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Mathematical Communication Skills Viewed from Self Regulated Learning (SRL) using LAPS-Heuristic Model with Guilford Approach

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Abstract

This study has the purpose of determining the quality of the learning using LAPS-Heuristic model with Guilford approach in achieving the students' mathematical communication skill and their skills patterns viewed from self-regulated learning (SRL). The research method used was a mixed method with an explanatory sequential design. The first stage was quantitative data collection, and it was done using questionnaires to categorized the subject and tests. The next stage was qualitative data collection, and it was done using triangulation techniques such as questionnaires, tests, and interviews. Based on the analysis and discussion, it can be concluded that: the learning with the LAPS-Heuristic model with Guilford approach is categorized in a very good quality in achieving the mathematical communication, seen from the classical completeness of the experimental class which is more than 75%, the classical completeness is better, the average of mathematical communication skill is better, the n-gain increased in the medium category, the mathematical communication skills in subjects with high SRL tend to meet the aspects of writing information, making mathematical models, and drawing diagrams very well; subjects with moderate SRL tend to fulfill aspects of writing information, making mathematical models, and drawing diagrams quite well; subjects with low SRL tend to have lack aspects of writing information, making mathematical models and drawing diagrams.

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INTRODUCTION

Education has a goal to improve the quality of Indonesian people and to achieve this goal, education experts, and the government has compiled effective learning steps called Curriculum 2013 (K-13) following Permendikbud Number 37 of 2018. Fadillah in Anshory, Saputra, and Amelia (2018) stated that the learning implemented according to K-13 is innovative. In its implementation, educators must recognize which subjects are considered difficult by students (learners).

Setyaningrum, Chotim, and Mashuri (2012) stated that mathematics is one of the subjects that is considered difficult by students. Liberna (2012) stated that many people judge mathematics as a difficult subject and not easily mastered, especially by students or learners. From the results of an interview with a mathematics teacher at Public Junior High School 1 Pati, it was stated that students still had difficulty in understanding the essay problem, and determining the mathematical model. The two aspects are included in the three indicators of mathematical communication skills listed in Permendiknas Number 22 of 2006 concerning the purpose of mathematics education.

The National Council of Teachers of Mathematics (NCTM) states that communication is an essential part of mathematics and mathematics education. Bicer, Capraro, R. M. and Capraro, M. (2013) stated that mathematics exists due to the existence of language. Therefore, communication in mathematics has a very important role. Dewi (2015) stated that this mathematical communication is useful for students to make an idea into an object of thought. Halmaheri (2005) given three indicators of mathematical communication skills, including, aspects of writing, aspects of making mathematical models, and aspects of drawing. In 2015, Indonesia was still ranked at 63 out of 72 countries that participated in PISA in the ability of counting, reading, and science. This is supported by the results of the initial mathematical communication skills test given by researcher to the students of grade VII Public Junior High School 1 Pati with an average score of 67, which is still below the school mathematics minimal mathematics pass score of 75. In this preliminary test, students stated that they have difficulty in solving problems independently. This fact shows that self-regulated learning (SRL) of students is still low.

Maes, and Gebhardt in Azka, and Santoso (2015) stated that SRLis a sequence of directed actions and or processes intended to achieve the individual goals. The lack of independence in learning mathematics will greatly affect the learners in understanding the material taught and related to mathematics. Innovative learning is expected to improve the mathematical communication skills and SRL of the learners.

Suherman in Deswita, and Kusumah (2018) said that one of the innovative learning models is LAPS-Heuristic. Krulik, and Rudnick (1988) explained that heuristic is a series of guiding questions in the context of problem solutions. LAPS (Logan Avenue Problem Solving) using the question words of what are the problems are there any alternatives, is it useful, what are the solutions, and how should it be done. It means that the determination of the learning model must also be accompanied by the determination of an appropriate learning approach, which is Guilford approach.

