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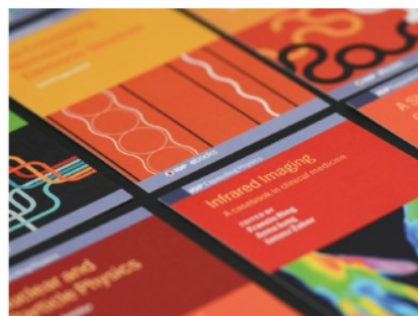
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Development of teaching materials arithmetic sequence and series based on android for problem based learning

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Abstract. This research aims to produce the teaching materials based on Android which is valid and practical in order to support the senior high school students in learning arithmetic sequence and series for problem based learning. The subjects of this research were the eleventh and twelfth grade students of Senior High School Number 1 Indralaya Utara. This research is kind of development research by adapting model development of ADDIE. The stages of the research conducted consist of analyze, design, and development. Data collection techniques which were used in this research were by walkthrough, observation and questionnaire. The result of this research is teaching materials of arithmetic sequence and series based on Android for problem based learning are valid and practical. Said to be valid because based on the assessment of experts who stated that in terms of content, construct and language in teaching materials had met the valid criteria. Whereas, based on the results of the questionnaire and observation it was concluded that the students think that this teaching materials is interesting, easy to use, easy to understand, can improve enthusiasm for learning and can help to improve concepts understanding of students.

1. Introduction

Arithmetic sequence and series are part of the number series material taught in eleventh grade. The success of students in material arithmetic sequence and series is one of the most important aspects and need to be considered because this material is contained in one of the competencies that must be achieved in learning mathematics which is explain and use the pattern to make predictions [1]. In addition, the material of arithmetic sequence and series is also one of the material contained in the senior high school national examination grid and domain content TIMSS [2, 3].

In fact, there are still many students who have difficulty studying arithmetic sequence and series. It can be know from the results of previous studies which found that most of students don't understand the concept of arithmetic sequence and series correctly and the students have difficulty using the definition in the form of formulas correctly [4].

Learning difficulties and the low understanding of concepts experienced by the students is caused by several factors, including the availability of teaching materials and learning models used [5]. At present, the majority of teachers use the conventional learning models so that teachers are more dominant in the learning process where learning begins with informative presentation of the material by the teacher, giving examples, and evaluation through practice questions [6]. This causes the students think that mathematics is not important in everyday life [7]. This resulted in the motivation and activeness of students in mathematical learning tends to be low, whereas the motivation of the students can give a positive impact for the students' success in learning mathematics [8]. Therefore, the need for change to move away from conventional learning where the students is seen as a passive



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consumer of educational knowledge to a learning in which the students are considered active participants [9].

Besides being a learning models, the use of teaching materials which is not appropriate is also being one of the factors causing learning difficulties of students, where most of mathematical learning is currently only focused on the use of ready-to-use textbooks [10]. Even though, textbook that is used to support the process of mathematical learning still have some shortcomings, among them are still don't show any emphasis in defining mathematical concepts, have not be able to spur to be involved actively in the learning process and also still contains concepts such as theorems and formulas which are presented directly without the process of forming knowledge for students [11, 12]. Meanwhile, it is known that the students who construct their understanding of mathematical concepts independently by using a contextual problem will have a better understanding of the concepts and the concepts will be more attached to the students' mind than the students who just receive information directly [13].

Problem based learning (PBL) is a learning strategy by presenting a contextual problem as a first step in learning so that the students can collect and integrate new knowledge and focus on the students' activeness in learning activities [14]. With PBL, the students can develop their thinking skill, can improve students learning outcomes, improve skills in solving problem and can foster students' motivation to be actively involved in learning process and actively to discuss in groups [15, 16]. The learning steps in PBL consist of step to orient the problem, organize students to learn, help individual and group investigation, develop and present the work, analyze and evaluate problem solving process [14].

