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Development of Android-Based Linear Program Teaching Materials with an Ethnomatematics Approach to Improve Students' Mathematical Problem Solving Ability

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Abstract

This study aims to determine process of developing teaching materials for android-based linear programming with an ethnomathematics approach that was valid, practical, and effective to improve students' mathematical problem solving abilities. This study uses research and development (R&D) methods with modifications to the ADDIE model developed by Dick and Carry Analysis, Design, Development or Production, Implementation and Evaluation. Data collection using test techniques and non-test techniques. The data analysis technique used a Likert scale, Guttman scale, one-sided average s test, proportion test, and N-Gain test.The results showed that the teaching materials had very valid criteria with an average percentage of material validity test of 93.84% and media validity test of 86.67%, very practical with an average practicality test of 90%, and effective for improving mathematical problem solving skills. students which include: (1) mathematical problem solving abilities of students who are taught using teaching materials meet individual mastery; (2) the proportion of completeness of students' mathematical problem solving ability test results after using teaching materials is more than 80% so as to achieve classical mastery. (3) based on the results of the pretest and posttest showed that the teaching materials were able to improve students' mathematical problem solving abilities where the average posttest score was greater than the average pretest score with an N-Gain result of 0.5659 on medium criteria. So, it can be concluded if the teaching materials are valid, practical, and effective so that they are feasible to be used in learning mathematics to improve students' problem solving abilities.

1. Introduction

Education is one of the efforts to realize the goals of the Indonesian nation, namely educating the nation's life, in accordance with the national education goals stated in Law Number 20 of 2003, education is an effort to create a learning atmosphere that has a role in increasing expertise and shaping the civilization of a nation. so that they can develop their potential who are spiritually competent, have noble character, maintained their health, are knowledgeable, and are capable and skilled in the life of society, nation and state (Depdiknas, 2008). The educational process must be managed properly in order to get good results maximum because education plays a fundamental role in the formation of the quality of human resources that will compete globally (Anwar, 2020).

Mathematics is one of the lessons that is always present at every level of education in Indonesia from elementary school to high school in accordance with the curriculum used in Indonesia today, namely the 2013 curriculum. Cockrof (1986) stated several reasons for the importance of learning mathematics, is mathematics is always used in all aspects of life where all fields of research require mathematical skills; mathematics is a strong, concise, and clear communication tool; mathematics can be used to present data in a variety of methods; mathematics improves logical thinking skills, accuracy, and understanding; and mathematics can provide satisfaction in solving complex problems. Friansah & Luthfiana (2018) stated

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that mathematics is one component of a series of subjects that have an important role in education. Mathematics is a subject with abstract content so it is difficult for students to understand (Maulyda et al., 2019).

The National Council of Teachers of Mathematics (NCTM) has set five standard abilities that students must have in learning mathematics, namely problem solving skills, reasoning abilities, communication skills, and connection skills, and the ability to represent (Hutagaol, 2013). Trends in International Mathematics and Science Study (TIMSS) is an international study conducted by the IEA (International for the Evaluation of Educational Achievement) since 1955 and is conducted every four years. The results of the 2015 TIMSS international survey, Indonesia again participated in TIMSS with 53 participating countries as participating members. Indonesia is ranked 9th with the acquisition of 397 points. Based on the results of the TIMSS survey (2015) Indonesia has a percentage of mathematical problem solving abilities that are still below international standards. According to the results of research at TIMSS, students' mathematical problem solving abilities are still low, which is reinforced by the reality at school (Darmawan & Ramlah, 2021). This shows that students' problem solving abilities are still lacking (Rahim & Roesdiana, 2021). This statement is in line with the results of research (Hidayat and Sariningsih, 2018) which states that students' mathematical problem solving abilities are still low.

