual Mathematics laboratory products and web-based teaching materials.

### 3. Development Stage (Development)

The Mobile Virtual Mathematics laboratory product was developed using articulate storyline software. The main page of the Mobile Virtual Mathematics laboratory is the home which is the front page as shown in the picture....



Figure 4. Display Home Page

The menu display is the access used to the practicum page, this page is designed according to the learning material that is in accordance with the teaching material at school, so teachers and students can immediately find practicum material in accordance with the material being studied, from the learning menu display there will be more sub\_material learning that must be passed to access the practicum

room as shown below:

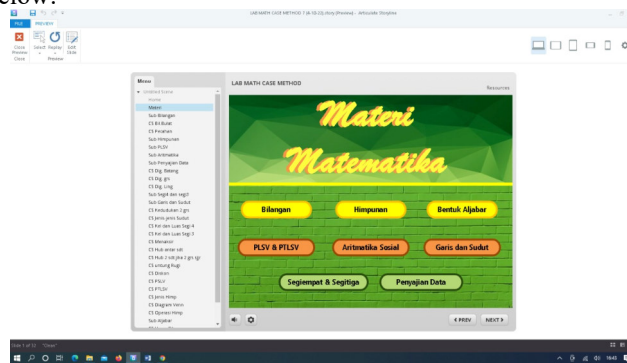


Figure 5. Display Menu Page

The appearance of Case Method Questions is a sub-topic that is studied in junior high school, Case Method Questions that have been designed are questions that have been adapted to learning indicators, so that the Case Method that is introduced will become the basis of the problems that must be solved through the questions presented in practicum. The display of the Case Methode page can be seen in the picture.....

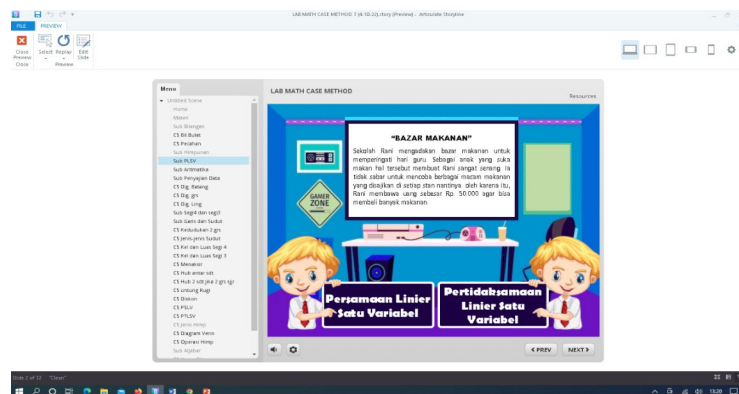


Figure 6. Display of Case Methode Page

The question page that will be tested on the practicum page is displayed after selecting material via the Case Method view. Where the questions that will be practiced are questions that are connected to cases on the Case Method page with the aim that students are accustomed to solving math problems according to cases that exist in everyday life. Thus students will get used to solving case-based questions which will be able to increase students' understanding of themselves, after students have finished doing practicum practicum results can be sent directly via the submission button where student work will be sent to the teacher's e-mail which can immediately correct student work. The appearance of the problem can be seen in the picture.....

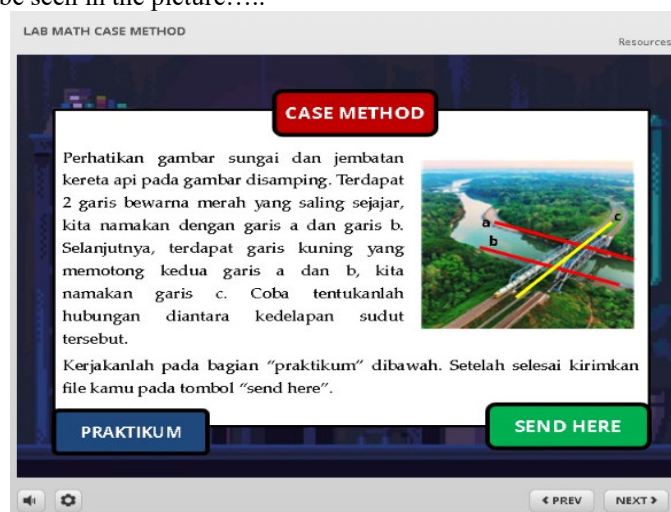


Figure 7. Display of the Case Method Question Page

The Practicum page contains spaces that students can work on, can change numbers and can increase student understanding through the practicum room. Students can repeat the answers they make until they produce the correct answer in the practice room. This is what makes students' understanding better, because students can try to fix every mistake they make on the practicum page. The display of the practicum page can be seen in the picture...

