Primarily research on the mathematical problem-solving abilities of grade X Vocational High School students for Computer and Network Engineering Competencies

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Abstract. Computer and network engineering are one of the skill competencies in Vocational high school. Graduates of this major are expected to have problem-solving abilities to be able to compete in the working world. Mathematics is a subject that can develop mathematical problem-solving abilities. This study aimed to see, review and describe the mathematical problem-solving abilities of students and draw conclusions about these things as the phenomena found and to review the conditions of the learning devices used and developed by the teacher. This research used descriptive quantitative research methods. The data was collected through interviews, observations, and giving tests. Data analysis techniques used descriptive techniques for the results of observation and interview data, and scoring rubrics for mathematical problem-solving abilities for test result data. The results showed that the students' mathematical problem-solving abilities were still not relatively low. Some of the factors that cause this are 1) the learning was still using the lecturing method so that learning became meaningless, 2) students were accustomed to copying and memorizing formulas given by the teacher without understanding them, 3) the learning tools used were the same for each skill program, 4) a mathematics learning approach had not led students to be actively involved in the learning process and had not guided students to construct their knowledge in improving mathematical problem-solving abilities. Based on these results, further action is needed in the form of research on the development of constructivism-based learning tools to improve the mathematical problem-solving abilities of students in the Vocational High School for Computer and Network Engineering Competencies.

1. Introduction
Education plays an important role in the process of educating the nation's life. One of the disciplinary is mathematics. Mathematics, as a basic discipline, plays an important role in the development of science and technology, because mathematics is a means of thinking to develop reasoning power, logical, systematic, and critical thinking power. Education is also a media for improving and developing human resources.

At school, students are guided by the teacher, through various approaches, models, strategies, and methods given. The teacher tries to develop the knowledge, potential, and experiences of students to become useful people, especially for vocational education. Students are prepared to work immediately and have expertise in their vocational fields. This is by Article 15 of Law Number 20 in 2003 [1] concerning the National Education System which states that vocational education is secondary education that prepares students especially to work in certain fields. Vocational education is a form of talent
development, basic skills education, and habits that lead to the world of work are seen as skills training [2]. Based on the Central Statistics Agency (BPS), the highest number of open unemployed graduates in Indonesia is vocational graduates compared to graduates from other educational levels [3]. Data from the Central Statistics Agency (BPS) states that most unemployment comes from vocational high schools, namely 17.26%. This is also a special deficiency for the education sector because vocational graduates should have a greater opportunity in the world of work compare to graduates of equivalent education or below. The cause of unemployment for vocational graduates is a lack of soft skills [4]. This is supported by Suryadi’s statement that vocational graduates create high unemployment rates [5].

To achieve the learning objectives at Vocational, it is necessary to develop the potential of students according to their respective expertise programs. Based on the decision of the Director-General of Basic and Middle School Education Number 30 of 2017 concerning Core Competency and Basic Competency of National Content Subjects, those are divided into 3 parts, namely: C1 (Basic Expertise), C2 (Basic Expertise Program), and C3 (Basic Competency). It means C1, C2, and C3 are competencies in vocational which must be studied by students which include productive subjects according to the expertise program [6].

From several existing expertise programs, researchers chose one part of the expertise program, namely the competency for Computer and Network Engineering expertise which is included in the ICT expertise program. As with other expertise programs, the competence of Computer and Network Engineering expertise requires students to be able to produce a product or work that will be marketed later. For this reason, it needs to be supported by problem-solving abilities so that students are trained to innovate so those creative products are created and are different from previous products.

One of the mathematical abilities of students based on the objectives of learning mathematics as stipulated in the Indonesian Minister of Education and Culture Regulation Number 58 of 2014 is the ability to solve mathematical problems [7]. Problem solving has an important function in teaching and learning mathematics activities [8]. Through problem-solving, students can foster responsibility, cooperation, pour out contextual ideas, healthy competition, and learning involvement. Furthermore, learning mathematical problem-solving is the core of learning in which a basic ability is in the learning process [9].

Based on the results of observations made by researchers at Vocational High School Number 8 Padang, it is known that there are still many students who do not pass daily tests. The minimum passing criteria at the school is 75 as shown in Table 1.

| Passing percentage | passed | Not passed | Number of students |
|--------------------|--------|-----------|--------------------|
|                    | 12     | 19        | 31                 |
| %                  | 38.7%  | 61.2%     |                    |

*Source: Mathematics teacher at vocational high school number 8 Padang*

Table 1 shows that there were 12 (38.7%) participants who passed and 19 (61.2%) did not pass the daily tests. From Table 1 it can be concluded that most of students are not able to solve the questions given by the teacher.