Problem solving ability is one of the components that must be possessed by students in learning mathematics. Problem solving is a very important part of learning, especially mathematics, where it is positioned as an integral part and cannot be separated from a learning goal (NCTM, 2000). Introducing the principles of problem solving in mathematics learning must be done early so that problem solving as a basic activity can be carried out well by students, which can further have implications for solving problems in their daily lives. The low ability of students to solve mathematical problems will reflect the low human resources (HR) of students due to the lack of opportunities to develop problem solving abilities given to students (Cahyani & Setyawati, 2016). Students have the opportunity to learn and understand mathematics better if they can solve mathematical problems where in learning at school, problem solving becomes the focal point in the teaching and learning process (Kharisma & Sugiman, 2017). The mathematical ability that will be focused on the development of this teaching material is the ability to solve mathematical problems.

Regulation of the minister of education and culture no.37 of 2018 states that linear programs are included in basic competencies in mathematics subjects for class XI of senior high school and equivalent, precisely contained in Basic competencies 3.2 and 4.2 which can be applied in various fields in the real world such as health, economy, industry, etc. One of the uses of linear programming is to find the maximum income and minimum expenditure so that the maximum profit is obtained. Many students have difficulty in understanding linear programming material. Ariawan et al (2017) stated that the low mastery of linear programming material was caused by several things, including learning using the traditional method, namely lectures, lack of appropriate learning support materials, low student interest in learning mathematics, and limited hours of mathematics lessons where in linear programming it takes a lot of time to solve the problem.

The importance of mathematics in life requires educators to change the mindset of students from scary mathematics to fun mathematics by changing the learning process from conventional to more up-to-date, starting from choosing the right teaching materials so that students are interested and enthusiastic in learning it. Teaching materials are aspects that play an important role in learning. The attachment of Minister of National Education Regulations No 16 of 2007 concerning Academic Qualification Standards and Teacher Competencies, also regulates the competencies that educators must have, both core competencies or subjects for teachers at the learning unit level at the secondary school level in the form of pedagogic or professional competencies, closely related to the expertise of teachers in improving learning resources and teaching materials. Learning resources or learning materials used must be efficient and selective and appropriate for the subject or material being taught (Oktaviana & Prihatin, 2019).

Teaching materials have the meaning of all forms of material (written or unwritten), helping teachers/instructors in teaching and learning activities. (Depdiknas, 2008). Fikriani & Nurva (2020), teaching materials mean materials that are arranged systematically and used to help teachers carry out teaching and learning activities that create an atmosphere that allows students to learn well. Various teaching materials will certainly provide benefits, namely the creation of more interesting learning for students (Ahmadi & Amri, 2014). The lack of innovation in teaching materials makes students less

enthusiastic in participating in learning. For this reason, innovative teaching materials are needed and attract students' interest to learn them.

The results of a pre-research interview conducted at SMA Negeri 1 Bergas on February 26, 2021 with Mrs. Ajeng Mukti Andhini S.Pd as a mathematics teacher for class XI MIPA showed that the previous mathematics learning process was carried out by providing material in the form of a brief explanation from the teacher in front of students with whiteboard media and Microsoft Power Point connected to an LCD projector, followed by practice questions with teaching materials in the form of textbooks from the government and accompanied by student worksheets. The learning carried out turned out to be less interesting for students to learn. Students are less enthusiastic in learning and prefer to use smartphones because it looks more attractive and flexible to use anytime and anywhere, in contrast to print-based textbooks which seem complicated and less up-to-date. Alternative teaching materials are needed so that students are interested in learning them.

This is in line with the research results of Nalurita et al. (2019) which states that currently, students also need learning other than books which not only present material but are accompanied by relevant examples that match the subject matter so that while studying students will enjoy and understand the material well. The existence of student interest in learning will be directly proportional to the increase in problem solving abilities and student achievement. With students having interest, knowledge, willingness, ability related to understanding, then efforts to optimize problem solving can be achieved.

