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Developing LKS Using a Realistic Approach to Improve Students' Mathematical Problem-Solving Abilities

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Abstract

This study aims to produce LKS with a realistic approach to improve the problem-solving abilities of high school students in grade XI of linear programming material that meet the criteria of valid, practical, and effective. This study uses the ADDIE model, which goes through five stages: analysis, design, development, implementation, and evaluation. The subjects of this study consisted of 32 students in grade XI IPA 1 of SMA Negeri 6 Medan. The results of the study show: (1) The results of the LKS validation assessment based on material experts and media experts are both 85.07% included in the "very valid" category. The results of the validation assessment based on the teacher response questionnaire are 86.81% included in the "very valid" category, and based on the student response questionnaire, 87.5% are included in the "very valid" category. (2) The results of the practicality data analysis are the readability of the LKS that have been developed, with the average results showing that ≥70% are included in the "practical" category, but there are suggestions and input from students. The results of the practicality analysis based on the teacher's response questionnaire obtained a percentage of 85% included in the "very practical" category, and based on the average response questionnaire of class XI IPA 1 students, 88% were included in the "very practical" category; (3) The results of the effectiveness data analysis are the results of the student's post-test percentage of 87.5%, which means it is effective so that problem-solving abilities increase, and the N-Gain value of 0.63, or the "medium" category, is said to be effective.

Keywords: *LKS; Realistic Approach; Problem Solving; Linear Program*

Introduction

Education is crucial in preparing human resources for development. The quality of a nation's education influences future change and progress. Mathematics is a field of study that supports the development of science and technology, particularly in problem-solving. Mathematics continues to evolve over time, making it theoretical and abstract. Learning mathematics involves more than just memorizing formulas; it involves thinking about solving problems to find solutions using the concepts and steps identified. Polya (1973:5) stated that "problem-solving is an effort to find a way out of a goal that is not easily achieved."

According to Hasratuddin (2018:107-111), there are four phases that are indicators in the formation of problem-solving abilities, namely (1) Understanding the Problem, (2) Making a problem-solving plan (Devising a Plan), (3) Carrying Out the Plan, and (4) Checking the Correctness of the Solution (Looking Back). According to Ahmad (2017), problem-solving ability is a mathematical skill that is very important for students to master. According to Lestari (2017) that in learning mathematics, there are some students who consider that mathematics is a science which is very difficult to be learned is learning mathematics, there are some students who think that mathematics is a science that is very difficult to learn.

Improving the quality of learning must begin with improving learning design. Teachers need to strive to improve students' problem-solving abilities by choosing applicable and engaging approaches that can engage students in learning. According to Hernawati (2016), the use of the word "realistic" does not merely indicate a connection to the real world but rather refers to the focus of RME in placing emphasis on the use of situations that can be imagined by students. Realistic mathematics learning has the advantage that students construct their own knowledge so they do not easily forget the material, understand the benefits of learning mathematics, and provide opportunities for students to reconstruct mathematical concepts so they can solve problems in mathematics. The process of improving mathematical problem-solving abilities requires students to practice a lot. This affects teachers or schools that use printed worksheets that are less innovative and effective so that some students are not interested in learning them. These worksheets also do not develop students' mathematical problem-solving abilities.

According to Hidayanti (2016), Student Activity Sheets (LKS) are printed teaching materials in the form of sheets of paper containing material, summaries, and instructions for implementing learning tasks that must be done by students, referring to the basic competencies that must be achieved. The advantages of using LKS include being able to increase student learning activities, encourage students to be able to work independently, and guide students well towards developing concepts (Majid,2013). According to Salirawati (2014:3), the existence of LKS has a significant influence on the teaching and learning process, so the preparation of LKS must meet various requirements, namely didactic requirements, construction requirements, and technical requirements.

Based on the problems with the solutions explained, the researcher conducted research and development of LKS with a realistic approach to improve the mathematical problem-solving abilities of grade XI high school students on linear programming material.

Method

This study uses the ADDIE Research and Development (R&D) method, which goes through five stages, namely: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The field test subjects consisted of 32 students of class XI IPA 1 of SMA Negeri 6 Medan. The instruments used in this study consisted of (1) a validity measurement instrument, namely a validation sheet; (2) a practicality measurement instrument, namely a practicality sheet; and (3) an effectiveness measurement instrument, namely a problem-solving ability test.

This validity analysis aims to determine the level of validity of LKS using the developed realistic approach. The validated instruments include products by material experts and media experts, problem-solving ability tests, teacher and student practicality sheets, and observation sheets for learning implementation. A research instrument is considered valid if it meets at least the "quite valid" criteria. Table 1 shows the validity criteria for the product.