In the current era of industrial revolution 4.0, rapid technological developments affect the world of education where education requires the concepts of teaching and learning supported by technology so that learning system can be done more innovatively [17]. The presentation of teaching materials by using a smartphone application is one form of learning system innovation in the era of the industrial revolution 4.0. The use of smartphones in the presentation of teaching materials as a form of utilizing technology implementation is based because more students are spending more time using smartphone and most students prefer to photograph their work with a smartphone rather than writing it on a book [18]. Nowadays, the type of smartphone that is most widely used is smartphone with Android operating system [19]. By using Android in the presentation of math teaching materials can foster enthusiasm and learning motivation for students, where with the Android operating system, teaching materials can be package in the form of software or applications which are interesting and easy to use whenever and wherever [20]. The use of multimedia in the form of Android applications can encourage students to be active in the learning process and make it easier for students to understand the math material being taught [21]. However, no one has developed teaching materials of arithmetic sequence and series by collaborating on Android with a learning model.

Based on the description above, the researcher is interested in conducting research with the title "Development of teaching materials arithmetic sequence and series based on Android for problem based learning".

34 Method

This research is type of development research by adapting development model of ADDIE that aims to produce teaching materials arithmetic sequence and series based on Android for problem based learning are valid and practical. The subject of this research were the eleventh and twelfth grade students which were conducted at Senior High School Number 1 Indralaya Utara. The stages of this research consisted of analyze, design, and development. Data collection instrumen used in this research include validation sheets to measure the validity of teaching materials and observation sheet and questionnaire sheets to measure the practicality of teaching materials. The validity of the teaching materials produced was assessed in expert review and one-to-one stage. The validity characteristics of teaching materials are assessed in terms of content, construct, and language used. As for the practicality of teaching materials are assessed from the testing results of teaching materials in small group stage by analyzing observation results of students responses while using teaching materials based on Android and sheet of questionnaire filled by the students after the teaching materials tested. If from each observation sheet and questionnaire obtained the percentage of students who fall into the

category of strongly agree is 84% or more, then the teaching materials of arithmetic sequence and series developed by researcher can be said have met the very practical criteria.

3. Result and Discussion

3.1. Analyze

At this stage, researchers conducted an analysis of the needs, curriculum, and characteristics of students. Based on the needs analysis obtained information regarding the availability of teaching materials used, the availability of Android, and the use of Android in the learning process. From the information that has been obtained, the researcher concludes that it takes innovative teaching materials that are interesting and fun for students to stimulate students' learning motivation. Meanwhile, the results of the curriculum analysis is that the researcher determines the material to be used wherein the researcher chooses the material in basic competencies 3.6 and 4.6 which is the material of arithmetic sequence and series. Furthermore, researcher determine indicators of student achievement after doing this learning. The results of analyzing the characteristics of students note that students tend to be passive in the process of learning mathematics and easily give up in finding out information in solving problems given by the teacher.

3.2. Design

The design stage is consisting of Compilation of teaching materials contents framework and storyboard design.

3.2.1. Compilation of Teaching Materials Contents Framework

At this stage, the researcher prepares the contents contained in the teaching material. The structure of the contents in the teaching materials arithmetic sequence and series developed by researchers include (1) Core competencies, basic competencies and learning objectives, (2) Initial problems in teaching materials which are in accordance with PBL characteristics, (3) Steps to solve the problems that refer to the steps PBL, (4) Material of arithmetic sequences and series, (5) Evaluation, namely a quiz consisting of 5 questions about arithmetic sequences and series, (6) Instructions for using teaching materials, and (7) Info of application consisting of descriptions and profiles teaching material application developer.

3.2.2. Storyboard design

The purpose of making storyboard is to be able to provide a clearer picture of the product design. In making the storyboard, researcher designed the display of teaching materials based on Android that were developed such as the layout between text and images, the layout of the buttons and the rough appearance of the teaching material to be made. The storyboard design results from a number of menus in the teaching materials arithmetic sequence and series based on Android are shown in Figures 1.2 and 3.



Figure 1. loading view storyboard.



Figure 2. main menu storyboard.

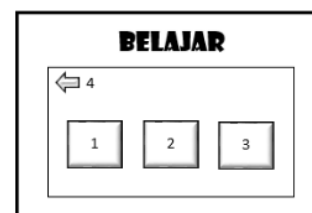


Figure 3. learning menu storyboard.

Figure 1 is a design on the loading view, which is the initial display when first opening the teaching material application. This display is a process display before heading to the main menu. Figure 2 is the main menu display where this main menu will open automatically after the loading view is complete. In the main menu there are several buttons that can be selected by the user, namely: (1) learning, (2) quiz, (3) usage instructions, (4) application info, and (5) exit. Meanwhile, Figure 3 is a learning menu in which there are 4 buttons to move to other menus, namely (1) Core competencies, basic competencies, and learning objectives, (2) problem, (3) material, and (4) buttons to return to previous menu.