In the 21st century, technology is developing rapidly in various parts of the world. The use of smartphones is increasing day by day. Life cannot be separated from smartphones, starting from social, economic, legal, health and education. Heriyanto (2014) as quoted by Nasution et al (2017) states that the use of smartphones is very widespread among teenagers. Smartphones are no longer seen as goods in the tertiary need group among students (Martono & Nurhayati, 2014). The massive use of android in everyday life can be used by teachers to develop learning that is supported by smart phones or based on android (Zahid, 2018). Development is needed by utilizing these technological advances to facilitate learning, one of which is by making teaching materials with the concept of m-learning (Mobile learning) with a smartphone as a device for its development.This is in line with the research results of Nalurita et al. (2019) which states that currently, students also need learning other than books which not only present material but are accompanied by relevant examples that match the subject matter so that while studying students will enjoy and understand the material well. . The existence of student interest in learning will be directly proportional to the increase in problem solving abilities and student achievement. With students having interest, knowledge, willingness, ability related to understanding, then efforts to optimize problem solving can be achieved.

M-learning developed in this smartphone was developed based on Android. Android is a Linux-based operating system, designed as an operation for devices with touch screens such as tablet computers and smartphones. Android-based teaching materials are the development of conventional teaching materials into teaching materials with the use of technology in it. The results of the observations show that there is no android-based teaching material used in the school. Mrs. Ajeng, as a mathematics teacher, strongly supports the development of modern and practical teaching materials, including the development of these Android-based teaching materials. These teaching materials are expected to make students interested and enthusiastic to learn so that they get good results and can use smartphones wisely in a positive way.

The influence of globalization is also increasingly widespread in the 21st century in addition to technological advances. Globalization is like two sharp blades where on the one hand it has a positive influence on technological developments and on the other hand it also erodes existing culture. The absence of efforts to reduce the erosion of culture is feared that the younger generation will increasingly forget the culture that is the identity of their nation, it is necessary to provide an understanding of the culture. Indonesian students learn about Indonesian culture through History, Cultural Arts and Social Sciences lessons, whereas students can learn culture through mathematics (Friansah & Luthfiana, 2018).

Wahyuni & Etfita (2020) said that cultural values are the foundation of the nation's character which is important to be instilled in every individual, for this cultural values need to be instilled from an early age so that every individual can understand, interpret, & appreciate and be aware of the importance of cultural values in society. when carrying out every activity in the phases of life either directly or indirectly that utilizes concepts in mathematics or known as ethnomathematics. Putri as quoted by Friansah & Luthfiana (2018), ethnomathematics is an approach that can be used to explain the reality of the relationship

between environmental culture and mathematics as a family of science. Combining culture and mathematics in learning is expected that students can more easily understand the concepts of learning, especially in mathematics subjects with linear programming material. The values of the surrounding culture can also be understood and implemented more easily in students.

The problems above gave rise to the idea of making linear programming teaching materials by utilizing Android-based technology for smartphones in high school mathematics learning by linking them to culture implemented in research with the title "Development of Android-Based Linear Program Teaching Materials with an Ethnomathematical Approach to Improve Students' mathematical problem solving ability". Expectations from the development of Android-based mathematics teaching materials with an ethnomathematical approach are valid, practical and effective so that they are feasible to use to improve problem solving skills in mathematics.

2. Methods

This research uses research and development (R&D) methods. Sugiyono (2015) suggests "Research and Development is a research method used to produce certain products and test the effectiveness of these products". The subjects of this study were 3 material experts, 3 media experts, 2 mathematics teachers, 16 students of class XI MIPA 2 instrument testing, 20 students of class XI MIPA 4 small-scale trials, and 36 students of class XI MIPA 3 for large-scale trials.

The research development procedure in this study is a modified ADDIE model developed by Dick and Carry in 1996 and consists of Analysis, Design, Development or Production, Implementation or Delivery and Evaluations (Evaluation). The ADDIE model can be used in various models, learning strategies, media and teaching materials (Aziz & Prasetya in Kurnia et.al, 2019). The development of the ADDIE Model for further development is often used in the development of teaching materials such as modules, worksheets and textbooks (Cahyadi, 2019).

