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Student Activity Sheet Development Quadratic Equations and Functions based on Problem Solving in Junior High School

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ABSTRACT
The study aims to produce student activity sheets (LAS) square equations based on valid and practical and look at potential effects on students' problem-solving abilities. The type of research used is development research, which consists of two stages, namely preliminary study (preparation stage, analysis stage and design stage) and formative study (evaluation and revision stage) which consists of self-evaluation, expert reviews, one to one, small group and field test. The data collection techniques used in this study are validity questionnaire, practicality questionnaire, interviews and test. The validity questionnaire was analyzed descriptively quantitatively, the practicality questionnaire was analyzed using the Likert's scale score, the interviews were analyzed descriptively and the tests were analyzed by giving an assessment score to the students' answers. The validity of the activity sheet can be seen from three aspects, namely the content, construct, and language contained in the validation sheet at the expert review stage and based on comments / suggestions from the results of the one to one trial. The practicality of the student activity sheet can be seen from the results of the calculation of the given questionnaire and based on observations at the small group stage and see the potential effects of students' problem-solving abilities at the field test stage. From the results of the expert validation sheet obtained an average percentage of 84.9% which includes quite valid criteria and from the results of practicality questionnaire obtained an average percentage of 83.75% which includes practical criteria. Based on expert review validation and one to one and small group trials, valid and practical student activity sheets are obtained. LAS developed also has a potential effect on problem-solving ability judging from the overall test results learners can solve the test questions given.

***Keywords**: Student Activity Sheet, Problem Solving, Equations and Quadratic Functions*

1. INTRODUCTION

Mathematics is not just a science of calculation, but can be used to prove the truth of ideas and can solve problems by thinking logically and structured [1]. Algebra includes the science of mathematics, whose application is widely used in everyday life and plays a role in the process of solving problems [2]. By learn algebra can bridge students in solving problems using their own strategies [3]. One of the algebra materials that is very close related to everyday life and is used in problem solving is the equation material and quadratic function.

The equation material and the quadratic function are one of the important materials to study because its application is widely used in life and is used as a prerequisite material in the study of other mathematical materials, such as geometric materials, integrals, linear programs, etc. [4]. But in the process of learning the square equation material students still find difficulty, including difficulty in understanding the concept and solving the problem items given due to lack of mastery of the material [5]. The results of the study conducted by Susilo said that students are unable to understand and solve the problem of quadratic equations and quadratic functions. The cause of students lacking understanding of the material based on research conducted is the lack of attention of students in the learning process because students consider math lessons difficult to understand and the absence of the student's desire to repeat the

lesson [6]. Similar research was conducted by Maituty and Lasmi where students still have a lot of difficulties and have not been able to master the basic concepts of equations and quadratic functions [7, 4]. Students' difficulty in finding a concept will have an impact on a student's mathematical breakdown abilities [8]. One solution in solving these problems is that teachers can develop an innovation in the learning process [9]. In addition, student learning activities must also be considered because in the learning process, student learning activities can affect student learning outcomes. Without activity, the learning process will not take place properly [10]. So that optimal learning activities will produce good student learning outcomes, and vice versa [11]. For that, teachers need to design learning activities so that students can optimize their learning outcomes. The results of this design can be poured in the Student Activity Sheet (LAS) which serves as a tool in the teaching and learning process [12]. The Student Activity Sheet (LAS) is a teaching material that can make it easier for students to solve problems [13].

But in reality, students' learning activities are still relatively low. This is seen from the research conducted by Agustin, where teachers still dominate in the teaching and learning process and the interaction that occurs between teachers and students has not been maximal, causing a lack of student participation in learning activities. Students are not given the opportunity to build their own knowledge and teachers tend to force their way of thinking similar to the way students think [15, 11]. In addition, the LAS used today still has a shortage. Most LAS only emphasizes formulas and contains a summary of material, problem examples, problem exercises without showing explanation or method of discovery of formulas and does not pay attention to the criteria for validity, effectiveness [16,17].