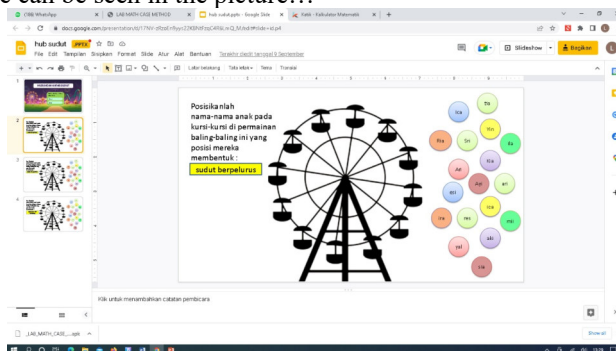


Figure 8. Practicum Page Display

Based on the results of the analysis of the needs of the SMP Muhammadiyah 1 Medan school, it can be concluded that the Mobile Virtual Mathematics laboratory can assist teachers in the teaching and learning process and evaluate student learning with a practicum page that can be directly corrected by their work to see and analyze the level of students' mathematical understanding.

#### 4. Implementation

Referring to the development model of Alessi & Trollip (2001: 548) product trials are carried out in two stages, namely through alpha testing and beta testing. During the early stages of the development process, ongoing evaluations are always carried out to minimize the possibility of errors in the program, and then to obtain evaluation responses from aspects of media, material, and user testing. The material expert said that the Mobile Virtual Mathematics laboratory product was feasible for testing, which can be seen in the picture...

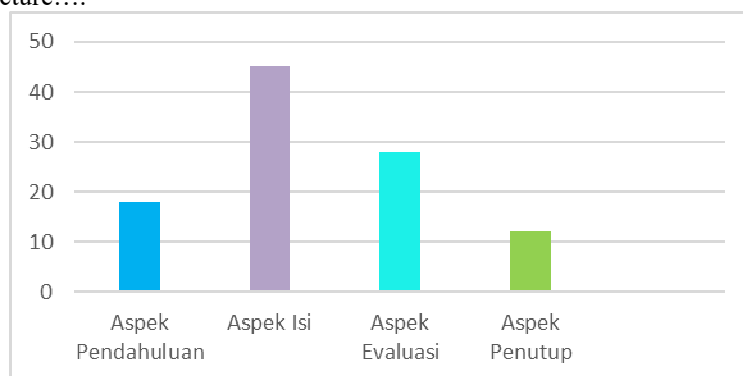


Figure 9. Aspects of Material Expert Assessment

Meanwhile, media experts say this application makes it easy for students with clarity and detailed instructions for use. All products of the Mobile Virtual Mathematics laboratory, seen from an overall average value of 4.21, are in the Very Good category or very suitable for use in learning, this can be seen in the picture...

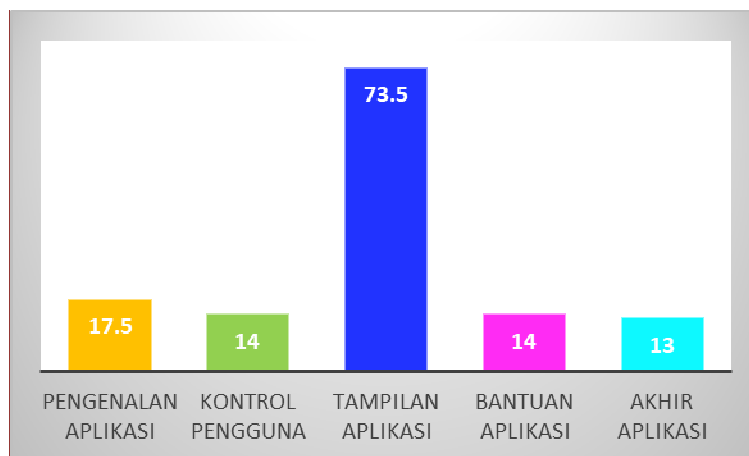


Figure 10. Media Expert Assessment Aspect

### Practicality Test Results

Practicality relates to the ease of using the Mobile Virtual Mathematics laboratory developed in learning. Practicality data was obtained by distributing questionnaires to teachers and students, to see how practical it was in using the Virtual Mathematics Laboratory Mobile application.

Table 3. Practicality

No	Assessment Aspects	Average Score	Category
1	Ease of Use of the Application	3,8	Good
2	Application View	3.79	Good
3	Ease of application to learn the contents	3.76	Good
Total Average Score		3.78	Good

Mobile Virtual Mathematics laboratory products from the aspect of ease of operation, aspects of application appearance, aspects of ease of application are studied. The Mobile Virtual Mathematics laboratory which was developed as a whole obtained a score of 3.78 so that it can be categorized as Good which states that the Mobile Virtual Mathematics laboratory product is suitable for use as a Learning laboratory.

### Effectiveness Test Results

The effectiveness test is obtained from calculating student learning outcomes from the control class and the experimental class. Before the researchers gave treatment to the experimental class, they were given a pretest with 40 students. There were 40 students who took part in the pretest, the average or mean value was 26.29, the median was 28 and the standard deviation was 1.856. While the control class is a class that is not given treatment using the Mobile Virtual Mathematics laboratory application. Similar to the experimental class, the researcher gave a test to the control class, the number of students in the control class was 40 people. The average value was 26.23, the median was 27.59, the mode was 25, and the standard deviation was 1.756. While the Posttest data for the experimental class uses the Mobile Virtual Mathematics laboratory application. After the posttest was carried out in the experimental class, the average value was 28.16, the median was 28.00, the mode was 28 and the standard deviation was 1.016. While the control class is the mean 27.24, median 27.00 mode 26 and standard deviation 1.349. Furthermore, to find out the significance of the differences in the learning outcomes of the two classes, a t-test was carried out by first carrying out the normality test and homogeneity test.

