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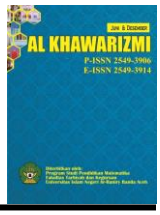

DESCRIPTION OF PROCEDURAL FLUENCY AND PRODUCTIVE MATHEMATICAL DISPOSITION OF MIDDLE SCHOOL STUDENTS

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Abstrak

The purpose of this research is to describe the mathematical procedural fluency ability and the level of mathematical productive disposition of students in class VIII SMP Negeri 1 Baitussalam, Aceh Besar, which is needed to determine the factors that cause these two abilities to be low and possible solutions to be given to overcome these problems. the. Both of these abilities are very important to analyze, because they are related to current assessments of student abilities, such as PISA and so on. This study used descriptive qualitative research with three students as subjects grouped into three categories namely high, medium and low. The results showed that mathematical procedural fluency (1) students in the high level category fulfilled all indicators. (2) students in the moderate level category fulfill two of the three indicators. (3) students in the low level category only meet one indicator. And the results for mathematical productive dispositions: (1) students with a high level fulfill all indicators (2) students in the medium level category fulfill five of the seven indicators (3) students in the low level category only fulfill two of the seven indicators.

INTRODUCTION

The National Council of Teachers of Mathematics (NCTM) has set standards for mathematical ability including mathematical communication, mathematical reasoning, mathematical problem solving, mathematical connections and representation. Students' mathematical ability becomes an important point in the learning process and in solving mathematical problems. To achieve the intended mathematical abilities, students must have skills in carrying out mathematical activities which are called mathematical skills. This mathematical proficiency is mentioned by Kilpatrick, Swafford, and Findell in their book

with the term mathematical proficiency which is used to fully describe the areas of mathematical expertise, knowledge, competence, facilities in mathematics and the perceived importance of all these fields so that mathematics can be studied successfully. Kilpatrick et al. states that mathematical proficiency has 5 interrelated components, namely: 1) Conceptual Understanding; 2) Procedural Fluency; 3) Strategic Competence; 4) Adaptive Reasoning; 5) Productive Disposition (Kilpatrick et al, 2001:34).

These five components are very important for students to have. If there is one component that is not mastered, it will greatly affect the other components. For example, if the component or ability to understand concepts is low, it will cause other abilities to be disrupted. However, the reality on the ground shows that there are still students whose mathematical prowess varies. Some are already good, some are still weak. Of course, this weakness needs to be studied further to find out the causes of this weak mathematical ability. Based on the results of initial observations conducted by researchers at Baitussalam 1 Public Middle School, namely in class VIII-1 with 27 students, the weakness of some abilities from mathematical proficiency was seen through a test of 5 components by providing questions that contained 4 components of mathematical proficiency, namely conceptual understanding (understanding of concepts), procedural fluency (procedural fluency), strategic competence (strategic competence), and adaptive reasoning (adaptive reasoning). Meanwhile, 1 component of math proficiency, namely the productive disposition component, the researcher did not provide in the form of questions, but statements concerning students' attitudes towards learning mathematics as many as 30 statement items.

The results of the observations show that of all the components of mathematical proficiency that have been tested on students, only one component has quite good results, namely the conceptual understanding component. Meanwhile, the other 4 components of math proficiency, namely procedural fluency, strategic competence, adaptive reasoning, and productive disposition, have not yet achieved good or maximum results. Therefore, it really needs to be studied more deeply, so that in the future it can be improved. Correcting this is of course taking into account the results of the problems found or the factors causing the low ability, then an appropriate solution will be given.

Weak abilities that every student should have were also obtained in research conducted by Uray Windi Haryandika which revealed that students did not fully have good mathematical procedural fluency because students often asked the teacher what steps to take to solve the problems they do (Haryandika, 2017:72-77). Students have not been able to know when and how to use procedures flexibly, efficiently and effectively, they can only work on the same questions as the example questions the teacher explained on the blackboard. Therefore, this study focuses on procedural fluency, because after understanding the concept, the next ability that must be possessed by students is procedural fluency. Procedural fluency is so important to be mastered by students, it affects other mathematical abilities or skills. If students' procedural fluency is good, then other mathematical skills will also be good. Therefore it is necessary to analyze and know the factors that influence these abilities, so that later the right solution will be given to improve students' procedural fluency skills. (Hamid, 2020).