Therefore, it takes the development of a quality LAS for the needs of students. LAS should also contain activities that contain problem-solving strategies because with problem solving students can be actively involved in exploring, observing, and experimenting where later it is expected to facilitate students in understanding concepts [18]. The problem-solving step according to Polya consists of 4 steps, namely 1) Understanding the problem, 2) Drawing up a Plan, 3) Implementing a Plan, 4) Looking back [19].

Previous research conducted by Sukmawati and Yenni only used LAS in the learning process to increase student independence without developing the LAS [12]. Furthermore, similar research was conducted by Kurniati and Hadinurdiana related to the development of problem-solving-based worksheets, but the research focused on facilitating students' mathematical problem-solving skills in quadrilaterals [20]. Thus, the authors are interested in conducting research entitled “Student Activity Sheet Development: Quadratic Equations and Functions based on Problem Solving in Junior High School”

2. METHOD

This research is a development research that aims to produce student activity sheets (LAS) especially on class IX square equation material based on valid and practical problem solving and look at potential effects on students’ problem solving abilities. The subject in this study are class XI C SMP Srijaya Negara Palembang as many as 14 students. The data collection techniques in this study consist of validity questionnaire, practicality questionnaire, interviews and test. The LAS expansion in the use this research consist of two steps namely preliminary study (preparation step, analysis step, and design step) and Formative study (evaluation and revision step) consist of self-evaluation, expert, reviews, one to one, small group and field test. Here is procedure or steps used in this study in develop LAS served in the form of flowcharts:

Figure 1 Development flowcharts

2.1. Step Preliminary

Preliminary stage consists of three stages, namely: Preparatory Stage, which at this stage researchers prepare several things, namely: determining the research place, determining the research subject, contacting the school or subject teacher, compiling research instruments and preparing other needs. Furthermore the Analysis Stage, which consists of three analyses that include student analysis, curriculum analysis and material analysis. Then the Design Stage, which is done to design the student's activity sheet square equation material based on problem solving. The product design results are called prototypes by focusing on three characteristics, namely content, construct and language.

2.2. Formative Evaluation Step

The stages in formative evaluation used in this study are:

2.2.1. Self-Evaluation

Products that have been designed in the previous stage will be evaluated by the researcher themselves, for example there are errors in writing or so on. The result of this stage is called Prototype 1.

2.2.2. Expert Review

From the results of Prototype 1, the product will be validated by experts consisting of one lecturer in mathematics education and one teacher of mathematics subjects using validation sheets that have been created by researchers. The validity of LAS is valued as content relating to the matter of quadratic equations, constructs relating to the conformity of activities with each other, and the suitability of the language used. Suggestions and inputs from validators will be used to.

Table 1. Category score validation sheet assessment category

Score	Category
4	Very Good
3	Good
2	Fair
1	Not Good

Furthermore, the calculation of the score was obtained from the validation data sheet to see the validity of the LAS adapted akbar (2013).

$$Validan\ Score = \frac{number\ of\ scores\ obtained}{msximum\ number\ of\ scores} \times 100\%$$

The validated validity score is used to determine the level of validity of the LAS that has been validated through the validated validity criteria presented in the following table :

Table 2. Criteria validated

Level of Validity	Criteria Validated
85,1% - 100%	Highly valid or can be used without revision
70,1% - 85%	Valid enough or can be used with minor revision
50,1% - 70%	Invalid or unusable
0,1% - 50%	Impractical

2.2.3. One to One

At this stage, individual product trials will be conducted. The goal is to see the feasibility of the product that has been developed whether it meets valid criteria or not. The trial was conducted directly with 3 students of Class IX. Comments or difficulties gained from the trial will be used to improve LAS. At this stage the researchers used three students selected based on recommendations from the subject teacher and the student's preparedness. The results of expert review and one to one are called Prototype 2.