Data collection techniques in this research used test techniques and non test technique include: interviews, observations, validation questionnaires for product validity, response questionnaires for product practicality, and questions to measure students' mathematical problem solving abilities. Product validity was measured through a validation questionnaire. The evaluation results from experts were measured using a validation instrument with a Likert scale for data in the form of numbers that could be analyzed using a formula based on Arikunto's (2003) research:

$$P = \frac{\sum x}{\sum x_i} \times 100\% \quad (1)$$

P =validity percentage, $\sum x$ = Total score (total ideal score) or number of items, and $\sum x_i$= Total score from validator's answer. The validity criteria of the teaching materials developed by consulting the percentage of validity (P) based on Indrianti (2020) with the following table.

Table 1 Qualification of the Validity of Teaching Materials

Percentage	Qualification
$\mathbf{84\% < P \leq 100\%}$	Very valid
$\mathbf{68\% < P \leq 84\%}$	Valid
$\mathbf{52\% < P \leq 68\%}$	Quite valid
$\mathbf{36\% < P \leq 52\%}$	Less valid
$\mathbf{20\% < P \leq 36\%}$	Very Less valid

Teaching materials must be revised when the percentage of validity is less than 69% to become a teaching material with at least a valid qualification.

Product practicality is measured using a user response questionnaire using the Guttman scale, which can be analyzed based on Sugiyono (2015) as follows.

$$k = \frac{\sum \frac{The\ number\ of\ scores\ that\ can\ be}{\max score}}{n} \times 100\% \quad (2)$$

$k =$ Average user response, and $n =$ many students. The level of practicality of the teaching materials developed by consulting the percentage of the average user response (x) based on Hamidah et al (2020) with the following table.

Table 2 Qualification Level of Practicality of Teaching Materials

Percentage	Qualification
$\mathbf{81\% < k \leq 100\%}$	Very practical
$\mathbf{61\% < k \leq 80\%}$	Practical
$\mathbf{41\% < k \leq 60\%}$	Quite Practical
$\mathbf{21\% < k \leq 40\%}$	Less practical
$\mathbf{0\% < k \leq 20\%}$	Impractical

Teaching materials must be revised if the percentage of practicality is less than 61% so that it becomes a teaching material with at least classified as practical criteria.

The effectiveness of the product can be determined by testing the use of teaching materials developed using the One-Group Pretest-Posttest Design experimental design. Teaching materials are considered effective to improve students' mathematical problem solving abilities if they meet: (1) individual mastery; (2) classical completeness; and (3) an increase in the average score of students' mathematical problem solving abilities before the use of teaching materials (pretest) and after the use of teaching materials (posttest) with the N-Gain test based on Hamidah (2020) with the following formula:

$$N - Gain\ (g) = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \quad (3)$$

The criteria for increasing students' mathematical problem solving abilities can be known by consulting the *N-Gain (g)* with the following table.

Table 3 Criteria for Improving Students' Mathematical Problem Solving Ability

Coefficient interval	Criteria
$\boldsymbol{g < 0,3}$	Low
$\mathbf{0,3 \leq g < 0,7}$	Medium
$\boldsymbol{g \geq 0,7}$	High

3. Result & Discussions

3.1 Analysis

The development of this Android-based teaching material goes through several stages. The analysis phase begins with a literacy study. Indonesia has a percentage of mathematical problem solving abilities that are still below international standards. In the opinion of Ulvah quoted by Putra, et al. (2018) that students who are actively involved in the learning process have better problem solving abilities than students who are not involved in learning. The existence of student interest in learning will be directly proportional to the increase in problem solving abilities and student achievement (Nalurita et al, 2019). The student's interest can be realized through the use of teaching materials that will be developed so that they can improve their mathematical abilities, especially problem solving abilities.