In addition to mathematical procedural fluency, there is something that is no less important to note in studying mathematics, namely the attitude of respect for mathematics

and its use in life. In Permendikbud Number 21 of 2016, the scope and level of competence that must be met by students are adjusted to national education goals and graduate competencies, namely attitudes, knowledge and skills. A high productive disposition will result in students being more enthusiastic in learning mathematics, which will have a positive effect on the grades students get. When the cause of the low level of productive disposition is found, solutions will be considered that will be used in the future to overcome the problem (Darwani, et.al, 2020),Thus, productive disposition is also very important to be discussed in this study.

Based on the problems that have been discussed, it is necessary to examine more deeply the mathematical procedural fluency abilities and productive dispositions of students in order to guide students in using their procedural knowledge smoothly, correctly, and flexibly in solving a mathematical problem, and students also have positive attitudes and views towards math itself.

There are several definitions of procedural fluency based on the opinions of experts, namely, according to Kusnawa, procedural fluency is knowledge of how to do something. Covers knowledge of skills and algorithms, techniques which as a whole are known as procedures or can be described as a series of steps (Rahman, 2018: 236). Kilpatrick et al. states that mathematical procedural fluency refers to knowledge of procedures, knowledge of when and how to use them appropriately and skills in doing so flexibly, accurately and efficiently (Kilpatrick et al., 2001:43).

In line with these matters, Watson and Sullivan revealed that mathematical procedural fluency involves applying procedures flexibly, accurately, efficiently, precisely, and having factual knowledge and concepts that come to mind easily (Watson et al., 2008: 56). The procedure here can be interpreted as a specific step-by-step description that is carried out at one time (Novita, 2018: 3). So it can be concluded that mathematical procedural fluency, namely the ability to use procedures appropriately, flexibly and efficiently.

Kilpatrick et al. mentions mathematical procedural fluency includes three indicators: a) Knowledge of procedures in general. b) Knowledge of when and how to use procedures correctly. c) Knowledge of performing procedures flexibly, precisely, and efficiently. Therefore the researchers measured procedural mathematical fluency according to indicators from Kilpatrick et al.

Procedural fluency can be achieved by someone with procedural fluency indicators. According to Hudiono, students can be categorized as having procedural knowledge if they are able to:

a. Select and apply procedures correctly and precisely
b. Proving or checking correctly from a method using symbolic methods or concrete models
c. Develop steps to describe various factors in mathematical problems (Hudiono, 2003:56).

Mathematical disposition is one of the influential factors in learning mathematics for students. Katz defines a disposition as a tendency to behave consciously, regularly and voluntarily in order to achieve the desired goals. These behaviors include persistence,

confidence, flexible thinking and curiosity to explore possible alternative solutions to problems and are also closely related to students' ability to reflect on their thoughts (Muslim, 2018: 3).

Katz defines mathematical disposition as a way for students to solve mathematical problems; are interested, diligent, confident, and think flexibly to explore various possible alternative solutions to problems. In learning, mathematical disposition is closely related to how students ask questions, answer questions, communicate mathematical ideas, work in groups, and solve problems (Trisnowali, 2018: 48).

Productive disposition ability can be measured with observational instruments, while the other 4 components can be measured with pencil and paper. In the book Kilpatrick et al. provide explanations related to productive disposition indicators including: (1) *beliefs*, (2) *attitudes*, dan (3) *confidence*. But Siegfried explains the mathematical productive disposition in detail in his dissertation by making connections between productive dispositions and other affective abilities. According to Siegfried, indicators of productive disposition are as follows:

a. Mathematics as a reasonable endeavour
b. Mathematics as beauty, useful and valuable
c. The belief that one can learn mathematics with the right effort
d. The habit of thinking mathematically
e. Mathematical integrity and academic risk taking
f. Positive goals and motivation
g. *Self-Efficacy* (Siegfried, 2012:66).

From the indicators above, students are said to have a productive disposition if they fulfill 7 categories. The indicators mentioned in detail by Siegfried include those from Kilpatrick et al. Therefore in this study, to measure students' mathematical productive dispositions using the indicators mentioned by Siegfried.

As for the purpose of this research is to describe the ability of procedural mathematical fluency and the level of productive dissociation of junior high school students.

