

Developing Progressive Web Application (PWA)-Based Mathematics Quiz on Equality And Inequality of Exponents Lesson

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1 Developing Progressive Web Application (PWA)-Based Mathematics Quiz on Equality And Inequality of Exponents Lesson

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1 Abstract

This study was aimed to develop a learning media namely progressive web application (PWA)-based mathematics quiz application on equality and inequality of exponent for high school students level which are valid, practical, and effective. The learning media was developed with 4D development model consisting of 4 stages, namely: 1) defining stage, 2) designing stage, 3) developing stage, and 4) disseminating stage. The population of this study was students of class X in SMA Batara Gowa which sample students were from class X MIA 1 in SMA Batara. This research instrument used validation sheets, student questionnaire responses, and student learning outcomes test. The results showed that the average score of the validator was 0.94 with a valid category interpreted as "very good" using the validity test, the practicality test and the student questionnaire responses showed a percentage of questionnaires at 90.5% with the "very feasible" category, and the effectiveness test showed a percentage of the students' value above the minimum mastery criteria of 80%. Based on the results of data analysis, it can be concluded that the progressive web application-based mathematics quiz is valid, practical, and effective in mathematics learning process.

Keywords: PWA, Quiz, Equality And Inequality Of Exponents Lesson

1. Introduction

Nowadays, the world is suffering from the COVID-19 epidemic. This makes policy makers, especially in the field of education in Indonesia, must immediately take action because it influences the process of education including learning process in schools. COVID-19 is a newly discovered virus that can be transmitted to humans and dangerous. Recently, there is no vaccine that can prevent this virus. Therefore, one of the actions taken by the Ministry of Education and Culture in dealing with this problem is to issue a circular on the handling and prevention of COVID-19 in schools. Hence, several local governments issued a policy to dismiss schools. The policy chosen by several local governments in Indonesia has the support of the Minister of Education and Culture-Higher Education, Nadiem Anwar Makarim. Nadiem in his written statement in Jakarta on 15/03/2020 stressed that " The Ministry of Education and Culture is ready with all scenarios, including the application of working together to encourage online learning (in networks) for students "[1]. Therefore, the use of technology in the world of education must be implemented immediately.

In this situation, the teacher's role in utilizing technology is very necessary so that the learning process continues at home. One of the learning media that suits the current conditions is technology-based or android-based learning media. Generally, when someone talks about technology, they think of objects such as computers, MP3 players and space shuttles [2]. The characteristics of technology is user-centered, flexibility, mobility, and media capabilities [3]. The development of technology has a great influence, especially in creating learning media. As in the world of education, teacher is required to prepare students in order to have good mastery, especially mastery of basic mathematical concepts so that they are able to solve practical problems by using mathematics. The mathematics teacher must be able to play a role in order to be able to transfer and develop students' skills to use mathematics in solving problems [4]. However, mathematics teachers should also provide learning media that can improve students' mastery of mathematical concepts. In addition, the media is also expected to stimulate students' attention to the world of mathematics.

A teacher plays an important role in facilitating students in the learning process. The National Research Council states that *"it is true the teacher's role is important to facilitating student in learning* [5]. This statement reveals that the teacher does play an important role in facilitating students in terms of learning. Therefore, the teacher's role in facilitating technology-based learning is also very influential toward the success of the learning process. Technology-based learning, for example, software technology in the form of systematic solutions in solving learning problems, becomes increasingly sophisticated and has a wide place in the world of education [6]. Following the era of globalization and the development of a very rapid era marked by the growth of products and the use of technology, the concept of learning shifted into an effort to embody modern learning [7]. Learning media of mobile based device is believed to expand mathematics frontier instruction and learning outside the classroom [8]. Meanwhile, Ebner [9] reveals that the mobile application is very important to be collaborated with mathematics education in schools. Darmawan (2016) added that there is a learning concept called virtual learning that can provide information by designing the learning. The word of virtual has been introduced by Jorge Martin in a statement that virtual technology has been applied in many sectors such as education [10].