The massive use of android in everyday life can be used by teachers to develop learning that is supported by smart phones or based on android (Zahid, 2018). The android application comes in the form of animation with text and images that can improve the experience, understanding, interest, and attention of students towards learning material. Research on ethnomathematical nuanced learning conducted by Supriyanti, et al (2015) resulted in students' problem solving abilities with ethnomathematical nuances achieving completeness and student process skills and students' love of local culture affect problem solving abilities.

These results are in accordance with the results of pre-research activities carried out at SMA Negeri 1 Bergas which showed students' ability to solve mathematical problems was still low because the teaching materials used were still limited, less innovative, less interesting, so that innovative and more practical teaching materials were needed, used anytime and anywhere. The above study is the basis for

developing Android-based teaching materials with an ethnomathematical approach to linear program material for class XI of senior high schools according to the approval of teachers and students, a research was conducted that aimed to develop teaching materials for android-based linear programming with an ethnomathematical approach to improve students' mathematical problem solving abilities. Literacy studies began to be carried out as a support in the development of the material contained in the teaching materials so that they were in accordance with the applicable basic competencies.

3.2 Design

The design starts from product design in the form of making flowcharts, designing prototypes that are used as guidelines in making teaching materials, making interface designs using Articulate Storyline 3 software and instruments used to test teaching materials. An example of the display of teaching materials is shown in the following Figure.

a. b. c.

Figure 1. (a) start page; (b) login page; (c) Menu

3.3 Development

The development stage is in the form of making applications based on the design stage. The previously created interface design will be formatted from *html5* to an *.apk* extension that can be installed in the android application using *Website 2 APK Builder*. The appearance of the Etnoproline application is not much different from the previous design. The logos for the Etnoprolin teaching materials that have been developed are as follows.

Figure 2. Etnoprolin teaching materials logo

The teaching materials that have been developed are then validated. The purpose of this validation is to evaluate the validity of ethnoproline teaching materials both in terms of material and media. The material validity test in this study was carried out by one lecturer and two teachers using a validation sheet that contained three aspects of the assessment, namely the aspect of material competence, the suitability of the material, and the language aspect. The results of the analysis obtained stated that Ethnoproline teaching materials met the validity standards of teaching materials with the acquisition of a material validation score for the ethnoproline application of 93.84% so that it met the material validity standards for teaching materials with very valid criteria based on the Indrianti (2020) criteria scale. The media validator consists of one lecturer and two teachers using a validation sheet that contains three aspects of the assessment, namely the suitability aspect, the display aspect, the usage aspect, and the superiority aspect. The results of the analysis obtained stated that the Ethnoproline teaching materials met the validity standards of teaching materials with the acquisition of a media validation score for the

ethnoproline application of 86.67% so that it met the media validity standards for teaching materials with very valid criteria based on the Indrianti (2020) criteria scale.

3.4 Implementation

The implementation stage is carried out when the results of the teaching materials to be applied have been declared valid. The implementation phase consists of teacher assessments, test instrument trials, small-scale trials (limited) and large-scale trials (field trials). The results of the implementation phase are used to measure the practicality and effectiveness of teaching materials.

3.4.1 The Practicality of Teaching Materials

The practicality of teaching materials is seen based on the results of teacher response questionnaires and student response questionnaires both in small group trials and large group trials. The teacher response questionnaire was given after completing the validation test given to two math teachers in class XI MIPA. The average practicality score obtained is 90% with a very practical category based on the Hamdiah (2020) criteria scale so that teaching materials can be tested on students.

Testing the practicality of teaching materials for students is carried out in two stages, namely for small groups followed by 20 students from class XI MIPA 4. The level of practicality of teaching materials individually gets the lowest percentage of 87% and the highest percentage of 100%. The average of the results of small-scale student questionnaires is in the percentage of 93%. The results of the
students of class XI MIPA 3 is 90% with the level of practicality individually the lowest percentage is 80% and the highest percentage is 100%.

