# DEVELOPMENT OF STUDENT WORK SHEETS TO TRAINREASONING AND PROOF MATHEMATIC ABILITIESON LINE AND ROW MATERIALS

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## ABSTRAK

Kemampuan matematis *reasoning and proof* menjadi hal yang krusial saat ini, terlebih pada tingkat pendidikan menengah, karena menjadi salah satu penunjang pada masa teknologi seperti sekarang. Tujuan dari penelitian untuk menghasilkan produk berupa LKS (Lembar Kerja Siswa) dan mengetahui kualitas LKS untuk melatih kemampuan matematis *reasoning and proof* pada materi barisan dan deret. Model pengembangan yang digunakan peneliti adalah ADDIE *(Analyze, Design, Development, Implementation,* dan *Evaluation*), namun pada pembuatan lembar kerja siswa ini peneliti hanya sampai pada tahap *development* atau pengembangan produk, mengetahui tingkat kevalidan dan tingkat kepraktisan lembar kerja siswa sebagai produk peneliti dengan menggunakan kuesioner untuk melihat kevalidan produk yang diisi oleh tim ahli, yakni ahli materi dan ahli produk. Sedangkan dalam mengukur tingkat kepraktisan, peneliti melihat respon siswa melalui google form. Berdasarkan hasil penelitian, dengan wawancara sebagai tahap *analyze*, mendesain produk sebagai tahap *design* dan tahap *development* dengan mengembangkan produk lembar kerja siswa.Pada kualitas produk lembar kerja siswa, ini mendapat hasil dari tim ahli materi 78,75% (dosen); 76,25% (guru), ahli produk 73,33% (dosen); 70% (guru) dan 71, 61% dari skor rata-rata 31 siswa. dilihat dari interpretasi data dapat disimpulkan bahwa produk valid dan praktis.

**Kata kunci**: ADDIE, LKS, *reasoning and proof*

## *ABSTRACT*

*The mathematical ability of reasoning and proof is crucial today, especially at the secondary education level, because it is one of the supports in today's technology. The purpose of this research is to produce a product in the form of student worksheets and to find out the quality of worksheets to practice mathematical reasoning and proof skills in the sequence and series material. The development model used by researchers is ADDIE (Analyze, Design, Development, Implementation, and Evaluation), but in making these student worksheets the researcher only reaches the development stage or product development, knowing the level of validity and practicality of student worksheets as research products with using a questionnaire to see the validity of the product filled out by a team of experts, namely material experts and product experts. Meanwhile, in measuring the level of practicality, researchers saw student responses via google*

*form. Based on the research results, with interviews as the Analyze stage, to design the product as the design stage and the development stage by developing student worksheet products. On the quality of student worksheet products, this resulted from a team of material experts 78.75% (lecturers); 76.25% (teachers), 73.33% product experts (lecturers); 70% (teachers) and 71, 61% of the mean score of 31 students. seen from the data interpretation, it can be concluded that the product is valid and practical.*
***Keywords**:* ADDIE, *worksheet, reasoning and proof*

## INTRODUCTION

Education is a process of obtaining new knowledge in which there is effort, influence, protection and assistance given to those who are educated. In the process of education, one must encounter arithmetic which is better known as mathematics. Since long time ago mathematics has become a scourge for most students, because mathematics is an abstract science, so many people consider mathematics to be a difficult subject and think for what it actually has mathematical abilities.

Mathematical ability is the student's ability to solve a mathematical problem in a logical and representative manner so that students are expected to be able to communicate these mathematical problems into something that can be understood for themselves and for others. NCTM formulates five basic mathematical abilities that are emphasized in students, the five mathematical abilities, namely, mathematical connection ability, mathematical modeling ability (representation), reasoning and proofing ability, mathematical communication ability, solving ability problem (problem solving).