3.3. Development

The development stage is consisting of product manufacture, expert review, one to one, and small group.

3.3.1. Product manufacture

At this stage, researcher conducted the process of making teaching materials that start from typing the contents that will be loaded in teaching materials, making animations, and designing the background display of teaching materials using the help of software Microsoft Office PowerPoint, Corel Draw, Camtasia, and Wondershare Filmora. After that, continued by inserting images, text, sound, and animation that have been made into the teaching material application where in making this application researcher use the help of Android Studio as an Android application developer software. The display of teaching materials developed by researcher is shown in Figures 4.5 and 6.



Figure 4. learning menu display.



Figure 5. material menu display.



Figure 6. quiz menu display.

3.3.2. Expert review

The application of teaching material that was designed was then validated by 3 lecturers of mathematics education FKIP Unsri as the material expert and the media expert to determine the validity of the teaching material developed by judging based on aspects of content, construct, and language. The researcher also asked for comments and suggestions from the validators which were used as guidelines for making the revision decision on the teaching material so that a valid teaching material was obtained. Table 1 shows the summary results of several comments and suggestions from the validators.

Table 1. Comments and suggestions from validators.

Lecturer	Comments and Suggestions
Jeri Araiku, S.Pd., M.Pd.	Texts and images in the background on the learning menu should be removed, add formulas $S_n = \frac{n}{2}(a + U_n)$, sentences are changed to be more communicative, buttons are made into 3D.
Ruth Helen Simarmata, S.Pd., M.PMat., M.Pd.	Give a different color to the elements that are patterned to find the arithmetic sequence formula, correct the words according to EYD, improve the description of teaching materials.

3.3.3. One-to-one

In this research, one-to-one stage was conducted along with the expert review stage [22]. Researcher conducted one-to-one trial to class XI and XII students of Senior High School Number 1 Indralaya Utara to get comments and suggestions from students regarding the use of teaching materials developed by researcher to further be used as material for consideration in making improvements to these teaching materials. Based on observations during the trial, it can be concluded that students do not experience significant difficulties when using teaching materials developed by researcher. In addition, based on the comments and suggestions sheets filled out by students, it appears that most students gave positive comments regarding the use of these teaching materials. However, there are students who give suggestions in the form of adding animation in teaching materials and improvements in delivering questions.

3.3.4. Revision

After the expert review and one-to-one trials on teaching materials are carried out, further improvements are made to the teaching materials based on the comments and suggestions given by the validator and students. Some of the results of improvements in teaching materials are shown in Figures 7.8, and 9.



Figure 7. revision of learning menu display.



Figure 8. revision of material menu display.



Figure 9. revision of quiz menu display.

Teaching materials that have been revised are shown again to the validator. The validators then agreed to the results of the revision by the researcher by stating that the teaching materials arithmetic sequence and series based on developed by the researcher were categorized as valid and worth testing at the small group stage.

3.3.5. Small Group

The revised teaching materials were then retested to 2 small groups consisting of class XI students and class XII students. In this small group trial, observation and questionnaire data were obtained which were used to assess the practicality of the use of teaching materials. Data from observations are shown in Table 2.

Table 2 above shows that teaching materials developed by researcher have fulfilled aspects: (1) Easy to use, this can be seen from the attitude of students who did not look confused and did not ask questions while using teaching materials. (2) Can increase students' learning motivation, this can be seen from the attitude of students who are enthusiastic about learning to use teaching materials based on Android. (3) Easy to understand, this can be seen from the results of the quiz work where each group can do the questions on the quiz correctly. (4) Requires a short time in its use, where during using teaching materials students do not need a long time to press the buttons on teaching materials or in other words students are not confused when they want to move from one menu to another menu. (5) Having interactivity in its use, this is because teaching materials can be operated by students where students can freely choose the menu to be opened next, even though there are some buttons that cannot be opened if the students have not completed the learning steps in accordance with the steps on PBL. From the percentage data, an average percentage of observational data is obtained, which is 96%,

which shows that the teaching materials arithmetic sequence and series based on Android for PBL developed by researchers are included in very practical criteria.