The assessment of the percentage of practicality both classically and individually can be said if the teaching materials are classified as very practical criteria based on the Hamdiah (2020) criteria scale. These results are in line with the results of research conducted by Sari & Hapizah (2020) which states that android-based teaching materials can increase students' practicality values based on questionnaires given to respondents.

3.4.2 The Effectiveness of Teaching Materials

The effectiveness of ethnoproline teaching materials in terms of students' individual mastery (value $>$ 74.9) , classical completeness more than 80%, and an increase in students' mathematical solving ability at least in the medium category (*n-Gain* $\geq$ 0.03). The research data for the effectiveness test was obtained through a pretest, namely a test conducted before the use of Ethnoproline teaching materials and a posttest, namely a test conducted after the application of Ethnoproline teaching materials. Testing the effectiveness of teaching materials was carried out in 2 different stages, namely a small-scale test with 20 samples from class XI MIPA 4 and a large-scale trial from 36 samples from class XI MIPA 3.

1) Individual Completeness Test Result

The average mathematical solving ability of students after using android-based linear programming teaching materials with an ethnomathematical approach is more than 74.9 (Minimum completeness criteria $=$ 75). The working hypothesis formulated for statistical testing purposes is as follows.

$H_0: \mu \leq 74.9$

$H_1: \mu > 74.9$

The results of the analysis of individual mastery tests after the application of Ethnoproline teaching materials (posttest) for small and large-scale groups that were carried out previously were explained to have met the normality test which is a prerequisite test before testing the hypothesis with a Sig value. *Sig. (2-tailed)* of 0.200 so that more than $\alpha = 0.05$. The data is normally distributed so that it can be continued with the *One Sample T- Test* to measure individual completeness. The test results show that the value of Sig. (2-tailed) for small-scale and large-scale trials get the same result, which is 0.000. Based on the probabilistic approach, it is clear that the value of Sig. (2-tailed) < 0.05 so the hypothesis H_0 is rejected and accept H_1. The t_{count} value obtained in the small-scale trial is 5.002, while the t_{table} value with probability $(1-\alpha) = 1 - 0.05 = 0.95$ and $dk = (n-1) = (20-1) = 19$ *is* 1.729 so H_0 is rejected. The average mathematical problem solving ability of students after using android-based linear programming teaching materials with an ethnomathematical approach on a small-scale trial is 83.75 so that more than 74.9, can be interpreted as having reached the minimum completeness limit on average

and has been tested with probabilistic approach as well as with the classical approach. The t_{count} value obtained in the big-scale trial is 9.222, while the t_{table} value with probability $(1-\alpha) = 1 - 0.05 = 0.95$ and $dk = (n-1) = (36-1) = 35\ is\ 1.6896$ so H_0 is rejected. rejected So the average mathematical problem solving ability of students after using android-based linear programming teaching materials with an ethnomathematical approach has been tested more than 74.9, statistically the average mathematical problem solving ability of students is good on small-scale trials as well as in large-scale trials of more than 74.9 with a minimum completeness criteria score of 75. The results of this study are in line with research by Nurliastuti (2018) that the application of an ethnomathematical approach can improve students' individual mathematical problem solving abilities.

2) Classical Completeness Test Result

The proportion of completeness test results of students' mathematical problem solving abilities after using android-based linear programming teaching materials with an ethnomathematical approach is more than 80%. The working hypothesis formulated for statistical testing purposes is as follows.

$H_0: \pi \leq 80\%$

$H_1: \pi > 80\%$

Classical completeness testing of posttest scores was carried out using the z-test (Mattjik & Sumertajaya, 2002). The Z_{count} for classical completeness value for classical completeness data in small-scale trials is 1.677more than Z_{table} which is 1,64 with $\alpha = 0.05$, so reject H_0 and accept H_1 Large-scale testing Z_{count} for classical completeness data is 2.1779 more than Z_{table} which is 1.64 with $\alpha = 0.05$, so reject H_0 and accept H_1 so that it is obtained that the percentage of classical completeness of students' mathematical problem solving abilities in large-scale trials is more than 80%. The proportion of completeness of students' mathematical problem solving ability test results after using android-based linear programming teaching materials with an ethnomathematical approach is more than 80%. So, the proportion of students who score more than the Minimum completeness criteria is more than 80% of the total number of students. These results are in line with Wiska et al (2020) which states that the development of ethnomathematical integrated teaching materials is able to improve students' mathematical problem solving abilities classically.