Lunenburg (2012) stated that the knowledge of the main mental abilities of Guilford could be used in the learning activities carried out and planned. The theory of Guilford is also called the structure of intelligence. This theory has three dimensions, including content, operation/process, product. The content dimension refers to the type of information being processed. The operation or process dimension refers to how information can be processed. The product dimension refers to the results of the processing carried out by the operating dimensions of various forms of information content (Kusumadhani, Waluya, and Rusilowati, 2015).

Based on the description above, there are several problem formulations proposed in this study, including the following: (1) how are the

quality of the learning process (planning, implementation, and assessment stage) in the classroom using the Heuristic learning model with Guilford approach, (2) what are the patterns of mathematical communication skills of the learners viewed from the SRL in the LAPS-Heuristic model with Guilford approach.

The objectives of this study are as follows: (1) Analysing the quality of learning with LAPS-Heuristic with Guilford approach model: (a) Planning stage: testing the validity of learning tools with LAPS-Heuristic model with Guilford approach, (b) Implementation stage: analysing the process of learning with the LAPS-Heuristic model with Guilford, (c) Assessment stage: testing the effectiveness of the LAPS-Heuristic model with Guilford approach on the mathematical communication skills, (2) determining the patterns of communication skill of learners on the mathematical communication viewed from the SRL in the LAPS-Heuristic model with Guilford approach.

The hypotheses proposed in this study are as follows: (1) Mathematical communication skills of the smart students in solving open-ended problems in the learning of LAPS-Heuristic with Guilford approach achieve mastery learning, namely the proportion of learners who achieve mastery learning more than 75%, (2) The proportion of classical completeness classes that obtain learning material using the LAPS-Heuristic model using Guilford approach is better than the proportion of classical completeness that obtains the LAPS-Heuristic learning model, (3) The average of mathematical communication skills of the learners in the learning of Heuristics LAPS with Guilford approach are better than the average ability of the learners on the mathematical communication in the LAPS-Heuristiclearning, (4) There is an increase in the mathematical communication skills after applying LAPS-Heuristic learning with Guilford approach.

METHODS

The method used in this study was a mixed-method with a sequential explanatory design. This design starts with collecting and analyzing quantitative data and then collecting and analyzing data in a qualitative manner (Creswell, 2016). The quantitative method was used to determine the effectiveness of LAPS-Heuristic model with Guilford approach on the achievement of grade VII mathematical communication skills in Public Junior High School 1 Pati, and the qualitative method was used to determine the pattern of learners mathematical communication skill viewed from the self-regulated learning (SRL) of student in class VII Junior High School 1 Pati, and the qualitative method was used to determine patterns of learners mathematical communication skills viewed from the self-regulated learning using LAPS-Heuristic model with Guilford approach.

The population used in this study were all students of grade VII Public Junior High School 1 Pati in the second semester of the academic year of 2018/2019, the classes used were grade VII-A - VII-I. The technique used in obtaining sample was random sampling (Sugiyono, 2016). Sampling was carried out randomly using a lottery. In this study, grade VII-H was determined as a control class that is a class with the LAPS-Heuristic model and grade VII-G as an experimental class that is a class with LAPS-Heuristic model with Guilford approach. The determination of the subject was done using purposive sampling technique, by selecting two research subjects from each category of SRL, which is the category of high SRL, moderate, and low (Sugiyono, 2016).

The independent variable in this study was the learning with the LAPS-Heuristic model with Guilford approach, and the dependent variable was the mathematical communication ability viewed from the SRL. The data collection methods used in this study were (1) SRL questionnaire, (2) tests of mathematical communication skills pre and post, (3) interviews to find out more information about the mathematical communication skills on the research subjects, and (4) documentation methods used for obtaining data related to the research.

Quantitative data analysis techniques were used to test the quality of learning of LAPS-Heuristic model with Guilford approach on achieving mathematical communication skills, and qualitative data analysis techniques were used to obtain a description of mathematical communication skills patterns viewed from the SRL in the learning of LAPS-Heuristic model with Guilford approach. This qualitative data was obtained through the triangulation technique of analyzing qualitative data, from an SRL questionnaire, final results, and interviews on six experimental class research subjects. From the six subjects, two subjects were students with high SRL, two subjects with moderate SRL, and two subjects with low SRL which were selected by purposive sampling technique.