In drawing conclusions to a mathematical problem, students need reasoning and proof ability to test the correctness of the answers to a problem. The reasoning ability of students who are less trained, causes students to identify problems and the process of concluding problems based on known facts is still low.

Reasoning according to The National Council of Teachers of Mathematics (NCTM) (2017: 2) argues that reasoning is a close component of arithmetic or mathematics. Intermediate students should hold the view that mathematics is concerned with examining patterns and noting regularities, making guesses about

possible generalizations, and evaluating guesswork. Meanwhile, according to Brodie and Kusnandi (2018: 26), "Mathematical reasoning is reasoning about and with the object of mathematics." The statement defines mathematical reasoning as reasoning about objects and with mathematical objects.

According to NCTM (2017: 391), reasoning and proof are very closely related. This means that it cannot be separated between teaching the ability of proof and reasoning (reasoning and proof). So that students when proving a problem can be accountable for every process they do. Developing the evidence is sometimes given through the problem. Reasoning is involved as reinforcing the results of proof that goes through the process of clarifying problem solving, in addition to strategic reasoning in solving problems is also needed, including simplifying problems, making tables or figures.

From the background of this problem, the researcher intends to develop student worksheets (student worksheets) on the line and series material. The first formulation of the problem, how is the development of worksheets to train mathematical reasoning and proof skills on the line and series material for grade VIII students of SMP Negeri 16 Pekalongan ?. The second formulation of the problem, how is the quality of the worksheets to train reasoning and proof mathematical skills on the line and series material for eighth grade students of SMP Negeri 16 Pekalongan in terms of validity and practicality ?.

Quoting from Borg and Gall (2003) “educational Research and Development (R&D) is an industry-based development model in which the findings of research are used to design new products and procedures, which then are systematically field-tested, evaluated and refined until they meet specified criteria of effectiveness, quality or similar standards. " The point is that development research has an industrial base, where this research finds a new product design and new procedures / procedures, then systematizes it in field testing, evaluation and refinement to find suitable benchmarks such as product effectiveness and quality.

Development research must produce a product. In the field of education, the products produced include learning media, worksheets (student worksheets), textbooks, modules or books.

The product produced in this study is in the form of student worksheets (LKS), according to Muhammad Yaumi (2018: 117) student worksheets (LKS) are a series of paper sheets whose contents are in the form of assignment sheets, learning steps or workmanship. Meanwhile, Trianto (2018: 147) suggests a simpler definition of worksheets, namely printed teaching materials that contain instructions and stages of completing tasks in the form of sheets.

Research conducted by AdityawarmanHidayat and IndraIrawan with the title of research on the development of RME-based worksheets with the Problem Solving Approach to Facilitate Students' Mathematical Problem Solving Ability in 2017. In the Journal of Scholar: Mathematical Teacher Journal In this journal, researchers use the ADDIE development model (Analyze, Design). , Development, Implementation, Evaluation), with this model inspires researchers to use the same development model.

The difference with this research is the basis of the worksheets to be produced. In this journal, the researchers produced worksheets based on RME and facilities for mathematical problem solving abilities, while this research was able to train students' mathematical reasoning and proof skills.

Research conducted by Assa Prima Sekarin with the title Development of Science Worksheets Based on a Scientific Approach for Class IV Students of Animal and Plant Body Forms and Their Functions in 2017. In this study, the products developed by the LKS were developed. From these products the researchers were inspired to develop student worksheets too, but in different subjects, materials and teacher levels.

The difference is the research subject, in Assa Prima Sekarin'sresearch the subject is elementary school students while the research thesis is junior high school. The development model chosen is also different.

The research was conducted by NurAtika and Zubaidah Amir MZ Education with the title of research on the Development of LKS Based on the Rme Approach to Develop Students' Mathematical Critical Thinking Ability. In Suska Journal of Mathematics in 2016. The similarity of this research journal with this research is the product developed in the form of worksheets and the development model used by ADDIE.

