

The Development of Mathematics Learning Device Based on Quantum Teaching Model to Improve Problem Solving Ability on Grade XI Students at Vocational School

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Abstract - This research aims to produce learning devices based on the Quantum Teaching decive to improve the problem solving ability of learners who are valid, practical, and effective. Learning decive developed in the form of a teaching plan and student's worksheets XI SMK math sheet. The research subjects were students of class XI of SMK Negeri 1 Lubuk Basung in the academic year 2018/2019. The learning model is an Quantum Teaching model consisting of Growing, Natural, Naming, Demonstration, Repeat, and Celebrate. The goal of the Quantum Teaching model is to motivate learners to solve difficult mathematical problems. This research is a development research using a plomp model. The plomp model consists of three stages, namely: preliminary research, prototyping stage, and assessment stage. The results of the analysis of the data obtained indicate that the learning decive developed are valid, practical, and effective. In this case there is an increase in students' mathematical problem solving abilities after participating in learning by using learning decive based on quantum teaching.

Keywords - Problem Solving Ability, Quantum Teaching, Learning Devices.

I. INTRODUCTION

The aim of national education is to educate the life of the nation (Nugraheni, 2014). Based on this, the purpose of giving mathematics learning at the school level includes having the ability to think critically, logically, analytically, creatively, problem solving skills, and the ability to communicate ideas and tenacious attitudes and confidence in solving problems in everyday life or the real world (Husna, 2013). Problem solving is a part of the mathematics curriculum that is very important because in the process of learning and its completion students are enabled to gain experience using the knowledge and skills they already have to apply to solving problems that are not routine (Utami, 2014). The problem solving ability is closely related to the ability of students to read and understand the language of story problems, present in mathematical models, plan

calculations from mathematical models, and complete calculations from non-routine questions (Nur, 2014).

Mathematical problem solving ability is the ability of students to solve mathematical problems that are not routine by using clear and correct completion steps. According to Polya (1973) the mathematical problem solving phase includes: (1) understanding the problem, (2) making a completion plan, (3) implementing the plan, and (4) looking back. The problem solving phase is intended so that students are more skilled in solving mathematical problems, namely skilled in carrying out procedures in solving problems quickly and accurately.

Students' problem solving abilities are still relatively low. This can be seen from the results of the PISA test. Based on the results of the PISA test, it was found that only 15.5% of

students were able to solve mathematical problems by using mathematical problem solving procedures and strategies (OECD, 2010). While the rest are able to solve routine problems and use existing mathematical formulas. Meanwhile, the results of TIMSS 2011 indicate that the problem solving abilities of Indonesian students are still below those of other countries (Eivers, 2012).

On a smaller scale, based on observations made on January 4 to January 11th, 2018 at three Vocational Schools in Agam District namely SMK Negeri 1 Lubuk Basung, SMK Negeri 2 Lubuk Basung, and SMK Plus Perbankan can be concluded that the ability of mathematical problem solving abilities of students is generally still low. This can be seen from the large number of students who have not been able to understand the problem when working math problems given by the teacher.

In line with the importance of problem solving skills in mathematics, it is necessary to have mathematical teaching packaged in such a way that it can provide experience for students to improve and develop their problem solving abilities. Teachers must be able to grow the activity of students in learning, namely by packing learning to be more interesting. One way is to make the learning atmosphere fun for students.

Therefore, there needs to be innovation in applying the learning model so that students get an interesting learning (Mawaddah, 2015). One way that is used to achieve these goals is to implement *quantum teaching*. In *quantum teaching* focuses on students and makes students more active.

Quantum Teaching is a learning model that has the main principle of bringing them into our world and delivering our world to their world. The purpose of this principle shows that the first step that must be taken by a teacher in starting the learning process is to enter the world of students, how to link the subject matter to be given with an event that occurs in their real life (A,la, 2010). After the connection is formed then the teacher provides understanding to students about the material being taught.

According to DePorter (2009) the *quantum teaching* design framework is known as the TANDUR design term. The material presentation in the quantum teaching model consists of 6 steps, known as TANDUR, namely: 1) Growing, growing interest in students, 2) natural, giving direct experience to students before presenting the material, 3) naming, delivering material, 4) demonstration, giving the

opportunity to students to explain and present the results of knowledge thoughts that have been obtained after the learning is carried out, 5) repeat, repetition by students that they really know, and 6) celebrate, reward students.

