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Mathematical Problem Solving Ability of Vocational School Students Reviewed from Self Regulated Learning in Selective Problem Solving (SPS) Assisted Learning Management System (LMS) Learning

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Abstract

Problem-solving abilities are one of the five standards of mathematical ability that students must have (NCTM). This study aims to describe the ability to solve mathematical problems in LMS-assisted SPS learning in terms of self-regulated learning (independent learning). The research method used is a mixed method with a concurrent embedded design method. This research was conducted at SMK Negeri 1 Bawen in the academic year 2019/2020. The subjects in this study were students of class XI which consisted of one experimental class with LMS assisted SPS learning and one control class. In the experimental class, two students were chosen from high, medium and low levels of independence. Hypothesis testing uses the proportion test, the average completeness test, the proportion difference test and the average difference test. The results showed that students with high learning independence could carry out each stage of problem solving well, students with moderate learning independence could carry out each stage of problem solving well but some stages were sometimes missed, while students with low learning independence could not carry out all complete problem-solving stages so that you cannot find a solution to the problem correctly.

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INTRODUCTION

The five standards of mathematical ability that students must have according to the National Council of Teachers of Mathematics (NCTM) are problem solving skills, communication skills, connection skills, reasoning skills, and representation skills. (representation) (Rahayu, 2017). In Permendikbud Number 21 of 2016 concerning Content Standards, it is emphasized that one of the objectives of the Mathematics subject content includes determining effective problem-solving strategies, evaluating results, and making announcements. The Indonesian government itself through the National Education Standards Agency (BSNP) states that one of the objectives of learning mathematics is that students have the ability to solve problems which include the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained (BSNP, 2006). These explanations place problem solving as an important part of the mathematics curriculum.

Self Regulated Learning (independent learning) is one of the factors that determine the success of students' studies. The importance of Self Regulated Learning in mathematics is supported by the results of Pintrich's study (in Cheng, 2011) with the findings, among others: individuals who have high Self Regulated Learning (SRL) tend to learn better, are able to monitor, evaluate, and organize their learning effectively, save money. time to complete the task, manage learning and time efficiently. Antonius (Maulana, 2013) has the view that an independent person will appear willing and able to realize his will and desire as seen from real action as an effort to fulfill his needs. Yang in Hargies (Hendriana, 2017) reports that students who have high SRL: a) tend to learn better in their own supervision than in program supervision, b) are able to monitor, evaluate, manage their own learning effectively, c) save time in completion his duties; and d) manage study and time efficiently. Wongsri, Cantwell, Archer (Hendriana, 2017) suggest that SRL must be owned by every individual, especially those who attend tertiary education (higher education). According to Paris and Winograd (The National Science Foundation, 2000), independent learning is not only thinking about thinking, but helps individuals use their thinking in designing designs, choosing learning strategies and interpreting their appearance so that individuals can solve their problems effectively.

Wongsri, Cantwell, Archer (Hendriana, 2002) suggested that independent learning can be developed through relevant learning. In line with this opinion, Butler (2002, in Sumarmo, 2006b, 2014) suggests that teachers should help students carry out the independent learning cycle in a flexible and adaptive manner, namely through: analyzing tasks, selecting and implementing strategies, monitoring themselves and reflecting.

From the description above the writer sees a relationship between Self Regulated Learning and problem solving abilities, as well as the importance of developing independent learning in order to improve students' mathematical problem solving abilities. This belief is supported by the results of Faroh's (2014) research which states that there is a positive effect of independent learning and problem-solving skills on problem-solving abilities by 79%.

The ability to solve math problems of students in Indonesia is generally still lacking. The low ability of students to solve problems can be seen from the results of an international study, namely the Program for International Student Assessment (PISA) organized by the Organization for Economic Cooperation and Development (OECD). The PISA report in 2015, the mathematics score of Indonesian students was in position 64 out of 72 countries with an average score of 386, while the average international score was 490 (OECD, 2016).

SMK Negeri 1 Bawen is one of the Vocational High Schools (SMK) in Indonesia which in 2013 was selected as a Reference SMK. By becoming a reference school, it is hoped that it can produce quality graduates. One of the indicators of quality graduates is those who have the ability to solve problems.