The difference is in the part of the variable that is intended for the product, in this journal the development of mathematical critical thinking skills, while the researcher's thesis is to train the mathematical ability of reasoning and proof. Another difference is the materials taken to produce the product.

Research conducted by YuliaFlorentyLamapaha with the title research Development of Student Worksheets Based on Scientific Reasoning Oriented Context. In the Journal of Mathematics and Science Teaching in 2017. The similarity of this research is the variable part to determine reasoning using tests, the difference is that this research only focuses on posttest. Then the resulting product is also the same, namely student worksheets (LKS). The reasoning variable section can be a reference for researchers to write a thesis.

The development model used by researchers is ADDIE (Analyze, Design, Development, Implementation, and Evaluation), but in making these student worksheets the researcher only reaches the development stage or product development, knowing the level of validity and practicality of student worksheets as research products with using a questionnaire to see the validity of the product filled out by a team of experts, namely material experts and product experts. Meanwhile, in measuring the level of practicality, researchers saw student responses via google form.

Table1.Data collection technique

| No. | Tester | Instrument | Subject |
|---|---|---|---|
| 1. | Ahli Materi | Angket | Mathematics lecture dan Teacher mathematics |
| 2. | Ahli Produk | Angket | Mathematics lecture dan Teacher mathematics |
| 3. | Students | *Google form* | 31 students of grade VIII |

The data analysis technique used to see the level of product validity is as follows:

$$\text{Level of validity} = \frac{\text{Score}}{\text{Total Score}} \times 100\%$$

Interpretasi data:

81% - 100% : Very valid

61% - 80% : Valid

41% - 60% : Enough valid

21% - 40% : Less valid

0 - 20% : Not valid

$$\text{Level of practicality} = \frac{\text{score}}{\text{Total Score}} \times 100\%$$

Interpretasi data:

81% - 100% : Very practical

61% - 80% : Practical

41% - 60% : Enough practical

21% - 40% : Less practical

0 - 20% : Not Practical

In processing data and describing data, using two data analysis techniques, namely qualitative descriptive analysis and quantitative descriptive analysis. In qualitative descriptive analysis, researchers used data analysis in the form of notes, suggestions or comments on the assessment results from questionnaire sheets from research subjects, observation sheets from observers and validation sheets from experts who have conducted expert tests on products that have been produced by the developer or researchers. Meanwhile, the quantitative descriptive analysis analyzes the data from the validation results, the results of the observations, the response questionnaires from the students. This data analysis is needed to determine the validity and quality of a product.

## DISCUSSION

The mathematical ability of reasoning and proof is crucial today, especially at the secondary education level, because it is one of the supports in today's technology. In training it, researchers develop student worksheets that aim to practice mathematical reasoning and proof skills.

This research and development produces teaching materials in the form of student worksheets to practice mathematical reasoning and proofing skills in the class VIII sequence and series material. The student worksheet that the researcher produced contains: (1) Cover page, (2) Introduction, (3) Table of contents, (4) Instructions for using student worksheets, (5) Basic

competencies and indicators using tables, (6) Material , the material has the following composition: material summary, student activity sheets and competency tests, (7) Bibliography. The composition of the student worksheets stated by the national teaching department that the worksheets are usually in the form of directions and ways to solve a problem / task that has been ordered on the activity sheet, the activity sheet must be clear so that it is easy for students to understand and clear the basic competencies they will achieve.

Student worksheets (LKS) developed by researchers through validation and practitioner tests conducted by a team of experts and student response retrieval. The following is an explanation of the stages carried out in research and development:

1. *Analyze*

This stage is the earliest stage for determining the products and materials to be developed. The review at this stage begins with a question and answer question to the mathematics subject teacher at SMP Negeri 16 class VIII who states that in learning mathematics at the school using teaching materials from the education department, other sources are used by the internet. Then learning in the classroom carried out by the subject teacher emphasizes on literacy. In gathering information and reviewing Basic Competencies (KD) in order to obtain material developed in teaching materials to practice mathematical reasoning and proof abilities, after that a literature study is carried out to collect material about sequences and series.