RESEARCH METHODS

Types of research

This study aims to describe the level of mathematical procedural fluency and mathematical productive disposition possessed by students. Based on these objectives, researchers used a qualitative approach with a descriptive research type. The qualitative approach referred to in this study is as a type of research whose findings are not obtained through other computational statistical procedures, but as a study with the results in the form of a text or description explaining the research being carried out.

Time and Place of Research

This research was conducted on October 12-14 2022 at Baitussalam 1 Public Middle School.

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Research Subject

Research requires research subjects as data sources. The subjects for this research were class VIII-1 students of SMP Negeri 1 Baitussalam. Determination of the subject is based on several considerations, namely, (1) students who have high, medium and low ability levels based on initial tests on written tests and filling out questionnaires, (2) communicative students based on recommendations from teachers at the research site, and (3) students are willing to work together to help achieve research objectives. The results of the answers to the initial test questions were scored based on the scoring guideline criteria for mathematical procedural fluency and mathematical productive disposition. Then students will be selected to be determined as research subjects totaling 3 people consisting of each category namely high, medium, and low.

Data Sources, Instruments and Data Collection Techniques

The data for this study were taken from Baitussalam 1 Public Middle School, Aceh Besar. The instruments used were in the form of procedural fluency test questions and productive disposition questionnaires. Data collection techniques The research was carried out by providing a procedural fluency test and a productive disposition questionnaire.

Data Analysis Technique

In this study used a qualitative analysis method which aims to provide an overall picture of the subject under study and is not intended to test hypotheses. Miles and Huberman reveal three activities that can be carried out to analyze data, namely:

a. Data Reduction

The stages in reducing the data carried out in this study were: checking student answer sheets related to the procedural fluency test and filling out the mathematical productive disposition questionnaire; playing the recordings obtained during the interview process, then the recording results will be compiled in the form of text containing the conversations of researchers with research subjects; the recording was played several times until it was clear and correct what the students expressed during the interview, then recorded all the results of the conversation; comparing text results with recorded data and removing unnecessary data; take the essence of the transcript obtained from the results of interviews; write down the results of extracting the essence of the transcript so that it is systematic.

b. Data Presentation

After the data is reduced, the next step to be taken is to present the data including organizing the data and compiling the data that has been successfully collected. Presentation of data is done based on the results of data that has been reduced. By presenting this data, it will make it easier for researchers to understand what happened so that it becomes a source when drawing conclusions. So the data that has been selected is data with a good category. The data here is in the form of student answer sheets from test results, filling out questionnaires, and the results of interviews with students. Furthermore, researchers group similar things with the aim of facilitating researchers in drawing conclusions.

The total score obtained by the subject, the researcher compared the total score obtained with the maximum score of students' mathematical procedural fluency and students' mathematical productive disposition. Mathematically it can be written as follows:

Calculation of students' mathematical procedural fluency scores:

$$TKPM = \frac{Skor_{yang\ diperoleh}}{Skor_{maksimal}} \times 100$$

Calculation of students' mathematical productive disposition questionnaire scores:

$$ADPM = \frac{Skor_{yang\ diperoleh}}{Skor_{angket\ maksimal}} \times 100$$

Information:
TKPM: Tes Kelancaran Prosedural Matematis
ADPM: Angket Disposisi Produktif Matematis

The researcher analyzed the data based on students' answers by looking at the level of mathematical procedural fluency and students' mathematical productive disposition. The level of mathematical procedural fluency and students' mathematical productive disposition are as follows:

Table 1
Grouping Students Based on Fluency Mathematical Procedural

Scores	Category
$75\% - 100\%$	High Level
$50\% - 74{,}55\%$	Medium Level
$< 50\%$	Low Level

Table 2
Grouping of Students Based on Disposition Mathematical Productive

Scores	Category
$73{,}91 \leq x$	High Level
$56{,}59 \leq x < 73{,}91$	Medium Level
$x < 56{,}59$	Low Level

c. Conclusion

The next step in conducting qualitative data analysis according to Miles and Huberman is drawing conclusions. Drawing conclusions in this study aims to describe the procedural fluency abilities and mathematical productive dispositions of students. At this

stage, the researcher compares the data that has been obtained with data from test results, questionnaires and interviews with the subject with the aim of drawing conclusions (Sugiyono, 2017:24).