Along with the renewal of the curriculum, learning media, guidance in the world of work, science and technology also continue to develop [11]. In further explanation, Putria dan S. Nunuk (2018) stated that the aim to be achieved by the development of the media is an increase of student creativity that can improve results. Therefore, the teacher must be able to provide interactive learning media in response to technological developments known as the industrial revolution 4.0. This is in line with the explanation of Oktavianingtya et al. (2018) that one of the innovations used by teachers as a response to the industrial revolution 4.0 is the use of interactive mathematics learning media. A research is written by Zaranis et al [13] revealed that teaching mathematics by using software results better learning. Learning methods and learning media can be said as two very prominent aspects in terms of learning [14].

The distance learning design was developed on the basis of needs analysis which includes an analysis of actual and ideal conditions based on technology [15]. E-learning has become one of the information technology development products in the world of education, starting to stimulate the attention of many parties from several circles, namely: academic, professional, and corporate and industrial [16]. If E-learning is fully used, it can be a tool that helps to create effective learning process, because students can learn by their own and from unlimited place, with an internet connection [17]. One of technologies that can support e-learning programs is a web

application. Web-based learning media is easily accessed by students from various places. Web-based learning environment makes internet technology as the main media in learning and [19]. Web-based learning environment is useful in organizing and improving education, as well as developing learning environments [20]. Web technology that is easy to access is technology based on progressive web application (PWA).

Progressive web application is just a name for the concept introduced by Alex Russell in 2015 [17]. PWA uses modern web capabilities to deliver an app [21]. The point is that PWA uses the capabilities of modern websites to deliver user experiences like applications. Furthermore, Tandel (2018) explained that PWA is a new technology designed and developed by Google. The point is that PWA was designed and created by Google so that PWA is under license from Google Chrome. Before developing technology-based or electronic learning materials, it is necessary to pay attention to six principles, namely: 1) based on instructional objectives, 2) based on basic competencies contained in curriculum, 3) facilitate learners in learning, 4) materials that are in accordance with the truth, 5) design as attractive as possible and easily understood, 6) appropriate supporting media, and 7) estimate the time needed to study the material [18].

Yaumi (2017) explains that when someone mentions the word "development", it is driven by three things: 1) a product that is developed, even though the development is the existing products and newly developed products; 2) the term development refers to the procedures, stages or systemic hierarchy carried out in producing products; 3) development is always related to models, such as models based on space such as teaching materials, strategies, media, methods, and evaluation of learning, models based on products such as media and technology, as well as system-based models such as distance learning, opening programs etc. Students at the high school level basically must own an ability to understand good mathematical concepts. Mastery of mathematical concepts that form the basis of other scientific fields must be strengthened. However, based on observations through information given by one of the Batara Gowa high school mathematics teachers, it is known that the mastery of students' mathematical concepts is still relatively low. The large number of students who have daily test, middle exam, and final exam scores below the minimum mastery criteria. Therefore, we need a solution to improve students' understanding of mathematical concepts, especially at the high school level.

Meanwhile, based on the results of previous research conducted by Hardiyanti K. (2011) stated that by giving examples of questions from the material being taught, it will improve students' understanding of mathematical concepts. Then clarified by the results of Wulandari's research (2015) which stated that by developing the ability to think creatively and mathematical reasoning through exercises questions, it can improve the ability to understand students' mathematical concepts. Therefore, we need a learning media that contains practice questions to sharpen the ability to think creatively and to learn mathematical reasoning in terms of understanding mathematical concepts. The media should also be equipped with a summary of material concepts along with example problems. To develop a media that can improve the ability to understand mathematical concepts, of course, it cannot be separated from the influence of technology. Therefore, the product developed in this study is in the form of instructional media oriented towards mathematical quiz applications based on progressive web applications (PWA). The developed media requires an internet connection. With an internet connection, a person can obtain or download information and knowledge from various sources that are web-based [27].