Table 1. Product validity criteria

Range	Category
85,01%-100%	Very Valid
70,01%-85%	Quite Valid
50,01%-70%	Less Valid
01,00%-50%	Invalid

Source: (Fatmawati, 2017:96)

This practicality analysis was conducted to determine the practicality level of the product being developed. The practicality level was obtained from the results of the learning implementation observation sheet and the product practicality assessment sheet completed by the teacher and students. A research instrument is considered practical if it meets at least the "practical" criteria. Table 2 presents the practicality criteria for the product.

Table 2. Practicality Criteria

Range	Category
$80\% \leq X < 100\%$	Very Practical
$60\% \leq X < 80\%$	Practical
$40\% \leq X < 60\%$	Quite Practical
$20\% \leq X < 40\%$	Less Practical
$0\% \leq X < 20\%$	Impractical

Source: (Arikunto, 2013:266)

The effectiveness analysis is reviewed from the purpose of its creation to improve students' problem-solving abilities. The effectiveness criteria for the problem-solving ability aspect in this study are (1) calculating the average increase in pre-test and post-test scores of problem-solving abilities and (2) calculating the N-Gain value on the LKS, which is effective if the minimum value is ≥ 0.60 or the "medium" category. Table 3 is the effectiveness criteria of the product.

Table 3. Effectiveness Criteria

Range	Category
$g \geq 0{,}70$	High
$0{,}30 < g < 0{,}70$	Medium
$g \leq 0{,}30$	Low

Source: Nirmalasari (2016)

Results and Discussion

Results

Research using the ADDIE model developed worksheets with a realistic approach to improve the mathematical problem-solving abilities of eleventh-grade students in linear programming. The following is an explanation of the development of worksheets based on each stage of the ADDIE model.

Analysis Stage

The analysis stage includes needs analysis, student characteristics analysis, and curriculum analysis. The results of observations conducted at SMA Negeri 6 Medan using observation sheets filled out by teachers and students, as well as interviews with mathematics teachers of class XI IPA 1, concluded that teachers and students use worksheets that do not only contain linear programming

material. This is because the worksheets are purchased from publishers and used for all class XI IPA in the school, usually several other schools that use the same worksheets, so they do not pay attention to the abilities of class XI IPA 1 students. An analysis of the characteristics of students accustomed to this teaching pattern is explained, along with example questions and practice questions. In general, current high school students born between 2006 and 2010 are Generation Z, requiring visual, interactive, problem-based learning that utilizes technology. The material analysis was conducted by adapting the curriculum implemented at SMA Negeri 6 Medan, which is the Merdeka Curriculum. The analysis was conducted by analyzing learning achievements into learning objectives and then developing a flow of learning objectives.

Design Stage

At this stage, the product to be developed begins to be designed to obtain an LKS with a realistic approach to improve students' mathematical problem-solving abilities. The design process involves selecting the appropriate format from compiling the LKS's cover, constructing a concept map, and compiling the LKS content with a realistic approach using linear programming material. The preparation of a learning implementation plan using the product and the instruments used. The stages carried out include assessment sheets, response questionnaires, grids, alternative answers, and scoring guidelines. The creation of test items to improve problem-solving skills. This study used Canva as the main media for creating LKS, saved in PDF format, then printed and given to teachers and students. The LKS consists of a cover, foreword, table of contents, concept map, exercise 1 (mathematical model), exercise 2 (set of solutions for a system of linear equations in two variables), exercise 3 (optimum value of linear programming), and a bibliography.

Development Stage

At this stage, the final product will be developed, validated, revised, and tested, as well as evaluated for its feasibility.

Product Validation

A product is considered valid if it can measure what it is supposed to measure. Expert validation is conducted to assess the appropriateness of the instrument used based on the opinions of experts or validators. The expert validation in this study was carried out by two lecturers from the Master of Mathematics Education study program at Yogyakarta State University and two mathematics teachers at SMA Negeri 6 Medan. The instruments whose validity was tested were the LKS product, teacher and student response questionnaires, and a problem-solving ability test. The validity analysis of the LKS was assessed by material experts and media experts. The results of the LKS validation assessment based on material experts and media experts were both 85.07% included in the "very valid" category. The results of the validation assessment based on the teacher response questionnaire were 86.81% included in the "very valid" category, and based on the student response questionnaire, 87.5% were included in the "very valid" category. The LKS is suitable for use because it meets the validity criteria.

Implementation Stage

A practicality analysis using a small-scale trial on a sample of seven students was conducted to determine the readability of the developed worksheets. The students commented on and provided feedback on the developed LKS in terms of content, language, and format, necessitating a review to mitigate weaknesses. A student response questionnaire was given to 32 students, and a teacher response questionnaire was given to a mathematics teacher who teaches in class XI IPA 1. An effectiveness analysis with a large-scale trial was conducted in class XI IPA 1 of SMA Negeri 6 Medan with 32 students on LKS. Effectiveness data was obtained from the results of the problem-solving ability test,

which can be seen from the results of the pretest and posttest, whether there was an increase or not. The trial was conducted in 5 meetings (including pre-test and post-test).