To guide the course of the *quantum teaching* process, the researcher develops a learning material based on *quantum teaching*. Learning devices play an important role. Before teaching a teacher is expected to prepare the material to be taught, prepare teaching to be used, prepare questions and directions to provoke students to actively learn, learn about the condition of students, understand the weaknesses and strengths of students, and learn initial knowledge students, all of which will decompose the implementation in the learning device (Suparno, 2002). The learning tool is one form of preparation carried out by the teacher before they carry out the learning process (Komalasari, 2011). So for this purpose a learning device was made in the form of a teaching plan and student worksheet.

Teaching plan is a decide that can help teachers manage the stages to be carried out in class and student worksheet can facilitate teachers and students in carrying out classroom learning. The student worksheet contains questions that will guide students to practice problem solving skills. So, teaching plan and student's worksheet are two things that really help teachers and students in carrying out learning and function to guide the course of the learning process, so that the goals and objectives of learning are expected to be achieved. Development of learning devices must be prepared based on the right learning model.

Based on the problems discussed above, the researchers developed a Quantum Teaching based learning device. The development model used in this study is the Plomp model which has three stages, namely the preliminary stage, the stage of developing or making a prototype, and the assessment stage (Plomp, 2013). The purpose of this development is to obtain quantum teaching based vocational mathematics learning tools that are valid, practical, and effective to improve the mathematical problem solving abilities of students in class XI Vocational High School. This means that the learning devices that will be used in schools must be valid, practical, and effective first. The formulation of the problem in this study is "What are the characteristics of the development of quantum teaching-based learning devices in class XI Vocational Schools that are valid and practical? What is the impact of quantum teaching based learning devices on students' mathematical problem solving abilities in class XI Vocational High School?"

II. THE RESEARCH METHOD

This research is a development research with development of Plomp model. The author this model because it is more systematic, directed, analytical, and suitable for developing learning devices. The Plomp model consists of 3 stages, namely preliminary research, development or prototyping phase, and assessment phase (Plomp, 2013).

Preliminary research is the preliminary analysis stage. At this stage, analyze the needs of the mathematics learning device. The analysis carried out is needs analysis, curriculum analysis of Core Competencies and Basic Competencies. The analysis that also needs to be done is the analysis of students through interviews with several students of SMK 1 Lubuk Basung to find out the characteristics of students, so that the learning tools produced are in accordance with the characteristics expected by the participants, and concept analysis.

Prototyping phase Learning devices are designed according to the results of the analysis that has been carried out. The design produced at this stage produces a prototype 1. This design is carried out formative evaluation aimed at improvements being developed (Arikunto, 2005). Beginning with self-evaluation, namely self-evaluation carried out by researchers and one colleague. The aim is to make corrections to the completeness of the components contained in the learning device developed. The results of the self-evaluation were analyzed, and revised. Furthermore, the validity test for mathematical learning devices based on quantum teaching was conducted. Validation is a test of validity, accuracy, and truth of something. The validation process is carried out by experts or experts in accordance with the field of study (Revita, 2017). Validation is carried out by 5 experts who are competent in their fields, including 3 mathematics education lecturers, one education technology lecturer, and one Indonesian language lecturer. Comments and suggestions from the validator are a reference for the revision of the mathematics learning device developed.

The development process can be continued if the mathematics learning device developed is declared valid. Evaluation is continued through product testing. Evaluation of mathematics learning devices consists of three stages, one-on-one evaluation, small group evaluation and large group evaluation. The instruments used were questionnaires and interview guidelines.

The type of data is data taken from the validation data of the mathematics learning device carried out by the validator,

practical data by the teacher and students, and effectiveness data seen from the results of the problem solving ability test. The data collection instrument used is the instrument for the preliminary research stage, the instrument of validity, practicality, and effectiveness. The data analysis technique used is descriptive statistics and qualitative data analysis.