RESEARCH RESULTS AND DISCUSSION

Research Results

The data from the results of the research that will be presented contains activities and descriptions of the results of tests and interviews that have been conducted by researchers. The data collection process was also carried out in two stages, the first stage was the administration of test questions and questionnaires in the form of a Mathematical Procedural Fluency Test (TKPM-1) and a Mathematical Productive Disposition Questionnaire (ADPM-1) followed by interviews for each selected subject after the subject completed TKPM-1 and ADPM-1. In the second stage, test questions and questionnaires were given back in the form of TKPM-2 and ADPM-2 followed by interviews for each subject after the subject completed TKPM-2 and ADPM-2. Furthermore, the level of mathematical procedural fluency in solving questions on number pattern material and the level of students' mathematical productive disposition can be identified from the results of students' answers and strengthened by interviews.

Subjects selected from each category from the results of the mathematical procedural fluency test and the results of the mathematical productive disposition questionnaire can be seen in the table below:

Table 3
Subject Code in Research of Mathematical Procedural Fluency and Mathematical Productive Disposition

No	Subject Code	Category
1	AN	High
2	MIR	Medium
3	AR	Low

a. Mathematical Procedural Fluency

Students who were selected as subjects representing the high category were AN subjects with very good scores on the first procedural fluency test and the second procedural fluency test. AN subject has excellent procedural fluency as an indicator of knowledge of procedures in general. In question number 1,2,3 subject AN can write down the information that is known in the question completely and correctly. AN subject has excellent procedural fluency on indicators of knowledge about when and how to use procedures correctly. In question number 1,2,3 subject AN can make a settlement plan and write a complete procedure and lead to the correct answer. AN subjects have excellent procedural fluency on indicators of knowledge in performing procedures flexibly, accurately and efficiently. In question number 1,2,3 subject AN carefully re-checked each completion step and the results obtained.

Students who were selected as subjects representing the medium category were MIR subjects with fairly good grades on the first procedural fluency test and the second procedural fluency test. MIR subjects have good procedural fluency on indicators of knowledge of procedures in general. In question number 1,2,3 the MIR subject can write down the information known in the question completely and correctly. MIR subjects have good procedural fluency on indicators of knowledge about when and how to use procedures correctly. In question numbers 1,2,3 the MIR subject can make a settlement plan and write a complete procedure and lead to the correct answer. MIR subjects have poor procedural fluency on knowledge indicators in performing procedures flexibly, accurately and efficiently. In question numbers 1,2,3, the MIR subject could not carefully re-check each completion step and the results obtained.

Students who were selected as subjects representing the low category were AR subjects with poor grades on the first procedural fluency test and the second procedural fluency test. AR subjects have good procedural fluency on indicators of knowledge of procedures in general. In question number 1,2,3 subject AR can write down the information that is known in the question completely and correctly. AR subjects have poor procedural fluency on indicators of knowledge about when and how to use procedures correctly. In question number 1,2,3 subject AR cannot make a settlement plan and write a complete procedure and has not yet led to the correct answer. AR subjects have poor procedural fluency on indicators of knowledge in performing procedures flexibly, accurately and efficiently. In question number 1,2,3 subject AR could not check carefully every step of completion and the results obtained.

b. Mathematical Productive Disposition

Students with a high category of mathematical productive disposition, namely AN subject fulfill all indicators, meaning that they have a good productive disposition because they are enthusiastic and happy in solving the given mathematical problems. When faced with a difficult problem, keep trying to use the ways he knows. In solving the given problem feel confident and optimistic about the abilities they have and feel curious about the solution to the solution. Thus these students have a good mathematical productive disposition.

Students with a moderate category of mathematical productive disposition, namely MIR subjects fulfill five of the seven indicators, meaning that they have a fairly good productive disposition because they are a little enthusiastic and quite happy in solving the given mathematical problems. When faced with a difficult problem, keep trying to use the ways he knows. In solving the given problem feel confident and optimistic about the abilities they have. Thus these students have a fairly good mathematical productive disposition.

Students with a low category mathematical productive disposition, namely AR subjects only fulfill two of the seven indicators, meaning that they have a poor productive disposition because they are less enthusiastic and less happy in solving the given mathematical problems. When facing a difficult problem just try your best to solve the problem. In solving the given problem, they also feel less confident and less optimistic about their abilities. Thus these students have a less good mathematical productive disposition.