2. *Design*

The next stage is making research instruments in the form of material expert validation sheets, product experts and students' responses. Then design the cover and content of student worksheets that emphasize training in reasoning and proof mathematical abilities, according to the theoretical description that mathematical ability is the ability to solve mathematical problems in a logical and representative manner so that students are expected to be able to communicate these problems into something that can be understood for themselves and for others. .

The mathematical abilities discussed are the ability to reason and prove or reasoning and proof. This mathematical ability can be improved and trained with student worksheets that the researcher develops, with a simple, cheerful and specific cover design that shows directly the material discussed on student worksheets. The content of student worksheets is to train students 'mathematical abilities in reasoning and proof, the researcher presents student worksheets with views that can help students learn independently so that they are expected to train and improve students' mathematical reasoning and proof abilities.

3. *Development*

At this stage, the product is produced in the form of student worksheet teaching materials for row and series material for class VIII students. This student worksheet consists of a summary of the sequence and series material, student activity sheets to practice reasoning and proof and competency tests.

In the development stage, there is a validation stage for the expert team to find out whether the student worksheet that the researcher has developed is valid or not. Some comments from the expert team which then formed the student worksheets were getting better.

Mr. Muh. Yusron, S.Pd as the teacher who served as the deputy head of the curriculum stated that the cover of the student research worksheets seemed stiff, as shown below:


Figure1.Cover before revision

Then the researcher revised the cover, so that it pointed to the specific material discussed in the student worksheets and did not seem stiff. The cover has been revised in the following image:


Figure 2. Cover After Revision

Then the product expert commented, namely Mrs. JuwitaRini, M.Pd as a mathematics lecturer at IAIN Pekalongan who served as Secretary of the Mathematics Education Department and Mr. Muh. Yusron, S.Pd, a teacher at SMP Negeri 16 Pekalongan who serves as the Deputy Head of the Curriculum that there are no instructions on the use of student worksheets and basic competencies, so researchers improve by adding instructions for use and basic competencies to the developed student worksheets, along with a picture showing student worksheets has been revised according to the comments:

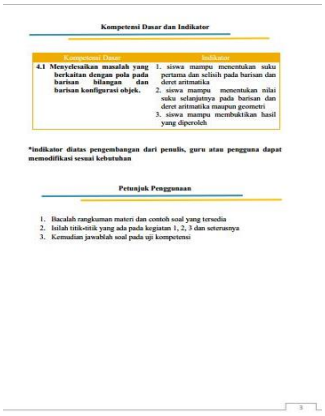


Figure 3. SK and KD

Next are the comments from product experts and material experts, namely Mrs. JuwitaRini, M.Pd as a mathematics lecturer at IAIN Pekalongan who serves as the secretary of the mathematics tadris department and Mrs. Santika LyaDiahPramesti, M.Pd, a mathematics lecturer at IAIN Pekalongan who serves as the head of the mathematics tadris department. that the font type and size have been improved and the reasoning and proof are more visible.

Student worksheets, before being corrected, the font type and size were not good, and the contents of the student worksheets had not yet highlighted reasoning and proof or reasoning and proof, along with the pictures before revision:

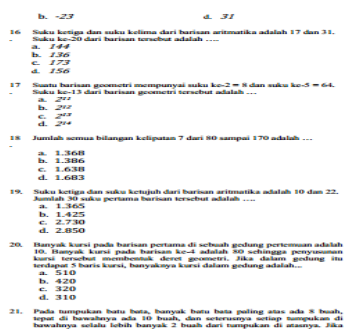

Figure 4.Font Revision

Figure 5.Font After Revision

Then the following is a picture that shows the researcher has improved the content of the student worksheet so that it accentuates reasoning and proof or reasoning and proof:

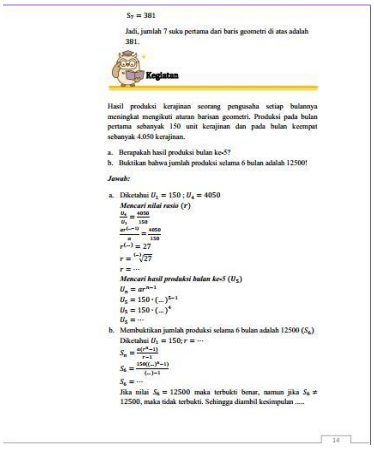

Figure 6.Work Sheet

**Analysis validation**

**Material expert validation**

The data that has been collected is then analyzed and the results of the analysis show that the worksheets to train the mathematical ability of reasoning and proof that have been developed are valid criteria with validity levels of 78, 75% of mathematics lecturers and 76.25% of mathematics teachers and suitable for use as learning materials.

However, according to the advice given, regarding the use of letters in the worksheets, according to the expert, the font size is equalized, because the font sizes used previously were not the same. In the contents of the worksheets, it is also suggested to emphasize the reasoning and proof even more.

**Product expert validation**

For product experts, 73.33% of mathematics lecturers and 70% of teachers are produced and are suitable for learning. Then as the advice given by the product expert is the cover of the worksheet that is too universal, then the researcher changes the cover of the worksheet to be more specific in the material or that describes the content of the material.

**Practicality Analysis**

The practicality test is used to see the practicality of the product and to see the student's response to this LKS product. Of the 31 students who filled out the google form, got an average result of 71.61%, so it can be said that the LKS product is practical.

Research and development of this student worksheet is carried out in several stages. At the beginning of the stage, researchers conducted interviews with class VIII mathematics teachers at SMP Negeri 16 Pekalongan to find out how the learning process took place and how heterogeneous the students were in each class. The teacher explained that in his mathematics class, he applied literacy from any source, the teacher also rarely made student worksheets which attracted more students' interest in learning mathematics. From this, the researchers developed worksheets for students 'independent study materials and to train students' mathematical reasoning and proof abilities. As where the definition of learning according to Hamalik (2018: 4) which means learning is a modification or reinforcing a behavior based on experience.

In this definition of learning, the student worksheet that the researcher develops can reinforce a theory, especially in the sequence and series material. In addition, the definition of learning according to Suprehiningrum (2018: 5) which combines the definitions of learning from these three figures states that learning is broadly a conscious effort to obtain certain changes that can be seen as experiences of interaction in the environment. The changes that are obtained by students after learning to use student worksheets that researchers develop are from ignorance to knowing or from knowing to knowing more, so that there is a learning process as the definition of learning according to I

NyomanSudanaDegeng (2017: 17), namely learning is an effort to teach students .

In order to achieve mathematical reasoning skills, it is necessary to know according to NCTM that reasoning itself is important to train students' thinking abilities in noting patterns, regularities and making assumptions then making conclusions from relevant and logical thinking.

On this student worksheet, there are steps to complete the activity sheet to make it easier for students to learn independently and the reasoning process occurs, according to the definition of reasoning according to Keraf, a thought process by connecting facts and then a conclusion is drawn.

To achieve or train students' mathematical proof skills, it is necessary to know that proof is the student's ability to think logically to determine an axiom similarity and then draw conclusions from an argument. According to Tri Utari and Hartono, quoted from Stylianides and Stylianides (2018: 130), they state that reasoning and proof describe a comprehensive activity that includes generalizing patterns, making conjectures, providing arguments and developing evidence. Meanwhile, according to Lestari &Yudhanegara, it is stated that in broad mathematical proof, students understand the statement then provide evidence of the correctness of the solution. The analysis carried out is in the ADDIE development model, namely Analyze or analyze needs.