From the initial observations made on 36 students, there were 3 students (8.33%) who could solve math problems correctly, there were 9 students (25%) who almost solved the problem correctly and 24 other students (66 , 67%) were unable to solve the problem properly. These experiments can show that the students' mathematical problem solving abilities are still low.

The results of the 3-year National Examination also show that the problem-solving abilities of students in SMK Negeri 1 Bawen are still low. The average score for the 2015 National Mathematics Examination was 52.77; 2016 was 44.73; and the year 2017 is 44.49.

The results of interviews with students who cannot solve the problem correctly indicate that their Self Regulated Learning is lacking. This can be seen from the information that their learning initiative is lacking, they are often confused in choosing the material to be studied, never have an achievement target, are less interested in solving problems, and rarely use learning resources other than their notebooks.

One learning model that teachers can apply to help students solve math problems is the Selective Problem Solving (SPS) learning model. Manah (2017) in his research said that learning mathematics with the SPS learning model can achieve learning completeness. According to Sak (2011), the purpose of the SPS learning model is to develop creative thinking and problem-solving abilities through the use of analogical, deep, and selective thinking, and to enrich individual knowledge so that it can be transferred to different problem situations.

Edmodo. According to Stroud (in Kusuma, 2016), Edmodo is a social networking site used for educational purposes. Edmodo's advantages include the user interface, compatibility, and application-based (Fahdisjro, 2013). Students of SMK Negeri 1 Bawen get an explanation about the use of Edmodo in Digital Simulation subjects in class X. The use of Edmodo has an important role in the learning process, namely as a medium for learning mathematics (Imam, 2013). The results of the study (Al-said, 2015) state that Edmodo learning process can create interesting, innovative and effective learning activities. Wardono's research (2016) states that e-learning with Edmodo gives good results in learning mathematics.

Based on the description above, the researcher conducted a study with the aim of describing the ability to solve math problems in LMS-assisted SPS learning in terms of self-regulated learning.

METHODS

This research is a mixed method research with the concurrent embedded design method (unbalanced mixed design). This research focuses more on quantitative research methods as primary methods, and qualitative methods as secondary methods for obtaining data to support data obtained from primary methods.

Qualitative research in research, as supporting data to analyze the ability to solve mathematical problems in terms of three categories of self-regulated learning. This research begins with a preliminary study, then collects quantitative as well as qualitative data followed by data analysis and interpretation. The research design used in quantitative research is a quasi-experimental design involving two groups (experimental and control).

This research was conducted at SMK Negeri 1 Bawen with the research population being students of class XI in the academic year 2019/2020. The population of this study were all students of class XI. Of the 22 classes, 3 classes were selected using cluster random sampling, namely for the initial problem-solving ability test trial class, for the control class namely Problem Based Learning learning, the experimental class using LMS-assisted Selective Problem Solving learning. In the experimental class, self-regulated learning was categorized on each student (high, medium, and low self-regulated learning). Each group selected two students as qualitative research subjects to analyze their mathematical problem-solving abilities in solving a problem.

Quantitative data collection techniques are carried out by tests of mathematical problem solving abilities. While the data collection techniques in this qualitative study used questionnaires, observation, interviews and documentation. The quantitative data were tested using the normality test, homogeneity test, classical completeness test, average completeness test, proportion difference test, average difference test and mathematics problem solving ability improvement test. While qualitative data analysis follows the concept of Miles & Hubermen (2007) with the following steps, namely data reduction, data display (data presentation), and conclusions (conclusions).

RESULTS AND DISCUSSION

At the learning planning stage, the validation of learning tools, research instruments and item analysis were carried out. The results of the learning device validation are listed in Table 1.

Table 1. Validation Results of Learning Devices

Device	Average	Category
Syllabus	4.60	Very good
Lesson Plan	4.66	Very good
Student Worksheets	4.57	Very good
Instructional Materials	4.63	Very good

From table 1, it can be concluded that the average score for learning devices is 4.62 which is very good category, so that the learning devices that have been arranged are suitable for use in research.