2. Methodology

This was a research and development to test the level of validity, practicality, and effectiveness of the PWA-based mathematics quiz application which was developed. The sampling technique used was simple random sampling with population consisting of students of class X in SMA Batara Gowa. The sample selected in this study were students of class X MIA 1 in SMA Batara Gowa. This research experiment was carried out twice, namely a small scale experiment involving 5-6 students of class X MIA 1 of SMA Batara Gowa and a large scale experiment involving all students of class X MIA 1 in SMA Batara Gowa.

The development model of this study was the 4D model suggested by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel. The development model consists of four stages [28], namely: (1) the defining stage that aims in determining the needs of the learning process as well as examining objectives and taking into account the limitations on learning material, (2) the designing stage consists of media selection, format, initial design and preparation learning media, (3) the developing stage that aims to produce a product or learning media that has been revised from the results of the experts' assessment, and (4) the disseminating stage is carried out in the research school environment by introducing learning media developed in the form of quiz applications mathematics.

3. Result and Discussion

The result of the study is in the form of a learning media development process developed with the 4D-model development model. This development model consists of four stages of development, namely: the defining stage (define), the designing stage (design), the developing stage (develop), and the stage of dissemination (disseminate). The stages of this research are explained as follows:

3.1 Defining Stage

At this stage, the students were observed to determine the extent of students' academic abilities, cognitive development, and students' skills to operate technological devices. The material included the mathematics quiz application which developed equality and inequality of exponent. The lesson was chosen because based on the information of the mathematics teacher in SMA Batara Gowa that in general, students had difficulty in understanding the material of equality and exponential inequality. In addition, other problems in mathematics learning in SMA Batara Gowa were also found, namely: (1) Lack of students' basic understanding of mathematics; (2) Lack of student interest in learning; (3) Lack of use of media or technology-based mathematics learning tools; and (4) Lack of use of internet and computer network facilities in schools.

The results of the analysis of the lack of understanding of the basic concepts of students towards learning mathematics and the lack of students' interest in learning can be caused by the lack of use of learning media that can attract students' interest or enthusiasm in learning mathematics so that students have a low understanding basic math concepts. The unattractive media usually do not keep up with increasingly sophisticated technological developments.

3.2 Designing Stage

At this stage, the design of learning media was carried out in the form of a progressive web application (PWA)-based mathematics quiz application. The selection of instructional media is based on several problems experienced by SMA Batara Gowa students towards understanding basic mathematical concepts.

Researchers chose the PWA-based mathematics quiz application, because the website is easily accessed in various places. In addition, students do not need to download the quiz application like other applications in general. They are only given a link to access the application so that it does not increase the storage memory capacity.

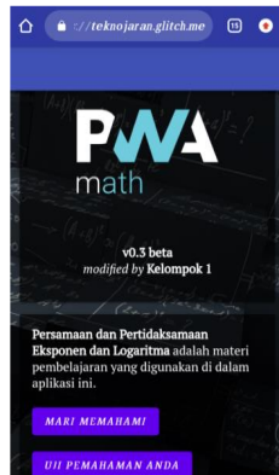


Figure 1. PWA Math Homepage

Figure 1 is the initial display (homepage) on the math quiz application. The application is given the name PWA_{math} which contains meaning, namely mathematics in PWA. On the display, there are two menus, namely: the "let's understand" menu containing modules that discuss the material of equations and inequality of exponents and the "test your understanding" menu contains a quiz in the form of math problems in class X of high school. This application is not only accessible in one technological device, but it can also be accessed via mobile phones, laptops, and computers.



Figure 2. Module Page

Figure 2 appears, if students click on the "let's understand" menu. Then students are confronted with the module page display. By scrolling, students see the contents

of the module. The module only discusses one mathematical material namely equations and inequality of exponents.

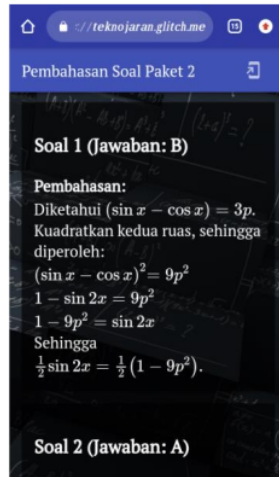


Figure 3. Questions Page

Figure 3 is a quiz display in the form of questions that appears when students click on the "test your understanding" menu. The questions on the PWAmath application quiz consists of 2 question packages with 10 question numbers for each question package. The package of questions includes math problems for class X of high school.