RESULTS AND DISCUSSION

Based on the results of the analysis of the SRL questionnaire, experimental class students obtained the fact that each student has different learning independence. The grouping of students based on their SRL category can be seen in table 1.

Table 1. SRL Grouping in Experimental Class

Category	Number of students	Percentage (%)
High	8	26
Moderate	16	53
Low	6	21

Based on table 1 it appears that in the experimental class, students with high SRL were 8, students with moderate SRL were 16, and students with low SRL were 6. The subject chosen was six students, with the following arrangement: 2 students from the category of high SRL with the highest score and lowest score, two students of the moderate SRL category with the highest and lowest score, and two students in the low SRL category with the highest and lowest score.

The Quality of Learning using LAPS-Heuristicwith Guilford Approach

Planning stage

The measurement of the quality of learning in the planning stage was carried out by testing the validity of learning tools and research instruments. The learning tools and research instruments are said to be valid if the average score of each learning device and research instrument from expert validators is in the good or very good category. The validation of the learning tools includes syllabus, lesson plans, group activities, and handout materials. The validation of the research instruments include the teacher skills observation sheets, the learning implementation observation sheets, the student activity observation sheets, the mathematical communication skills test, the interview guidelines, and the student SRL questionnaire. The validation scores of the learning tools can be seen in table 2.

Table 2. The Validation Result

Tools	Average score	Category
Lesson plans	4.35	Very good
Group activities	4.45	Very good
Handout materials	4.4	Very good
Average	4.425	Very good

Based on table 2 it can be seen that the average score of the results of the validation of the learning tools by an expert validator is 4.425, which is categorized in the excellent category. Therefore, it can be concluded that the learning tools made by the researcher are suitable to be used in the research. Then, the results of the validation of the research instrument can be seen in table 3.

Table 3. The Validation Result

Tools	Average score	Category
SRL questionnaire	4.5	Very good
Mathematic communication skill test	4.5	Very good
Interview guide	4.4	Very good
Teaching skill observation paper	3.6	Very good
Implementation of leaning observation paper	3.85	Very good
Student activities observation paper	3.8	Very good

Based on table 3 it can be seen that the results of the assessment of the expert validator, obtained an average score for the research instrument included in the excellent category. Therefore, it can be concluded that the research instrument is feasible to be used for the research. From the two assessments on the learning tools and research instruments that categorized in the excellent category, the planning stage is included in the qualified category.

Implementation stage

In the implementation stage, the measurement of the quality of learning using the LAPS-Heuristic model with Guilford approach was carried out by conducting observations on the teaching skills, the implementation of learning, and the student activities. The measurements of the three components were seen from the observation sheet of each component. The learning is considered qualified if the observations of the three components are at least included in the good category. Observations during the learning process were carried out by two observers. The learning process was carried out in three meetings. The results of observations of the implementation of learning can be seen in table 4.

Table 4. Observation of Implementation Stage

Observed aspect	Meeting			Average	Category
	1	2	3		
Teaching skliis	3.7	3.8	4	3.8	Very good
Learing implementaion	3.8	3.9	4	3.9	Very good
Student activities	3.9	3.9	4	3.9	Very good
Average	3.8	3.8	4	3.9	Very good

Based on table 4 it can be seen that the average implementation of learning at the first, second, and third meeting is 3.9, which is included in the excellent category. Therefore, it can be concluded that the implementation of the learning of LAPS-Heuristic model with Guilford approach that has been implemented by the researcher was qualified.

Assessment stage

In the assessment stage, the measurement of the quality of learning of LAPS-Heuristicmodel with Guilford approach was carried out quantitatively by providing pre and post-test of mathematical communication skill.