The results of the research instrument validation are presented in Table 2 below.

Table 2. Results of Research Instrument Validation

Research Instrument	Average	Category
Math Problem Solving Ability Test	4.80	Very good
Interview Guidelines	4.50	Very good
Learning Independence Questionnaire	4.59	Very good
Learning Independence Questionnaire	4.70	Very good

From table 2, it can be concluded that the average score for all instruments is 4.65 in the very good category, so that the instrument that has been prepared is also suitable for use in research.

Table 3. Results of Analysis of Math Problem Solving Ability Test Questions

Number	Validity	Reliability	Power of Difference	Level of Difficulty	Explanation
1	Valid	Reliable	Bad	Easy	Reject
2	Valid		Good	Easy	Accepted
3	Valid		Good	Easy	Accepted
4	Valid		Good	Easy	Accepted
5	Valid		Bad	Moderate	Reject
6	Valid		Enough	Moderate	Accepted
7	Valid		Bad	Moderate	Reject

From Table 3, the results show that the questions used for the problem-solving ability test are questions number 2, 3, 4, 5, and 6.

At the implementation stage, it is measured by observing the implementation of learning.

Table 4. Observation Results of Learning Implementation

No	Learning Quality	Average	Criteria
1.	Meeting 1	4.58	Very good
2.	Meeting 2	4.60	Very good
3.	Meeting 3	4.55	Very good
4.	Meeting 4	4.65	Very good

Based on Table 4, it can be seen that the average observation of the implementation of learning is in the very good category, so it can be concluded that the researcher's ability to prepare and manage learning is in the very good category.

At the assessment stage of the implementation of learning, the results of students' responses to learning were obtained.

Table 5. Results of Students' Responses to Learning

Response	Percentage
Positive Response	84.37
Negative Response	15.63

Based on Table 5, it was found that students who gave a positive response to learning were more than 75%. This shows that the majority of students,

namely 84.37%, considered that the SPS learning assisted by Edmodo was implemented well.

The quality of learning is quantitatively determined based on the proportion of completeness test, the average completeness test, the proportion difference test and the average difference test.

From the assessment of learning outcomes, it was found that the results of Math Problem Solving Ability Test were normally distributed with sig = 0.092 and homogeneous with sig = 0.235. In calculating the proportion of completeness test and average completeness test, the significance level or α used is 0.05. The proportion of completeness obtained was 87.5%, with the value of $z_{count} = 0{,}3961$ and $z_{0,5-\alpha} = 1{,}64$. So that $z_{count} > z_{0,5-\alpha}$ means the proportion of experimental class students who have achieved completeness of more than 85%. The average value obtained is 72, with the value of $t_{hitung} = 2{,}4586$ and $t_{(1-\alpha),dk} = 1{,}684$ so that $t_{hitung} > t_{(1-\alpha),dk}$, which means the average solving ability Mathematical problems of students from the class who received learning materials using the SPS learning model assisted by Edmodo is more than 65. From the calculation of the proportion difference test, the results obtained were $z_{count} = 3{,}031$ and $z_{(0,45)} = 1{,}64$. Because $3{,}031 > 1{,}64$ then $z_{count} \geq z_{(0,5-\alpha)}$, meaning that the proportion of completeness of class students who obtained learning material using the SPS learning model assisted by LMS was more than the proportion of completeness of class students who received learning material using the PBL learning model. From the calculation of the average difference test, the results obtained $t_{count} = 3{,}974$ and $t_{(1-\alpha),dk} = 1{,}699$. Because $t_{hitung} > t_{(1-\alpha),dk}$, the average mathematics problem solving ability of class students who received LMS-assisted SPS learning material was more than those who received learning material using the PBL learning model.

Table 6. Final Math Problem Solving Ability Test Results

Class	Average Math Problem Solving Ability Test
Experiment Class	72.50
Control Class	58.26

Based on the results of the description above, it can be concluded that learning with the Selective Problem Solving (SPS) model assisted by LMS is included in the quality category.