Table 2. Percentage of observation data.

No	Observation aspects	Percentage	Criteria
1.	Learners are easy to use teaching materials based on Android	100%	Strongly agree
2.	Students are motivated in the process of learning mathematics using teaching materials based on Android	90%	Strongly agree
3.	Material arithmetic sequence and series on teaching material based on Android are easily understood by students.	100%	Strongly agree
4.	Teaching materials based on Android used require a short time in use	100%	Strongly agree
5.	Learners have interactivity in using teaching materials based on Android	90%	Strongly agree
Average percentage		96%	Very practical

The questionnaire results are shown in Table 3.

Table 3. Percentage of questionnaire data.

No	Indicator	Percentage	Criteria
1	This teaching materials based on Android is easy to use	100%	Strongly agree
2	Learners become more excited about learning mathematics by using teaching materials based on Android	96.67%	Strongly agree
3	Learners are interested in learning to use teaching materials based on Android	93.33%	Strongly agree
4	The questions on teaching materials are easy to understand	90%	Strongly agree
5	Display attractive teaching materials based on Android	93.33%	Strongly agree
6	Images, illustrations and animation effects help me understand concepts	96.67%	Strongly agree
7	Submission of material is clear so that students easily understand the material presented	96.67%	Strongly agree
8	The language used in teaching materials based on Android is easy to understand	90%	Strongly agree
9	The question exercise strengthened my understanding of the material presented	93.33%	Strongly agree
10	Students like this teaching materials based on Android	90%	Strongly agree
Average percentage		94%	Very practical

Based on Table 3 above, it is known that the indicators: (1) Teaching materials based on Android is easy to use, get a value of 100%. This value is obtained because all students strongly agree that teaching materials are easy to use and do not make students confused when using them. (2) Students

become more eager to learn mathematics using teaching materials based on Android, obtaining a value of 96.67%. This value was obtained because most of the students strongly agreed that by using teaching materials based on Android, their motivation in learning mathematics became more improved. (3) Students are interested in using teaching materials based on Android and (5) Display attractive teaching materials based on Android, getting a value of 93.33%. This value is obtained because most students strongly agree that using teaching materials based on Android can increase the attractiveness for learning that is greater than using ordinary textbooks. (4) The questions in the teaching material are easy to understand, (7) The material submitted is easy to understand, and (8) The language used is easy to understand, each score 90%, 96.67% and 90%. This value is obtained because most students strongly agree that the language, questions and material in teaching materials are easy for them to understand. This was also seen during the use of teaching materials, none of the students raised questions to researchers about things they did not understand. (6) Pictures, illustrations and animation effects help in understanding concepts, obtaining a value of 96.67%. This value is obtained because most students strongly agree that the images, illustrations and animation effects make it easier to understand the concepts conveyed. (9) Exercise questions on teaching materials strengthen understanding, getting a value of 93.33%. This value is obtained because not all students strongly agree with the statement. In class XI, they had difficulty in solving some questions on the quiz, but in the end they found the correct answer for each question. (10) Students like this teaching material based on Android, getting a value of 90%. This value is obtained because most students strongly agree with the statement, although there are still students who only check the agreed column because they are still not accustomed to using this type of teaching material. From the percentage data, an average percentage of questionnaire data was obtained which is 94%, which showed that the teaching materials of arithmetic sequence and series based on Android for PBL developed by researcher were included in very practical criteria.

Based on the test result of teaching materials at the small group stage, it can be concluded that the use of teaching materials arithmetic sequence and series based on Android for PBL developed by researcher in accordance with the result of research states that learning with PBL can foster students' learning motivation and actively working together in groups to solve problem are given [15, 16]. In addition, the results of this research are also in accordance with the results of previous research which states that learning by using Android can improve students' learning motivation because the material is packaged in an interesting applications so that can make it easier for students to understand the material being taught and can support the learning process independently in outside the classroom [20, 21, 23].

4. Conclusion

Based on the analyze of the data that has been done above, it can be concluded that the teaching materials of arithmetic sequence and series based on Android for PBL developed by researcher are in accordance with characteristics that are categorized as valid and practical. Declared valid based on the results of the validator's assessment of the aspects of content, constructs and language in teaching materials and declared practical based on the percentage of observational data and questionnaires which scored 96% and 94% which are categorized as very practical.

5. Acknowledgments

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