2.2.4. Small Group

Prototype 2 results will be tested to small groups or groups of students with selected three different groups from stage one to one. After the trial, the subject was given a practicality questionnaire and a comment/suggestion sheet. The comments, suggestions, and difficulties students face will be used to revise the product so as to obtain a valid and practical LAS. The results of the revision at the in stage in the form of prototype 3. The questionnaire sheet is analyzed using the Likert scale with the following practicality criteria :

Table 3. Likert scale statement format

Statement of Attitude	Score	
	Positive	Negative
Totally Agree	4	1
Agree	3	2
Disagree	2	3
Strongly Disagree	1	4

Table 4. Practicality criteria

Level of Achievement	Information
$84\% \leq Na$ <100%	Very Practical
$68\% \leq Na$ <84%	Practical
$52\% \leq Na$ <68%	Less Practical
$36\% \leq Na$ <52%	Impractical

2.2.5. Field Test

Furthermore, prototype 3 in the form of a valid and practical LAS was piloted on the research subjects, namely class IX learners. C Srijaya Negara Junior High School. The purpose of this stage is to look at the potential effects of problem-solving LAS on students' problem-solving abilities. After the trial, learners were given tests that were used to see the appearance of descriptors on indicators of problem-solving skills and interviewed as supporting data. The test data results of all learners are analyzed with the following steps: 1).

Create a question answer-matching rubric; 2) Check answers based on the brushing rubric; 3) Score according to the specified. Test scores obtained by students from 0-100. Then the scores obtained are made into a form of grade using the following rules:

$$Student\ Score = \frac{number\ of\ scores\ obtained}{msximum\ number\ of\ scores} \times 100\%$$

Then, the final value of learners is classified based on the following table.

Table 5. Value predicate category

Score	Criteria
$90 \leq n \leq 100$	Very Good
$80 \leq n \leq 89$	Good
$70 \leq n \leq 79$	Fair
< 70	Not Good

3. RESULTS AND DISCUSSIONS

First of all at the Preparation stage, researchers develop teaching materials in the form of LAS. In addition, researchers determined the school chosen as a research place, namely SMP Srijaya Negara Palembang. Furthermore, the researcher met the principal of Srijaya State Palembang Junior High School to ask for research permission at the school and meet the teacher of class IX mathematics subjects to discuss so as to obtain the information needed when carrying out research such as information on research subjects and research implementation time. Then the researchers began to take care of administration such as research licenses.

The second step is the Analysis stage, which consists of the analysis of learners where researchers analyze class IX of Srijaya State Palembang Junior High School with the help of Mathematics subject teachers. Based on interviews with teachers, researchers found that student learning is still relatively low. This is because students have difficulty mastering the material and students also have difficulty presenting a problem that is given to a mathematical model because students are not used to solving non-routine problems. In addition, at this stage the teacher chooses students of class IX. C Srijaya State Palembang Junior High School as research subjects. Research subjects are selected based on students' problem-solving abilities, student availability, and students have studied prerequisite materials such as Number Operations and Linear Equations.

Furthermore, curriculum analysis, at this stage is carried out based on Core Competencies (KI) and Basic Competencies used by SMP Srijaya Negara Palembang by paying attention to previous learning tools for quadratic equation material. Finally, the analysis of the material, where this material is selected based on the results of discussions with lecturers and subject teachers who are known that the material quadratic equation is one of the important materials to be studied because its application is widely used in everyday life and is often used as a prerequisite material in studying other mathematical materials. Here are the indicators used in developing LAS based on the basic competence of class IX quadratic equation material: (1) Describes quadratic equations and their characteristics, (2) Determines the root of quadratic equations by factoring, (3) Solves problems related to quadratic equations.

In the third stage, the design stage, researchers designed a LAS based on problem solving quadratic equation material that contains student activities. In the design process starts by formulating indicators and learning goals and determining the appropriate and appropriate activities. The last content design to be developed is prepared as follows:

Table 6. LAS frame

LAS Program	Content
Front Cover	1. Title: Student Activity Sheet 2. Material Name: Quadratic Equation 3. Curriculum : 2013 revise 4. Group Member Name 5. Day and Date 6. School Name 7. Time Allocation
Page 1 and 2	1. Basic Competence 2. Indicator of Achievement of Basic Competence 3. Learning Objective 4. Basic Concepts 5. Instruction for Use
Lesson Plan	1. The First Meeting LAS Consists of 2 activities and 1 problem, where the activity designed in the LAS leads students to be able to explain the quadratic equation and its

	characteristics. 2. The Second Meeting LAS Consists of 2 activities and 1 problem, where the activity designed in the LAS directs students to determine the solution of the quadratic equation by method graph.
Back Cover	1. A brief explanation of the problem-based LAS developed. 2. Author name : Dyna Meriza

3.1. Self-Evaluation

At this stage, the researchers assess the LAS that has been made with the quadratic equation material an revise if there are errors or activities that are not appropriate. In addition, researchers consult with a guidance lecturer to obtain comments / suggestions used in LAS improvement.

3.2. Expert Review

Validated LAS focuses on the content, constructs and languages discussed and corrected by validators consisting of lecturers in mathematics education of Universitas Sriwijaya and a teacher of mathematics subjects of Srijaya State Palembang Junior High School. The LAS validation process is done by means of QandA and charging of LAS validation sheets. The validation sheet contains 17 statements in terms of content, construct, and language. Furthermore, the validator provides suggestions and comments by writing them on a LAS validation sheet that will be used as a consideration to improve LAS. Based on the results of validation that has been done, obtained an average percentage of 84.9% which indicates that LAS-based problem solving of square equation material is quite valid but needs to be revised based on comments and suggestions from validators. Comments/suggestions from validators are as follows.

Table 7. Comments and suggestions along with revised decision

Comment and Suggestion	Revised Decision
Validator 1: Because what you want to develop is activity in the square equation material, the contents of LAS must be an activity not a problem solving. So develop activities that invite students to move in the form of activities instead of moving about. For LAS Meeting 1 • We recommend adding a box in the answer column to clarify where students write the answer • Explanations obtained from the activity are combined into 1 sheet so that students are not confused For LAS Meeting 2 • Illustration for factoring should be long × width	• LAS contents have been corrected as advised • The box in the student's answer column has been added • Explanations have been merged • Illustrations have been corrected
Validator 2 : For LAS Meeting 1 • In activity 1 the word "constant" is clarified again meaning and should be written "go into formula" • In activity 2 parts originally added again command sentence • Should the finished word be replaced with a symbol For LAS Meeting 2 • Illustration for factoring should be long × length • Add less information to activity 1 • Remove one of the same problems at number 2 and 4	• Word writing has been added • Command sentences have been added • Sentences have been corrected • Illustrations have been corrected • Information on activity 1 has been added • The same issue has been removed one

3.3. One To One

In addition to being given to expert review, prototype 1 was also piloted to 3 students to see the validity of LAS-based problem solving quadratic equation material that has been developed. The student is a student of Sumsel Jaya Junior High School. The One to one trial was held from September 1, 2021 to September 02, 2021. On September 1, 2021, researchers gave LAS meeting 1 and meeting 2 through a WhatssApp group and asked learners to pay attention to the LAS given. On September 02, 2021 researchers conducted direct interaction with students at South Sumatra Jaya Junior High School, where students were asked to do the LAS given. Then the researchers find out what difficulties are accepted by learners during LAS work, so as to provide input to be able to improve LAS. Here is one of the comments / suggestions of learners after working on LAS.

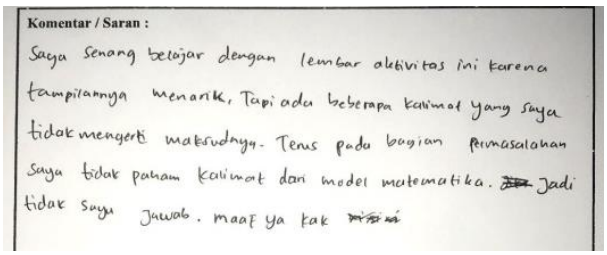


Figure 2 Student comments/suggestions

Based on the observations of researchers, learners can carry out steps on activities contained in LAS, it's just that learners experience confusion that causes errors in some activities in LAS such as looking for the difference of two equations. Learners find it difficult to find the difference of the equation given. This may be due to learners forgetting the elimination material that has been studied in class VIII. Furthermore, the problem encountered is that learners experience confusion in completing activity 2 at the second LAS meeting. This is because the measures are less effective. So that researchers improve LAS to make it easier to understand. Learners also find it difficult to change the problem to a mathematical model. After working on LAS, learners are asked to provide comments and suggestions about LAS that have been given, where the results of the comments and suggestions will be used as a consideration to revise the LAS. Here are the overall observations about the difficulties experienced by learners in doing LAS at stage one to one along with revision decisions.