The giving of independent learning questionnaires in the experimental class was carried out 2 times, namely before receiving LMS-assisted SPS learning and after receiving LMS-assisted SPS learning. From giving a questionnaire before LMS-assisted SPS learning, it was found that 11 students had low learning independence, 16 students had moderate learning independence and 5 students had high learning independence. From giving a questionnaire after LMS assisted SPS learning, it was found that 9 students had low learning independence, 19 students had moderate learning independence and 4 students had high learning independence. Based on these results, information is obtained that there is a difference between the learning independence of students before and after learning. The results of this difference will be used to determine the increase in learning independence of students before and after LMS-assisted SPS learning.

The Math Problem Solving Ability Test results obtained by students with high learning independence, namely SE02 and SE27 are 100 and 80. Based on the results of Math Problem Solving Ability Test and interviews, it is seen that SE02 can understand the complete problem problems, make plans according to procedures and lead to correct solutions, carry out the process correctly and get the correct results, checks are carried out to see the correctness of the process. Meanwhile, SE27 can understand the complete problem problem, make the correct plan, but not complete, carry out the process correctly and get the correct result, an examination is carried out to see the correctness of the process.

The Math Problem Solving Ability Test results obtained by students with high learning independence, namely SE06 and SE25 were 77.5 and 72.5. Based on the results of Math Problem Solving Ability Test and interviews, it appears that SE06 can understand the full problem of the problem, make a correct but incomplete plan, carry out the process correctly and get the right result, and carry out checks to see the correctness of the process. Meanwhile, SE25 understands the complete problem of the problem, makes a correct plan, but is

not complete, carries out the correct procedure and may produce the correct answer but miscalculated, there is an examination but is not complete.

Math Problem Solving Ability Test results obtained by students with high learning independence, namely SE01 and SE32 are 60 and 65. Based on the results of Math Problem Solving Ability Test and interviews, it is seen that SE01 can understand the complete problem problems, make plans that are right but wrong in results / no results, carry out procedures correct and may result in the correct answer but miscalculated, there is a check but not complete. Meanwhile, SE32 misinterpreted some of the questions, ignored the condition of the questions, made a correct plan, but was not complete, carried out the process correctly and got the right result, there was an examination but it was not complete.

At the stage of understanding the problem (understanding the problem), students with high, medium or low learning independence can understand the problem in full.

At the devising a plan stage, students with high learning independence can make plans according to the procedure and lead to the correct solution, students with moderate learning independence can make correct plans but are not yet complete and students with low learning independence can make plans right but wrong in results / no results.

At the carrying out the plan, students with high learning independence can carry out the process correctly and get the right results, students with moderate learning independence can carry out the correct procedure and may produce the right but wrong answer and students with low learning independence can carry out correct procedures and may produce correct but incorrect answers.

At the stage of checking back (looking back), students with high learning independence carry out checks to see the truth of the process, students with moderate and low learning independence carry out an examination but are not complete.

The learning carried out in the experimental class used SPS learning assisted by Edmodo LMS. The learning activity lasts for 3 weeks (6 meetings) with details of 2 meetings for Math Problem Solving Ability Test (pre-test and post-test) and filling out a questionnaire for students' learning independence, the remaining meetings are held online using Edmodo. At the first meeting after giving the pre-test and questionnaire for students' learning independence, researchers provided information to students regarding the learning to be applied using the Learning Management System, namely Edmodo. Therefore, the teacher provides opportunities for students to join Edmodo classes that have been prepared by the researcher. The results of students' responses regarding the application of SPS learning assisted by Edmodo, the average score was 68.86 or 68%, so it can be concluded that students assessed the learning being carried out as good and students felt happy to have new experiences in learning.

CONCLUSION

The results of this study indicate that learning with the Selective Problem Solving (SPS) model assisted by LMS is effective in students' mathematical problem solving abilities. Students with high learning independence can carry out each stage of problem solving well. Students with moderate learning independence can carry out most of the problem-solving stages well, but some stages are sometimes missed. Students with low learning independence cannot carry out all stages of problem solving completely so they cannot find a solution to the problem correctly.

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