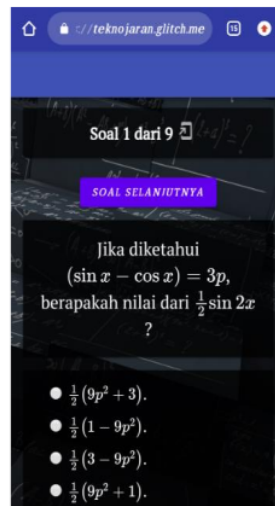


Figure 4. Discussion menu

Figure 4 is a discussion display that contains a discussion of quiz questions that have been answered by students. The discussion menu is not displayed on the homepage, but it appears after students finish answering quiz questions in one package.

3.3 Developing Stage

The developing stage consists of 3 stages, namely: the validation stage, the provision of questionnaire responses of students, and product trials. The validation stage was carried out to obtain the validity level of the PWA-based mathematics quiz application developed. Giving questionnaire responses addressed to students to find out the level of practicality of the PWA-based mathematics quiz application. Product trial was conducted to obtain the level of effectiveness of the PWA-based mathematics quiz application. This initial learning media (draft I) was validated by experts who produced draft II. The expert who validate this media is called validators. The validator validates by providing input, suggestions, and an assessment of the learning media in the form of a PWA-based mathematics quiz application developed. This media validation was carried out by three validators. The results of data analysis showed that the value of the correlation coefficient of the development of this learning media by 0.94, including the category of "very high", so it can be concluded that the learning media in the form of PWA-based mathematics quiz application is valid.

Table 1. Results of Validation of PWA Based Mathematics Quiz Applications

No.	Aspect Criteria	Indikator	Validator Value (V _{ij})			H
			V11	V21	V31	
1.	Content Section (Material and Package Questions)	1. The accuracy of the material on the module with SK and KD.	5	5	4	4,66
		2. The correct of the concepts in the module.	5	5	5	5
		3. The clear material and sample questions in the module.	4	4	5	4,33
		4. The clear questions related to what the students have known and what it is asked.	5	4	5	4,66
		5. The clear questions related to what the students have known and what it is asked.	5	5	5	5
2.	Grammar	6. The use of language based on the general guidelines of the Indonesian language.	5	4	5	4,66
		7. Ease of students in understanding the language used.	5	5	5	5
3.	Format	8. Advantages compared to existing learning media	5	5	5	5
		9. Appropriate text size on modules, package of questions and discussion.	4	4	5	4,33
		10. Creativity and innovation in learning media	4	5	5	4,66
Total Average (V _α)						4,73

$$\alpha = \frac{4,73}{5} = 0,94$$

Practicality test was carried out by using a student response questionnaire. Based on the response questionnaire, it was obtained the percentage of questionnaire

responses of 90.5% of 25 students of Class X MIA 1 at Batara Gowa High School which was included in the "very feasible" category. This shows the learning media product in the form of a progressive web application (PWA) based mathematics quiz application meets the practicality criteria.

Table 2. Results of Analysis of Response Questionnaire Data

No.	Indicator	Mean
1.	I can open learning media in the form of the PWAmath application.	0.96
2.	I am interested in the background of learning tools in the form of PWAmath quiz applications.	1.00
3.	I easily operate the learning media in the form of the PWAmath application.	0.96
4.	I easily understand the contents of modules in the PWAmath application.	0.88
5.	I am interested in module design in the PWAmath application.	1.00
6.	I easily work on the concept of material functions, equation and inequality of exponents, and logarithms in PWAmath applications.	0.68
7.	I easily understand the purpose and concept of the question package in the PWAmath application.	0.92
8.	I am interested in the appearance of the question package in the PWAmath application.	0.93
9.	I easily understand the discussion of the question package in the PWAmath application.	0.80
10.	I agree if the PWAmath application is used as one of the learning media in schools.	0.92
Total Average		9.05
Percentage of Questionnaire		90.5%

Based on the analysis of the students' questionnaire response data in table 3, students have no difficulty in using learning media while participating in learning in the form of the PWA-based mathematics quiz application. However, when first opening the PWA-based mathematics quiz application, students experience a few obstacles in terms of internet connection so there are some students who disagree with the PWA-based mathematics quiz application.