Table 8. Observation results and revised decisions

No.	Student Difficulties	Revised Decisions
1.	Learners do not understand some commands on activity 1 at the first LAS meeting	Maintained
2.	Learners cannot turn problems into mathematical models	Maintained
3.	Learners do not understand the question on drawing conclusions	Questions corrected
4.	Learners experience confusion about the steps of activity 2 at the second LAS meeting	Steps improved

3.4. Small Group

The results of the revision of expert review and one to one are called Prototype 2 which is then piloted to small groups that are divided into 3 groups with each group consisting of 2 students who are not the subject of the study. The small group trial aims to look at the practicality of the problem-solving of the square equation material that has been developed. The Small group trial was conducted from September 08, 2021 to September 9, 2021. On September 8, 2021, researchers gave LAS meeting 1 and meeting 2 through a WhatssApp group and asked learners to pay attention to the LAS given. On September 09, 2021 researchers conducted direct interaction with students at South Sumatra Jaya Junior High School, where students were asked to work on LAS given by discussing with their group friends. Before working on LAS researchers ensured in advance that learners had sat according to the group shared through the WhatssApp group. When learners do LAS, researchers observe learners to see what difficulties they experience.

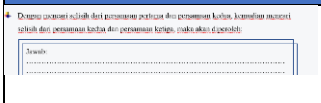
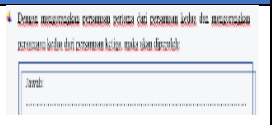
After last was completed, the researchers conducted an interview and asked for some of their work after discussing with the group. Furthermore, learners are asked to write comments and suggestions freely. The results of comments and suggestions given by learners will be used by researchers as considerations to make further revisions. Here are the comments / suggestions of learners at the small group stage presented in the form of the table below:

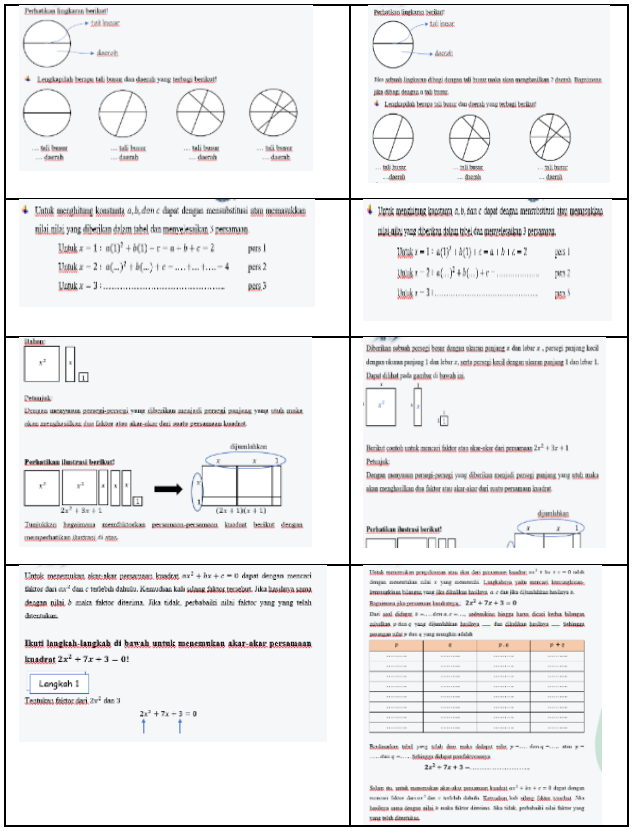
Table 9. Comments/suggestions learners at the small group step