Based on the problems above, it will affect the learning ability of students, especially problem solving, especially the conditions of teaching materials (textbooks) that do not support creating a conducive learning atmosphere. The strategies and learning media used by the teacher are not in line with learning activities, so that students, especially in vocational, think that mathematics is a difficult, uninteresting, and less useful subject [8]. Textbooks are only used as teacher’s handbooks and presenting subject matter the same as in textbooks. This is because the teacher has not designed a learning device that can accommodate the needs of students to learn actively. The material taught by the teacher is obtained from various sourcebooks, such as using sourcebooks from the 1994 curriculum, KBK, KTSP, and the 2013 curriculum mathematics books. Armianti’s research also revealed that the reason for
mathematics subjects at vocational undesirable is the learning tools and teaching materials used by teachers are the same as the tools and teaching materials used in senior high school. Besides, the materials and approaches used are generalized in all vocational fields of students in vocational [10]. Realizing this problem, it can be concluded that the expected objectives of learning mathematics have not been achieved.

From the above problems, it is necessary to do "Primarily research on the mathematical problem-solving abilities of grade 10 Vocational High School students for Computer and Network Engineering Competencies.

2. Method
The method used in this research was quantitative descriptive research. Descriptive research is not intended to test certain hypotheses, but only describes what it is about a variable [11]. Much quantitative research is required to use numbers, starting from the collection of data, interpretation of the data, and the appearance of the results [12]. So it can be concluded that quantitative descriptive research in this research is to see, review and describe in numbers about the object under study as it is and draw conclusions about it according to the phenomena seen when the research was carried out. The variables in this study were the mathematical problem-solving abilities of grade 10 Vocational High School students for Computer and Network Engineering competency. The research was conducted at vocational high school number 8 Padang, namely in class X.2 with 31 students. The data collection techniques used were (a) Data Analysis from Interviews and Observations: Data analysis using descriptive techniques and consists of three stages, namely reducing data, presenting data, and drawing conclusions. Reducing data is the process of selecting things or important information according to the problem under study. After reducing the data, the data was presented and conclusions are classified, (b) Data Analysis of Problem Solving Ability Test: The answer sheet was checked using a scoring rubric for mathematical problem-solving abilities as shown in Table 2 below:

| Problem-solving indicator          | details                                                                 | score |
|-----------------------------------|-------------------------------------------------------------------------|-------|
| Understand the problem            | No identification for the variable which is known, asked, and the needed data. | 0     |
|                                   | Identify for the variable which is known, asked, and the needed data.    | 1     |
| Plan to solve the problem         | All variables are is known, asked, and the needed data.                 | 2     |
|                                   | No plan to solve the problem                                            | 0     |
| Solve the problem                 | There is a plan to solve the problem                                    | 1     |
|                                   | Arrange the plan correctly                                              | 2     |
|                                   | No answer provided                                                      | 0     |
|                                   | There is a solving way but not correct and the answer is wrong.          | 1     |
|                                   | There is a correct solving way and the answer is wrong                   | 2     |
|                                   | There is a correct solving way and the answer is not complete            | 3     |
|                                   | There is a correct solving way and the answer is correct                 | 4     |
| Define and conclude the result    | There is no definition.                                                 | 0     |
|                                   | There is proof and definition but not based on the problem.             | 1     |
|                                   | The proof and definition is correct and based on the problem            | 1     |
3. Result dan Discussion
Based on the results of observations in March 2019 at Vocational High School 8 Padang, it was found that mathematics learning was not as expected by the objectives to be achieved. This is because, in learning, teachers still use the lecturing method. Based on this situation, students can listen to all the things that are said by the teacher, while a person's absorption of what is heard depends on the person's concentration. Everyone has different abilities in solving math problems. Taofiq’s research found that problem-solving abilities were low because vocational students had a lot of difficulties understanding questions and finding solutions to problems given [13].

Based on an interview that was conducted with one of the mathematics teachers at vocational high school number 8 Padang, it was found that the students were less interested in learning mathematics because students thought that learning mathematics was difficult, the teacher also explained that students only memorized the problem-solving steps that were usually given without understanding what the real problem solving is. Furthermore, mathematics learning that occurs in Vocational High Schools was not following the expected objectives. In contrast to Senior High School students, students in vocational schools, both technical and non-technical expertise programs, have different views on mathematics. Students felt mathematics was difficult compared to other lessons according to their respective skill programs. Besides, vocational students consider that mathematics was only for graduation requirement subject, it did not have many benefits. From the deep-analyze, it was found that the practice questions were given routinely, so that the students are less skilled in solving problems that require high thinking ability. The learning tools used by teachers were still general or can be classified to be the same for each expertise program. Besides, there were no compulsory learning resources used by students in the learning process. The teacher only asked students to listen to and pay attention to the material he explains and does not use student worksheets in the learning process, even though the use student worksheets of in the learning process is very important because one of the functions of student worksheets was as a teaching material that can make it easier for students to understand the material given [14]. Additionally, the researcher also obtained data which showed that the mathematics problem-solving abilities of students in these schools were still relatively low. This data is obtained based on the results of tests of mathematical problem-solving abilities. Overall, the test results can be seen in Table 3 below:

| Indicator                                      | Percentage |
|------------------------------------------------|------------|
| Understand the problem                        | 30%        |
| Problem-solving plan                          | 45%        |
| Solving problem                               | 38%        |
| Paraphrasing and concluding the result         | 20%        |

| Indicator                                      | Percentage |
|------------------------------------------------|------------|
| Understand the problem                        | 46%        |
| Problem-solving plan                          | 51%        |
| Solving problem                               | 40%        |
| Paraphrasing and concluding the result         | 37%        |

Based on Table 3, it can be seen that there is still a small percentage of students who achieve the highest score for each indicator. This shows that the mathematical problem-solving abilities of students are still not as optimally as expected.

Based on the research’s finding, the researchers argue that the right solution to overcome this problem is to develop learning tools, especially lesson plans and student worksheets because it can help teachers and students to achieve learning objectives and create meaningful learning by providing students with learning experiences and learning experiences. according to the program of expertise, one learning approach that can make students to be involved in the learning experience so that learning activities
center on students and can develop thinking skills in solving mathematical problems, namely by applying constructivism-based learning.

Constructivism is a theory of cognitive development that emphasizes an active role in building their understanding of the knowledge they learn so that it can be applied in solving mathematical problems. The development of teaching materials in the form of constructivism-based student worksheets is expected to improve problem-solving abilities because the authors think they can lead students to achieve indicators of problem-solving abilities. Through the development of learning tools in the form of constructivism-based student worksheets, students are asked to construct their understanding of the subject matter based on the initial knowledge they already have. In the learning process, the teacher helps students find concepts and apply them in problem-solving through scaffolding techniques. At the initial stage, the teacher still guides how to solve the subject matter problems completely. Furthermore, assistance and guidance will be gradually reduced. Constructivism is the basis of thinking in contextual learning, namely that knowledge is built by humans little by little whose results are extended through a limited context [15]. An educator in the constructivist class encourages students to find their way of solving problems. Students are empowered by the initial knowledge that is within them, to share resolution strategies, debate with one another, and think critically about the best way to solve problems [16].

According to Suparno, five components characterize constructivism which is explained as follows: (1) Orientation, meaning that students are allowed to develop motivation in learning a topic, students are allowed to make observations on the topic to be studied; (2) Elicitation, meaning that students are helped to express their ideas clearly by discussing, writing, making posters, and so on. Students are allowed to discuss what was observed, in the form of writing, pictures, or posters; (3) Idea restructuring, in this case, there are three things, namely, (a) Classification of ideas that are contrasted with the ideas of other people or friends through discussion or through gathering ideas. Faced with other ideas, a person can be aroused to reconstruct his ideas if they do not fit or vice versa, become more certain when his ideas are compatible; (b) Building new ideas. This happens when in the discussion the idea contradicts another idea or the idea cannot answer the questions asked by friends; (c) Evaluating the idea by experimenting. If possible, it is best if a new idea is formed to be tested by a new experiment or problem; (4) Application of ideas, the use of ideas in many situations. Ideas or knowledge that have been formed by students need to be applied in various situations at hand. This will make the student's knowledge more complete and even more detailed with all the exceptions; (5) Review, how that idea changed. It can occur in the application of knowledge to situations faced daily, someone needs to revise their ideas either by adding a description or maybe turning it into a complete one [17].

Thus, learning with a constructivist approach is a learning process that can make the knowledge obtained by students last a long time, because students find and construct their knowledge so that it can help students solve various contexts of problems in everyday life.

Based on the description above, constructivism-based learning can be an alternative solution to improve students' mathematical problem-solving abilities. Learning experiences in constructivism-based learning are expected to be able to trigger students to become human resources who are ready to work as the learning objectives in vocational high school.

4. Conclusion
The results showed that the mathematics learning media used by teachers in schools were still general and had not been able to facilitate students to build their concepts and improve problem-solving abilities. This is because the learning media used do not link the subject with the skills program of students and with everyday life so that learning becomes meaningless. The learning media used by the teacher cannot help students think logically, be active, and motivate students to learn mathematics. Based on the results of this study, further action is needed in the form of research on the development of constructivism-based learning media to improve the mathematical problem-solving abilities of students in the Computer and Network Engineering Competency of Vocational High School.
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