Pre-test of research data

Three tests were conducted for the initial data analysis, namely the normality test, the homogeneity test, and the average similarity test. The normality test was performed with the help of SPSS 20 software, with the results of the sig values of the two sample classes in the Kolmogorov-Smirnov Test being 0.241 and 0.263 both greater than 0.05 so that H_0 is accepted. Therefore, the initial data are normally distributed. In the homogeneity by SPSS 20, it was obtained that the sig value of the sample class is 0.075 > 0.05 so that H_0 is accepted. Therefore, the pre-test data has a homogeneous variance. In the average of two similarity test, using the Mann Whitney test assisted by SPSS 20, obtained a sig value of 0.657 > 0.05 so that H_0 is accepted. Therefore, it is concluded that there is no difference in the average initial mathematical communication skills in the experimental class and the control class.

Post-test of research data

Before testing the hypothesis, a prerequisite test was first performed, namely the normality test and the homogeneity test, to determine the statistical test that will be used in the parametric test hypothesis or the nonparametric test.

The normality test results showed that the class VII-G sig value (experimental class) 0.106 > 0.05 and class VII-H sig value (control class) 0.181 > 0.05 so that H_0 is accepted. Therefore, the post-test results are normally distributed.

In the homogeneity test results obtained sig value for both classes is 0.064 > 0.05 so that H_0 is accepted; therefore, the post-test results have homogeneous variants. Based on the prerequisite

test results, the statistical test used is the parametric test.

Hypothesis test 1

Based on the average initial test score, the KKM obtained by the Mathematical Communication Skill of learners is 71. The final mathematical communication test results of the experimental class can be seen in figure 1.

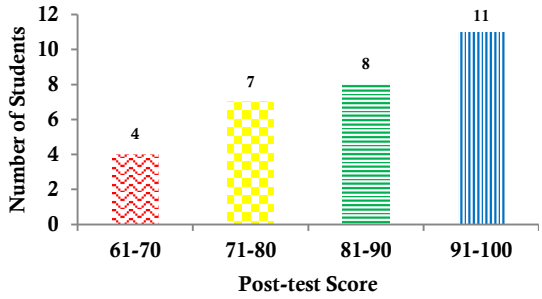

Figure 1. Final Test Score of VII-G

Based on figure 1 it can be seen that the learners who meet the minimal pass score limit are 26 learners out of 30 learners, whereas, four other learners were below the minimum pass score. In the average proportion difference test using the z-test, the calculated z_{value} = 1.714 and z_{table} = 1.64, therefore, according to the testing criteria, H_1 is accepted, so that the proportion of students in the experimental class who completed the learning is more than 75%. Therefore, it can be concluded that 75% of the experimental class students are completed classically.

Hypothesis test 2

One way the proportion of different test was carried out to determine the proportion of classical completeness of the experimental class and the control class. From the z-test calculation, the z_{value} = 1.8317 with z_{table} = 1.64. $Z_{value} > z_{table}$ so that according to the test criteria. H_1 is accepted. Therefore, the proportion of the classical completeness of class that obtains the learning material using LAPS-Heuristic model with Guilford approach (experimental class) is more than the proportion of the classical completeness of class students who obtain learning using LAPS-Heuristic model (control class).

Hypothesis test 3

The average difference test done using by SPSS 20 serves to test the average mathematical communication skills of the experimental class compared to the control class. From the calculation results obtained the sig value of (2-tailed) is 0.039 < 0.05 and t_{value} = 2.870 > t_{table} = 2.009 so that H_0 is rejected, and H_1 is accepted, therefore, the average of mathematical communication skills of students who obtained learning material using the LAPS-Heuristic model with Guilford approach is more than the class that obtained learning material using the LAPS-Heuristic model.

Hypothesis test 4

The gain test was used to determine the improvements in the experimental class and the control class. Based on the n-gain calculation, it was found that the gain normality value in the experimental class is 0.60 in the medium category, then in the control class, the normality gain value is 0.57 in the medium category. It can be concluded that the two classes experienced almost the same increase with a difference of 0.03 compared to the experimental class. The learning in the experimental class using the LAPS-Heuristic model with Guilford approach was considered qualified since the gain normality values obtained are in the medium category.

The test results based on hypothesis showed that the learning using the LAPS-Heuristic model with Guilford approach was effective in achieving the mathematical communication skills of the learners. Then, at the planning stage, the implementation stage, and the learning assessment stage using the LAPS-Heuristic model with Guilford approach was qualified.