III. RESEARCH RESULT AND DISCUSSION

1. Research result

This research starts from the initial investigation phase, where at this stage needs analysis, curriculum analysis, analysis of concepts and analysis of students on the mathematics learning devices to be developed.

The results of the needs analysis conclude that teachers and students need learning plan and student's worksheets that can facilitate students to improve students' problem solving skills.

The results of curriculum analysis are determined by examining the curriculum used in SMK. From the results of the curriculum analysis it is known that the curriculum used is the 2013 curriculum based on the SK Director General of Primary and Secondary Education number 330 in 2017. The curriculum analysis is focused on KI and KD for XI grade SMK material. The analysis of KI and KD indicates that a sequence change and the combination of the two KD will be made into one, this is done to adjust the relationship between each concept.

Mathematical learning devices are designed based on the results of analysis in the initial investigation phase. Teaching plan was designed using a quantum teaching model with presentation of material using the TANDUR step. Learning activities are designed according to the characteristics of students. The examples submitted to students are real problems or can be reached by students' imagination or problems in the daily lives of students. Establishing real problems in the implementation of learning mathematics needs to always pay attention to the reality and environment that exists, so as to enable and simultaneously motivate students to enjoy learning mathematics (Sinaga, 2007). The goal is to increase the curiosity and motivation of students in learning mathematics.

Student's worksheets were prepared using a quantum teaching model in accordance with the previously designed learning plan. Student worksheet based on quantum teaching is made using the TANDUR step. Student's worksheet begins with growing student interest by displaying problems

related to daily life. Student worksheet based on quantum teaching has interesting images in accordance with the problems to be solved in finding the concepts of the material being studied.

Mathematical learning devices that have been designed are formatively evaluated.

The results of the validation of mathematics learning devices are in the very valid category with the values in each aspect being assessed. Based on the data, it can be concluded that the mathematics learning device based on the *quantum teaching* model is in a very valid category.

One to one evaluation was carried out by asking three students to comment on the designed student's worksheet. Students consist of one low, medium and high ability student. After completing several activities at student worksheet, students were asked to provide comments on the designed student worksheet (interview). Comments given by students are used as references to develop mathematical student's worksheet based on *quantum teaching*.

Then a small group evaluation is carried out. Small group evaluations were carried out after the one to one evaluation was completed. Small group evaluations carried out with 6 students. 2 high-achieving students, 2 moderate-capable students and 2 highly-skilled students. After the implementation of the learning all the meetings were completed, students were asked to give comments on student worksheet that had been designed (interview) and fill out a questionnaire to see the practicalities of student worksheet based on quantum teaching. The recapitulation of the results of the LKPD practical questionnaire by students in the small group stage can be seen in Table 1.

Based on Table 1, it can be seen that the practicality level of student worksheet in the very practical category is 87,27. The results of the small group revision were followed by a field trial (large group test) on mathematics teachers and students of class XI AKL₂ SMK Negeri 1 Lubuk Basung to find out the teacher's response and students' responses. The teacher response test obtained information about the practicality of the learning devices developed, and student response tests were conducted to determine the practicality of the developed student worksheet (Widya, 2017).

Table 1. On to one test resul on student worksheet

Assessed Aspects	Obtained Score (R)	Value Practicality	Criteria

Presentation Aspect	20	84,72	Practical
Practical Ease of Use of LKPD	22	91,67	Very Practical
Readability aspects	21	85,42	Practical
Time Aspect	23	95,83	Very Practical
Average	21	87,27	Very Practical

The results of observation of the implementation of learning using by the teacher are presented in table 2.

Table 2. Recapitulation of the results of RPP implementation observation phase field test

Aspects Rated	P (%)	Category
Introduction Activities	83,33	Practical
Core Activities	88,89	Very Practical
Closing Activity	90,00	Very Practical

Based on Table 2 above, it can be seen that the results of observations carry out learning in the practical category.