Initials	Comment/Suggestion
KO	• Attractive activity sheet display • I became passionate about learning to use LAS • I still experienced confusion at activity 1, first meeting • There are sentences that are difficult to understand
SE	• I enjoyed learning to use LAS • LAS given interesting and easy to understand • Initially confused by the given activity, but finally understood after discussing with group friends
MAJ	• Learning is easy to understand and not boring
HA	• LAS Interesting • LAS is easy to understand
HR	• Activity in LAS make me understand quadratic equations • Too much activity
MPS	• Nice LAS look • The activity is right • I understand the material provided

Based on the comment/suggestion of learners, overall it can be seen that learners have given a positive impression of the LAS developed. It's just that there is still confusion at activity 1 in the first LAS meeting. Learners give input that the sentence of his command is difficult to understand. So researchers reconsider each sentence used and simplify the sentences used in LAS to make it easier to understand. Furthermore, researcher have discussions with guidance lecturer on the result of the small group step and guidance lecturer give input that every activity should begin with a problem. Here are the result of small group step revision.

Table 10. Small group step revision result

Before the Revision	After the Revision
	



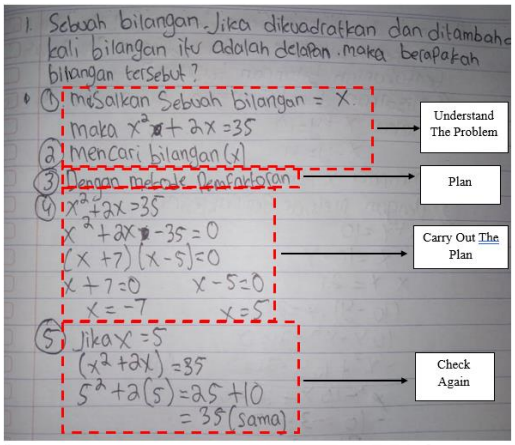
After filling out the comment/suggestion sheet, learners are also given a practicality questionnaire that aims to see the practicality of LAS that has been developed. The questionnaire is provided through google form which contains 10 questions and filled out individually by learners. Based on the results of filling out the student questionnaire, it was obtained that the average result of the percentage of the calculation of the questionnaire amounted to 83. 75%. This suggests that problem-solving-based LAS that has been developed falls within the criteria of the practical category. After obtaining the results of small group trials and revisions to LAS based on comments/ suggestions of learners obtained prototype 3 and can be declared as a valid and practical product.

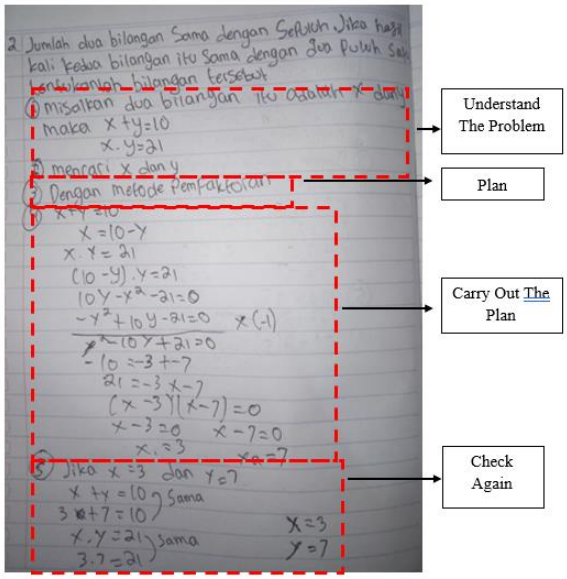
3.5. Field Test

The field test stage is the last stage in formative evaluation conducted in 3 meetings, with details of the first and second meetings conducted by learning by being given a problem-solving-based LAS through WhatssApp groups while dividing learners into groups, one group of 3 people. After the learning process, at the third meeting the test was carried out. The test problem consists of 3 points of questions in the form of a description of the quadratic equation. The learning

process of the first meeting is done face-to-face limited and the second and third meetings are conducted online through google meet. This stage aims to find out the potential effects of LAS that has been developed on students' problem-solving abilities.