The Mathematical Communication Skills Viewed from SRL

Based on the triangulation of the qualitative data analysis techniques through questionnaires, final mathematic communication skill test, and interviews related to students' mathematical communication abilities towards

Subject A_1 and Subject A_2 with high learning independence, Subject B_1 and Subject B_2 with moderate learning independence, whereas, Subject C_1 and Subject C_2 with low SRL.

The following is a summary of qualitative analysis using triangulation of data collection techniques in the classroom using LAPS-Heuristicmodel with Guilford approach. Then, the summary of the analysis of the learner's mathematical communication skills viewed from the SRL can be seen in table 6.

Table 6. Resume of Mathematical Communication Skills Viewed from SRL using LAPS-Heuristic Model with Guilford Approach

Mathematical communication skill indicator	SRL Category		
	High	Moderate	Low
The arguments based on the picture or formal concept's analysis (writing aspect).	Freely communicate the mathematic ideas either verbally or non verbally and write the problem's information completely and correctly.	A little hesitantly communicate their mathematic ideas, needed their friend confirmation of the solution first, either verbally or non verbally, and write the problem's information correctly.	Having difficulty to communicate the mathematic ideas either verbally or non verbally and in writing the problem's information tend to it incompletely.
Forming a mathematic model or algebra equation (forming a mathematic model aspect)	Always easily determine the formula, doing the substitution and calculation correctly.	Determining the formula correctly, doing the substitution and calculation correctly, seldom put the answer not in order or incomplete.	Having difficulty in determining the formula, more often doing the substitution and calculation inconsistently.
Drawing a conceptual model such as a table, diagram, or graphic (drawing aspect)	Drawing the table and diagram correctly, complete, and in order.	Drawing the table and diagram correctly and clearly.	Drawing the table correctly, having difficulty in differentiating the function of each kind of diagram.

Based on table 6 it can be seen that students with high SRL also have excellent communication skills. This is in line with the research conducted by Fahradina, Ansari, and Saiman (2014) regarding the main characteristics of self-regulated learning is the development of learners ability to conduct the learning processes that are not dependent on the factors of educators, friends, class, and others.

The level of student's SRL in the learning can be determined based on the level of the initiative, confidence, and responsibility of the learners to play an active role in the learning. The greater the active role of the learners in various learning activities indicates that the learners have a high level of learning independence. Learners with high learning independence tend to be more flexible in expressing the mathematical ideas that they have.

In accordance with the theory of Zumbrunn, Tadlock, and Roberts in Azka, and Santoso (2015) that the essence of SRL lies in the learning process, educators can help student create positive learning habits and strengthen their learning abilities, apply learning strategies to improve student learning outcomes, monitor student performance them, and evaluate their academic progress. Learning with the theme "Traditional Markets" in this study helps students become the focus in providing various examples of problems in daily life, active students in question and answer with group friends because they think following the experience they get when going to the traditional market.

This is in line with the theory expressed by Sungkono (2006) that this thematic learning has an important role in increasing the attention, learning activities, and understanding of students towards the material learned, since the learning which is more student-centered, providing direct learning experiences to participants students, presenting concepts in a learning process, are flexible, learning outcomes can develop according to requests, and the needs of students.

CONCLUSION

Based on the analysis and discussion, it can be concluded that mathematical communication skills influenced by the learning process, the

LAPS-Heuristic model with Guilford approach is categorized in a very good quality in achieving the mathematical communication, the mathematical communication skills in subjects with high SRL tend to meet the aspects of writing information, making mathematical models, and drawing diagrams very well; subjects with moderate SRL tend to fulfill aspects quite well; subjects with low SRL tend to have lacked all aspects. The student who had lack ability in nonverbal communication tends to do good at verbal communication. That could be seen by the interview face to face with the researcher. Although they seem a little bit uncertain, they could explain how to solve the math problem correctly. The teacher could give more encouraging, motivating, and routine practice verbally and nonverbally to the student with moderate and low communication skills, so their mathematical communication skills could be level up.

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