Evaluation Stage

The evaluation stage is the final stage in development research using the ADDIE model. The evaluation stage produces data on the practicality and effectiveness of the developed LKS.

Product Practically

The results of the practicality data analysis were obtained based on the results of a small-scale trial conducted to determine the readability of the developed LKS; the average results showed that ≥ 70% were included in the "practical" category, but students provided suggestions and input on the LKS. The results of the practicality analysis based on the teacher response questionnaire obtained a percentage of 85% included in the "very practical" category. The results of the practicality analysis based on the average questionnaire response of class XI IPA 1 students obtained 88%, included in the "very practical" category. It was concluded that the LKS with a realistic mathematics approach was helpful and made it easier for students to understand linear programming material.

Product Effectiveness

A product is considered effective if it meets established criteria. The indicator for measuring the effectiveness of LKS is the cognitive aspect, which aims to improve students' mathematical problem-solving abilities. The instrument was subjected to large-scale trials in the form of pre-tests and post-tests. The results of the effective analysis are in the form of (1) individual learning completion, where students are said to have completed if their mathematics score is ≥ 75, and (2) classical learning completion, where the pre-test and post-test scores are said to have been completed if the scores of all students who completed are ≥ 85%. The results of the LKS effectiveness analysis are presented in the following table 4.

Table 4. Results of the Effectiveness of the First Aspect

Individual Completion (student score ≥ 75)		**Information**		**Classical Completion Percentage (≥85%)**		**Information**	
Pre-test	***Post-test***	***Pre-test***	***Post-test***	***Pre-test***	***Post-test***	***Pre-test***	***Post-test***
10	28	Completed	Completed	31,25%	87,5%	Ineffective	Effective
22	4	Not Completed	Not Completed	68,75%	12,5%		
32	32	Number of Students		100%	100%		

Furthermore, the results of the effective analysis are in the form of (2) effective N-gain value results with a value of ≥ 0.60, or the "medium" category. The results of the LKS effectiveness analysis are presented in the following table 5.

Table 5. Results of the Effectiveness of the Second Aspect

Information	**Total**
Average pre-test results	73,16
Average post-test results	90,15
Average N-gain result	0,63
The improvement category of N-gain	Medium

Based on the analysis of effective data in the two tables, it is concluded that LKS with a realistic approach meets the effective criteria for improving students' problem-solving abilities.

Discussion

The results of the study showed that the percentage of students who completed the post-test was said to be effective at 87.5%, which means that problem-solving abilities increased. This finding is in accordance with the results of research conducted by Piaget, namely that high school students are included in the stage of cognitive development theory because students are able to develop abstract and formal thinking frameworks, are able to think logically regarding abstract data, are able to conduct analysis, are able to formulate hypotheses and test them, are able to build theories, and are able to conclude logically and systematically. Based on these findings, students are able to analyze the given problems and solve them according to the problem-solving steps contained in the LKS. This is in accordance with the findings by Nieveen (2007:94) that a high quality material referred to three quality criteria namely validity, practically and effectiveness, which means that a material is said to be of high quality if it meets three criteria, namely validity, practicality, and effectiveness. Based on these findings, the developed LKS are suitable for use by students and teachers in learning if all three criteria are met. Furthermore, research findings conducted by Haryonik (2018) showed that students liked the product developed when developing student LKS with a realistic mathematics approach, with 165 students scoring an average of 3.27 with a maximum score of 4.

Conclusion

Based on the results of the research and development of LKS, the following conclusions were obtained: The LKS employs a realistic mathematical approach to enhance the problem-solving abilities of grade XI high school students in linear programming. The steps are: LKS mathematics activities are designed based on the characteristics and principles of a realistic mathematical approach. LKS activities are carried out in groups consisting of 4-5 students and then completed with problem-solving steps, and student LKS is facilitated with various interesting images so that students are interested in learning the material. LKS with a realistic mathematical approach to improve the problem-solving abilities of eleventh-grade high school students on linear programming material are suitable for use in terms of validity. The validation results by material experts and media experts show that the LKS, teacher and student response questionnaires, and problem-solving ability tests are included in the "very valid" category. LKS with a realistic mathematical approach to improve the problem-solving abilities of eleventh-grade high school students on linear programming material are suitable for use in terms of practicality. The readability results of the LKS are included in the "practical" category, while the teacher and student response questionnaires show that the LKS are included in the "very practical" category. LKS with a realistic mathematical approach to improve the problem-solving ability of high school students in grade XI on linear programming material is suitable for use in terms of effectiveness. The results of the effectiveness data analysis are the results of the student's post-test percentage of 87.5%, which means it is effective so that problem-solving abilities increase, and the N-Gain value of 0.63, or the "medium" category, is said to be effective. Thus, it is concluded that LKS with a realistic mathematical approach for high school students in grade XI on linear programming material is effective in improving students' mathematical problem-solving abilities.

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