3) Test Results for Increasing Mathematical Problem Solving Ability *(N-Gain Test)*

Rata – rata skor gain ternormalisasi setelah penggunaan bahan ajar program linear berbasis android The average gain score normalized after the use of android-based linear programming teaching materials with an ethnomathematical approach is more than 0.299 (increasing students' mathematical problem solving abilities at least in the medium category ($g \geq 0.3$). The working hypothesis formulated for statistical testing purposes is as follows:

$H_0: \mu_g \leq 0.299$

$H_1: \mu_g > 0.299$

The N-Gain test is used to determine the increase in students' mathematical solving abilities based on the scores before the use of Ethnoproline teaching materials (pretest) and after the use of Etnoprolin teaching materials (posttest) (Sundayana, 2015). The N-Gain test was carried out using the *One Sample T Test* formula with a variable in the form of a normalized gain score. The test results on the small-scale test show that the value of *Sig. (2-tailed)* on a normalized Gain of 0.000. It is clear that the value of *Sig. (2-tailed)*< 0, *so hypotesis* H_0 is rejected H_1 is accepted. So the average gain score normalized after the use of android-based linear programming teaching materials with an ethnomathematical approach is more than 0.299. The increase in students' mathematical problem solving abilities which is seen in the normalized gain gets an average of 0.597 (small-scale trial) and 0.5659 (large-scale trial) is in the medium classification. ($0.3 \leq g < 0.7$). The results of this study are in line with the research of Sari & Sumulistiana (2018) which states that the use of teaching materials is in the form of an Android-based Mobile Learning application. can make students' N-Gain increase.

3.5 Evaluation

This stage consists of reflection on implementation and revision of teaching materials based on the results of implementation reflection. The implementation reflection stage is carried out to review the obstacles that arise during implementation both from students and from teachers, as well as to analyze the

results of student assessments. The data obtained is used to improve the teaching materials that have been designed, so that valid, practical and effective teaching materials are obtained for use in learning mathematics.

The results of the data analysis that have been described previously, the results show that the criteria for validity, practicality, and effectiveness of teaching materials have been met. So, it can be concluded if the teaching materials are feasible to be used in learning mathematics to improve students' problem solving abilities.

4. Conclusion

The results of research and development that have been carried out, it is concluded that android-based linear programming teaching materials with an ethnomathematical approach are of good quality and are suitable for use because of innovations in the use of technology and the implementation of cultural approaches in mathematics teaching materials and supported by the following reasons: (1) The process of developing linear programming teaching materials in the form of learning applications that can be installed on smartphones with the Android operating system and linking them in culture using the development of modified ADDIE models. (2) The android-based linear programming teaching materials with an ethnomathematical approach that were developed met the standards of the validity of teaching materials with the acquisition of a material validation score of 93.84% and the acquisition of a media validation score of 86.67% so that they met the standards of material validity for teaching materials with very valid criteria. (3) Android-based linear programming teaching materials with an ethnomathematical approach get very practical criteria after testing in three stages with an average percentage of practicality obtained from teacher assessments of 90%, classical percentages based on questionnaires from the small-scale trial stage of 93%, and percentages of classical as much as 90% obtained from the large-scale trial phase. The assessment of the percentage of practicality both classically and individually can be said if the teaching materials are classified as very practical criteria. (4) Android-based linear programming teaching materials with an ethnomathematical approach are effective for improving students' mathematical problem solving abilities based on individual mastery, classical mastery is more than 80%, and increasing students' mathematical solving abilities with the results obtained in large-scale trials of 0.5659.

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