### Normality test

From the normality test results that have been calculated and presented in tabular form.... found the following values:

Table 4. Normality Test Results

Class	P	Information
Pretest Experiment class	0.474	P > 0.05 = Normal
Control Class Pretest	0.363	
Experiment Class Posttest	0.172	
Control Class Posttest	0.221	

Based on the table above, it was obtained that the normality test and the experimental class pretest were  $0.474 > 0.05$  and  $0.363 > 0.05$  were obtained from the class pretest results. While the normality test for the experimental class was obtained by an index of  $0.172 > 0.05$  and  $0.213 > 0.05$

from the posttest data of the control class. If you look at all index calculations  $> 0.05$ , it can be stated that the data used is normally distributed. So that it can be continued for the next test.

### Homogeneity Test

In addition to testing the normal distribution of the samples, it is also necessary to test the similarity, namely whether the variants of the samples taken from the same population are uniform or not. Summary of homogeneity test results as follows.

Table 5. Homogeneity Test

Class	F Count	F Table	P	Information
Pretest Experiment class	1,086	2,380	0.413	Fh < Ft = Homogeneous
Control Class Pretest				
Experiment Class Posttest	1,668	0.82		
Control Class Posttest				

From the table above it can be seen that the calculated F obtained from the homogeneity test of the variants from the pretest and posttest is 1.086 and 1.668 which is smaller than the F table 2.380, so it can be said that the distribution of the data is homogeneous.

### T-Test

The calculation of the posttest t-test for the experimental class and the control class is listed in the following table.

Table 6. T-Test Calculation Results

Class	Average	t-count	t-table	DB	P
Experiment	28,16	2,332	2.0032	57	0.025
Control	27,24				

From the results of the t-count of 2.332 with t-table at a significance level of 5% and 56 db of 2.0032 it turns out that the t-count is greater than the table, meaning that there is a significant difference in the posttest experimental class and control class.

## 5. Evaluation

Through evaluation by experts for the revision of the Mobile Virtual Mathematics Laboratory product, students are also evaluated to find out the attractiveness and ease of this learning material to be used as a learning laboratory that can improve their understanding in learning mathematics. So it can be concluded that this media can improve students' mathematical understanding by using the Mobile Virtual Mathematics Laboratory, where we know the questions presented in the mathematics laboratory are Case Method questions. Case-based questions that are solved using mathematical material are also supported by opinions Budi Legowo (2021) who stated that one of the advantages of the Case Method is that it trains the application of mathematical theory in real life and encourages active and independent learning habits.

## DISCUSSION

Virtual mathematics laboratory mobile products are developed in accordance with procedures and development steps through the stages of design, design, development, implementation and evaluation. The Virtual mathematics laboratory mobile product is a learning medium that supports the practice of learning mathematics for Class VII students of SMP Muhammadiyah 1 Medan. Based on the analysis of the needs of the researchers to obtain information that the mobile virtual mathematics laboratory is a laboratory needed to assist the learning process that is packaged in a mobile form by utilizing a smartphone that is free to use anytime and anywhere with attractive and more interactive visualizations.

This product development process involves the performance of several programs or *softwares* such as Adobe Flash, Corel Draw, Adobe Illustrator and Adobe Premiere. The virtual mathematics laboratory mobile product after an alpha test was carried out on material experts and media experts obtained a validation result score with Very Good criteria. Based on the average score of the validation results of the material expert 1 and material expert 2, it is known that the preliminary aspects, content aspects, evaluation aspects, closing aspects are categorized very well. The overall average obtained from the validation results of the two material experts is 4.46 with a very good category for use or can be said to be feasible for use in the field as a mathematics laboratory in the learning process. So that the components of the initial introduction to the virtual mathematics laboratory mobile program can be categorized as very good, aspects of user control, aspects of program application display, aspects of program application assistance, final aspects of applications, aspects of multimedia design principles have very good categories. as a whole the Virtual mathematics laboratory mobile products in the media aspect get an average score of 4,



## CONCLUSION

The advantages of the Mobile Virtual Mathematics Laboratory are that it is portable, learning can be done anytime and anywhere because it uses an Android device that adjusts user mobility, easy to access because it doesn't require a full internet network connection (only downloads). Mobile Virtual math laboratory is simple and simple because it only consists of three main features; competency, Case Method questions and practicum as well as navigations that are easy to remember. From the above conclusions, the actual development of the virtual mathematics laboratory mobile has produced a quality prototype. Therefore the development of the Mobile Virtual mathematics laboratory needs to be followed up by developing a number of applications or a number of questions with even more cases so that students can become more proficient in working on case-based problems or the case method. While the impact will reduce the number of students, the number of teachers and the number of available laboratory space.

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