The next stage, researchers designed worksheets which would later be validated by appointed experts. Starting from designing the cover of the worksheets to the content to be written and the source of reading to be taken. The cover of the revised worksheets has a bright color and on the cover describes the contents of the worksheets. In developing this product, researchers adhere to the flow of design thinking analysis which puts forward the best solutions related to existing problems or problems. Making products such as student worksheets, the researcher designs a teaching material that can train students' mathematical abilities through teaching materials that are not taught in the junior secondary stage. This stage is the second stage

of the ADDIE model, namely designing a product to be developed.

After the design stage of a product is complete, the next stage is product development. At this stage, a validation test was carried out on a team of experts and saw student responses by filling out a questionnaire from the researcher. The questionnaire was addressed to material experts who were mathematics lecturers of IAIN Pekalongan and class VIII mathematics teachers of SMP Negeri 16 Pekalongan, then product experts who were mathematics lecturers of IAIN Pekalongan and teachers of SMP Negeri 16 Pekalongan who served as deputy head of the curriculum.

Then looking at student responses related to student worksheet products from the researcher questionnaire, taking randomly from the total students of class VIII, namely 31 students via google form, obtained an average score of 71.61% with the interpretation of the data included in the practical category. From the questionnaire filled out by the expert team, several comments were received, so that some things should be revised according to the suggestions of the experts and the student worksheets produced were better, so that the student worksheets could be used.

The quality of student worksheets seen from the data analysis conducted by researchers, from material experts, product experts and student responses seen from data interpretation, student worksheet products produced by researchers are categorized as valid. Judging from the understanding of student worksheets, that student worksheets in general are sheets containing material, summaries and assignments that must be done by students. From a general understanding, the student worksheets that the researcher produced have met in terms of definition. Usually student worksheets have an example section of the steps for solving a problem, especially in mathematics.

From several comments from the expert team, the researcher revised several contents according to the comments of the expert team, one of which was the comments from the mathematics lecturer on the material expert team to further highlight the

reasoning and proofs. According to Keraf, reasoning in general is a thought process that tries to connect known facts to a conclusion. If applied to the student worksheets that the researcher produces, the content display on the activity sheets is made for students to reason and determine a conclusion, for the proof section the researcher presents the form of questions that prove the similarity of the results.

After being revised so that the student worksheet is better and meets the requirements as a worksheet that contains a summary there are steps to solve a mathematical problem as well as instructions for use. It can be said that the student worksheets that the researchers produced are valid and practical. In accordance with the theory of the purpose of packaging material in the form of worksheets, namely worksheets can help students find concepts; LKS serves as reinforcement; as a printed media learning material; and as a student learning guide. This student worksheet is included in the type of student worksheet as reinforcement, because this LKS is made for deepening the material in accordance with IsnaRafianti's theory which classifies various forms of LKS.

## CONCLUSION

The development in this study was carried out in three stages, namely analyze, design and development. The initial stage is a needs analysis by conducting an initial interview with a grade VIII mathematics teacher, then the researcher gets an idea of what kind of product should be designed based on the existing problems. The next stage of designing student worksheets begins with designing the cover of the worksheets, the content of the worksheets sees the purpose of making this worksheets, namely to train students' mathematical reasoning and proof skills. the last stage is product development by calculating the results of the validation test and practicality test.

The quality of the student worksheets is declared valid seeing the results of the percentage and interpretation of data on material experts and product experts. This student worksheet is also said to be practical, seen from the average

percentage of student responses and data interpretation.

Suggestions that can be given based on the research that have been done are as follows.

1. The learning tools developed can get a better implementation score if the students can do the exercises in the LKS and there is a discussion related to the practice questions. So that students' understanding of concepts will be better.
2. Developing this product with a wider scope.
3. It is necessary to carry out further development of worksheets to train mathematical skills of reasoning and proof.
4. Suggestions for further researchers that it would be better to conduct field tests so that they know more about how this worksheet is applied.

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