Discussion

a. Mathematical Procedural Fluency

Based on the results of research conducted by researchers, subjects who have procedural mathematical fluency by fulfilling indicators of procedural mathematical fluency in solving math problems. Subjects with knowledge of procedures in general, knowledge of when and how to use procedures correctly, and knowledge of performing procedures flexibly, accurately and efficiently.

On the indicators of knowledge regarding procedures in general the subject is able to analyze problems by understanding the problem, linking information with the purpose of the problem to planning a solution. That means students must know the information that is known then connect what is known with the purpose of the problem, and connect what is known by representing verbal sentences into mathematical models (Huzaimy, 2019: 78). This describes the subject's ability to associate the algorithm process with the problem situation and use the algorithm correctly. Furthermore, for indicators of knowledge about when and how to use procedures correctly, the subject is able to choose the method to be used and can use it in solving math problems. Besides that, the subject must understand the principles of the method used (Aprianti, 2014: 3). This was revealed by Novita Sari, et al the steps used to solve a problem, so what must be considered is how the steps will be applied by looking at the form and situation of the problem and the method that is suitable for use (Sari, 2018: 3). On indicators of knowledge in displaying procedures flexibly, accurately and efficiently the subject carries out the overall completion process (Junpeng, 2020). The subject solves the problem using a clear procedure, performs basic number calculations correctly, and understands alternative procedures that can be used to ensure that the answer is correct by re-checking the results of the solution that has been done. This is in line with the research conducted by Deni Pratidiana and Nunung Muhayatun that the subject is able to solve the problem correctly and is able to provide an explanation of solving the problem (Pratidiana, 2021:199). Therefore, for those whose procedural fluency is low, special treatment needs to be given to improve it, such as providing scaffolding and so on. To make students familiar with non-routine questions.

b. Mathematical Productive Disposition

Based on the results of research conducted by researchers, subjects who meet the indicators of mathematical productive disposition. The subjects stated that they were enthusiastic and happy in solving the given mathematical problems. When facing a difficult problem, the subject tries to keep trying to use the methods he knows. In solving the given problem, the subject feels confident and optimistic about his abilities and feels curious about the solution to the solution. The subject also thinks that mathematics is very useful in everyday life. Furthermore, the subject is faced with a difficult question and tries to keep working on it until it finds an answer.

Students' beliefs about their ability to do mathematics and understand the properties of mathematics have an important influence on how they approach problems and ultimately how successful they are in solving problems (Shodikin, 2018: 182-183). Students' attitudes (likes, dislikes, and pleasure) about mathematics are as important as their beliefs. Students who are happy and satisfied if they can solve problems or are happy to solve confusing

questions will be more persistent to try a second or third time, and even look for new questions (Shodikin, 2015: 182).

In terms of self-confidence, the subjects indicated that they believed they could complete the test questions. As stated by Pearson Education that self-confidence is having confidence in one's abilities, and viewing problems as challenges (Trisnowali, 2018: 54). Sumarmo said that in a mathematical productive disposition there are positive attitudes that support the growth of character, namely a critical attitude, creative and careful, objective and open, self-confident, flexible, diligent, curious, directing interest in learning, assessing oneself, appreciating culture, values , and the beauty of mathematics, serious and passionate in learning, persistent, and sharing opinions with others (Trisnowali, 2018:48). The author hopes that this research will be continued to overcome existing problems. Bisa jadi dengan menerapkan model pembelajaran yang menyenagkan bagi siswa.

CONCLUSION

Based on the results of the discussion and based on the research objectives, the following results describe the procedural fluency ability and mathematical productive disposition of junior high school students:

Students with a high level of procedural fluency are able to fulfill all indicators and there are no problems when working on math problems. This is directly proportional to the level of productive disposition which is also high. Students with a moderate level of procedural fluency only meet three or four indicators. But the level of productive disposition is still high. There are indicators that are not met because they are not accustomed to working on non-routine math problems. Students with a low level of fluency only meet one or two indicators and some do not even have one. This is directly proportional to the low level of productive disposition. Lack of motivation and interest in learning mathematics, and lack of habit in working on non-routine questions. So that several solutions are needed, including implementing strategies and learning models that support to increase these capabilities.

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