Besides observing the implementation of learning there is also a teacher response questionnaire. This instrument is filled by the teacher after carrying out learning activities using learning tools based on quantum teaching. The results of the teacher response questionnaire are presented in Table 3

Table 3. Recapitulation of Questionnaire Results for Teachers' Response

No	Assessed Aspects	Obtained Score	Value Practicality (%)	Criteria
1	Attractiveness	4	100	Very Practical
2	Ease of Use	3,67	91,75	Very Practical
3	Ease of Use	3,75	93,75	Very Practical
4	Time	3	75	Practical
5	Equivalence	3,67	91,75	Very Practical
	Average	3,62	90,45	Very Practical

In addition to the teacher's questionnaire responses there were also questionnaires for students' responses. The results of the student response questionnaire are presented in Table 4.

Table 4. Recapitulation of Questionnaire Results for Students' Response

No	Meeting	Obtained Score (R)	Score of Practicality (%)	Criteria
1	Presentation Aspect	99,17	85,49	very Practical
2	Ease of Use of LKPD Aspects	96,67	83,33	Practical
3	Readability aspects	101,50	87,50	very Practical
4	Time Aspect	94,00	81,03	Practical
5	Presentation Aspect	99,17	85,49	very Practical
	Average	97,84	84.34	Practical

Based on table 3 and table 4, it can be concluded that the learning plan (RPP) and Student worksheet (LKPD) based on quantum teaching are practical for use in learning activities.

The effectiveness test is measured through tests of students' problem solving abilities. The results of tests on students' problem solving abilities are presented in Table 5.

Table 5. Results of Data Analysis on Student's Problem Solving Ability Test Results

	Attainment		Total
	Complete (≥ 70)	Not complete (< 70)	
Number of students	22	7	29
Percentage	75,86%	24,14%	100%

Based on Table 5 above, it can be seen that out of the 29 students who took the test, 21 students or 75,86% were complete, meaning the value of students above the specified KKM value and 8 students or 24,14% had not been completed. the value of students is still below the KKM. This means that classically quantum teaching-based learning has

shown complete. From the results of this final test it is known that more than 75% of students are above the KKM.

2. Discussion

After going through several stages in accordance with the plomp development model, quantum teaching-based learning tools were obtained that were valid, practical, and effective to improve problem-solving skills of students in class XI of SMK semester III.

Devices that will be tested for practicality must be tested for validity first. Based on the validity test, learning devices (learning plan and student worksheet) are in very valid criteria.

The practicality of student worksheet is based on the teacher's assessment, the response of the students and the implementation of student worksheet conducted at the product trial phase (Sannah, 2015). Practical testing is done by distributing questionnaires and interviews with students and teachers. The response of students is one of the parameters to determine students' responses to the use of learning devices that have been developed and used in limited trials (Azzohro, 2014). Respondents who filled the practice sheet consisted of 1 math teacher at SMK 1 Lubuk Basung and 29 students in class XI AKL₂ at SMK 1 Lubuk Basung. The practice test results of learning devices aim to determine the extent of benefits, ease of use and efficiency of usage time by teachers and students. Practical data is obtained from observations of the implementation of learning and the results of practical questionnaires by teachers and students. Based on the teacher's response questionnaire and students' response questionnaire, it shows that the learning device developed is interesting and easy to use. It can be concluded that learning devices based on quantum teaching are practical.

The effectiveness of research is done to see how far the uses and benefits of quantum teaching-based learning tools in improving students' problem solving abilities. This effectiveness assessment is done by giving students a problem solving problem solving ability. Usually students working on problem solving problems in the training at the LKPD make it easier for students to work on evaluation questions. The increase in the value of these students is supported by a quantum teaching based learning process that guides students to solve problem solving problems, so that students feel confident in the answers to each question. Based on the above review, it can be concluded that learning devices based on quantum teaching can improve students'

mathematical problem-solving abilities so that the devices developed become feasible to be used in learning activities. The application of quantum teaching in the learning process can improve student learning outcomes (Widiyaningsih, 2013).

IV. CONCLUSIONS AND SUGGESTIONS

Based on the results of the study, it was concluded that mathematical learning devices based on quantum teaching developed by researchers were valid, and practical based on one to one evaluation, small group testing and field testing, and could improve students' problem solving abilities for each indicator of problem solving abilities and used in SMK XI semester III mathematics learning 1. As for suggestions for the next researcher who develops learning devices to pay more attention to the accuracy of typing, sentences that are effective and in accordance with the cognitive level of students, and refer to the procedures for development of clear learning plan and student worksheet

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