Based on the results of high-skilled learners' answers meet all indicators of problem-solving ability. Here are the results of answers of AR learners who are categorized as learners with high abilities.





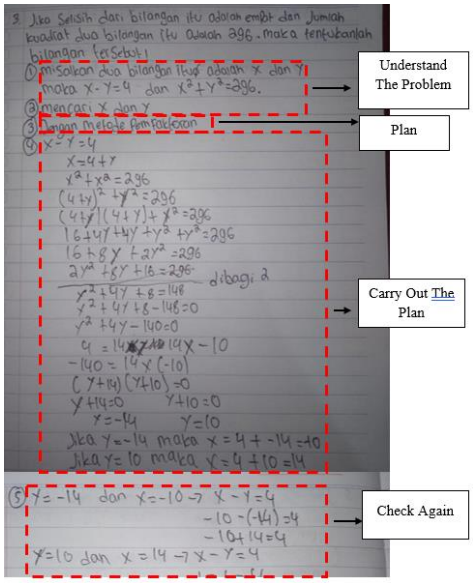
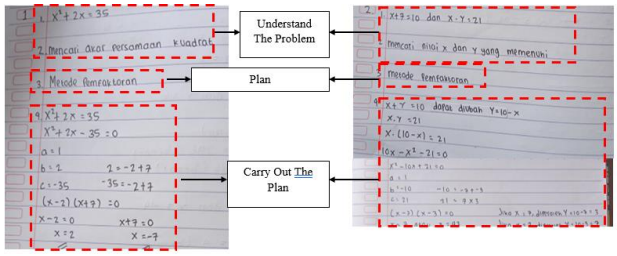


Figure 3 Answers to the AR tests

In working on test problems, AR meets all indicators of problem-solving capabilities. The first indicator is that AR can understand the problem by writing down what is known/asked in the problem. AR can also draw up a plan by determining the strategies used in solving the problem. Furthermore, AR is able to solve problems using factoring methods. However, AR experienced errors in determining factors when completing test problem number 2. On the recheck indicator, AR can check the answer by entering the answers obtained into the proble.



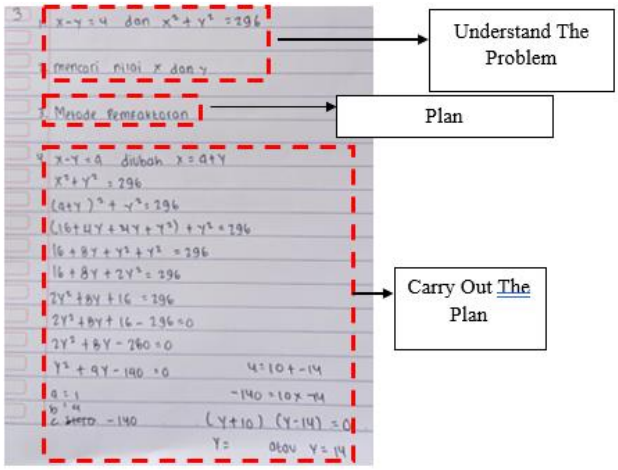


Figure 4 Answer to the ED test

Based on the results of the tests obtained, ED is categorized as a moderately capable learner. In working on test problems, ED meets three indicators of problem-solving ability, namely understanding the problem, preparing a plan and implementing a plan. The first indicator, namely ED can understand the problem by writing down what is known / asked from the problem. In the second indicator, AR can determine the strategy used in solving the problem, using factoring methods. In the third indicator, AR can solve the problem but for test problem number 1 is still not right. AR has difficulty finding factors from test problem number 1. In the indicator recheck or still experiencing confusion. This is made clear by interviews conducted where AR does not understand the intent of re-examining.