In addition, practicality analysis is also supported by positive responses from teachers who agree that the PWA-based mathematics quiz application is appropriate for use in learning mathematics in schools. The effectiveness test can be known by analyzing the results of the learning test by using a package of questions on the PWA-based mathematics quiz application.

There are two question packages that are tested to students using the PWA-based mathematics quiz application. From the results of the learning tests taken by 25 students of Class X MIA 1, SMA Batara Gowa showed a percentage of completeness of 80% with a minimum mastery criteria that has been set, namely 75. Based on these data, the learning media in the form of PWA-based mathematics quiz application are categorized effective. The test results obtained by students can be seen in Figure 5.

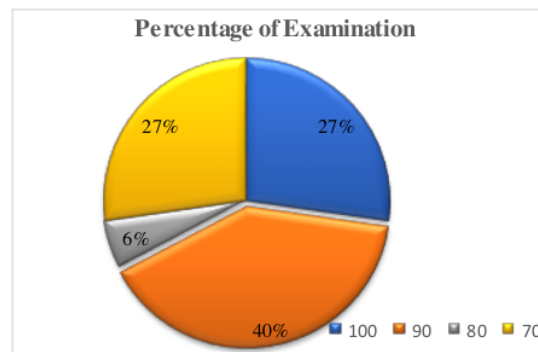


Figure 5. Percentage of Examination

3.4 Disseminating Stage

This stage is carried out at the trial location given by the website of the learning media in the form of PWA-based mathematics quiz applications, namely SMA Batara Gowa. The application was also disseminated with the help of mathematics teachers in SMA Batara Gowa through mathematics MGMP activities in Somba Opu Subdistrict, Gowa Regency. The PWA-based mathematics quiz application can be accessed via a link <https://teknokaran.glitch.me>. To use the PWA-based mathematics quiz application, it can apply some ways as follows: (1) In the PWA-based mathematics quiz application, math questions are included in class X consisting of two package of questions. In addition, there are also modules on equality and inequality of exponent, and logarithm for reviewing lesson learned by students; (2) Students will get a link to access and answer questions that have been uploaded on the PWA-based mathematics quiz application; (3) Students will get a score after answering all the questions in one package as well. Discussion of questions only appears when students have finished answering all the questions in one package and have obtained a score. This application has many uses, including: (1) it can help students understand the material of equation and inequality of exponents (2) it can help students understand math question that often appear on national exams; (3) teachers can streamline time to check student test results because in the PWA-based mathematics quiz application, the score will be seen after students finish working on the questions; (4) the school can submit questions by itself to the PWA-based mathematics quiz application. Corresponding author should have an asterisk sign (*) if possible, after the corresponding author's name. The Corresponding author (e.g., *Corresponding Author) label should be appeared at the footnote section of the first page of the paper, Times New Roman in style and 10 in font size.

4. Conclusion

Learning media in the form of Progressive Web Application-Based Mathematics Quiz was developed with a 4D development model which consists of four stages of development, namely: defining stage, design stage, development stage, and disseminate stage. Learning media in the form of Progressive Web Application-Based Mathematics Quiz, known as PWA math, have fulfilled valid, practical and effective criteria. The validity level based on the validator rating of 0.94 is included in the "very good" category. The level of practicality based on data analysis questionnaire responses of students amounted to 90.05% of 25 students of class X MIA 1 in SMA Batara Gowa included in the category of "very good". The level of effectiveness is obtained from the test scores of student learning outcomes that is equal to 80% above the minimum mastery criteria of 25 students so that it belongs to the category of "very effective".

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