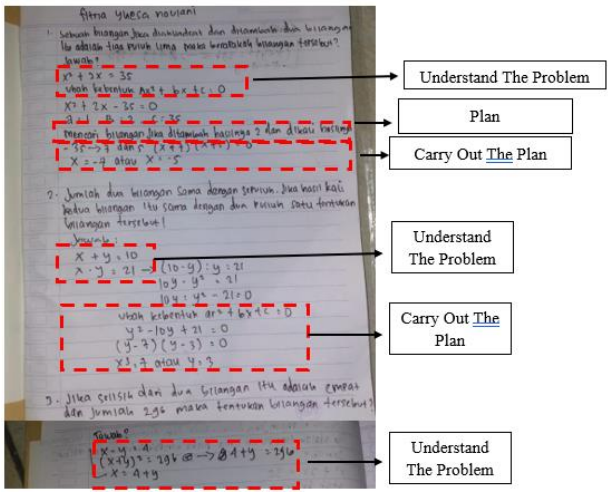


Figure 5. Answer to the FY test

Answer to test question number 1, FY only meets three indicators of problem-solving ability, namely understanding the problem, preparing a plan and implementing a plan. FY writes down the information obtained from the problem and solves the problem by looking for numbers that meet or can be said to be FY using a smart guessing strategy. In test number 2, FY meets only two indicators of problem-solving ability: understanding the problem and solving the problem. FY writes down the information obtained from the problem and it appears that FY solves the problem by factoring method. It's just that FY doesn't write down the methods he uses. In test number 3, FY meets only one indicator of problem-solving ability, namely understanding the problem. This is made clear by the interview conducted where FY can actually double check the answers to test questions number 1 and 2 but have not been able to complete the number 3 test problem because they are still experiencing confusion in preparing a plan.

Based on the results of the analysis of test and interview data, the indicator that most often appears is implementing the plan and the indicator that rarely appears is re-examining. This is in line with the results of research conducted by Simatupang, et al, where students with low and moderate abilities have not been able to re-examine. The cause is that students do not understand the purpose of re-examining [21].

Overall, students have given a positive impression of the developed LAS. It's just that I'm still a little confused about doing it. Students give input that there are commands that are difficult to understand. So the researchers reconsidered each sentence used and simplified the sentences used in LAS. According to Purwasi and Fitriyana, student worksheets should use clear, simple and easy-to-understand sentences and have a clear learning flow [22]. Learning to use LAS is also easier to understand because it is not boring, easy to remember, and the activities are sequential and have instructions at each step. In line with the opinion of Annajmi and Afri, learning using LAS can make students dominate in understanding concepts and discussing groups [23].

Furthermore, the results of the answers of all learners were analyzed in accordance with the brushing rubric that has been made by researchers where there are 4 learners categorized very good with a percentage of 28.5%, 7 learners are good categorized with a percentage of 50%, 1 learners are fair categorized with a percentage of 7,1% and 2 learners are not good categorized with a percentage of 14.28%.

4. CONCLUSION

LAS development research based on problem solving in quadratic equation material is carried out with a development procedure consisting of two stages,

namely preliminary study (preparatory stage, analysis stage and design stage) and formative study (evaluation and revision stage) consisting of self-evaluation, expert, reviews, one to one, small group. The results of research that has been done by analyzing students, curriculum, and materials, as well as designing a problem-solving-based LAS can be concluded that the LAS developed according to experts is quite valid but needs to be revised based on comments and suggestions. Validators pay attention to three aspects, namely content, constructs, and languages that have an average percentage of 84. 9%. Furthermore, the product was piloted to 3 learners to find out what difficulties were received during LAS work, so as to provide input to be able to improve LAS. Practicality in LAS is seen when learners are able to work on LAS with a predetermined time and based on the results of filling the questionnaire learners obtained that the average result of the percentage of the calculation of the questionnaire of 83.75% which shows that the product that has been developed falls into the practical category. This problem-solving-based LAS also has a potential effect on students' problem-solving abilities. Judging from the analysis of the results of the test results of learners that overall learners can complete the test questions given with 4 learners categorized very good with a percentage of 28.5%, 7 learners are good categorized with a percentage of 50%, 1 learners are fair categorized with a percentage of 7.1% and 2 learners are not good categorized with a percentage of 14. 28%.

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