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Students' Mathematical Procedural Fluency Based on Self-regulated learning

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Abstract
Mathematical procedural fluency is an important aspect and must be mastered by students, whose mathematical skills are built on conceptual understanding, strategic competence, adaptive reasoning, and problem-solving. Procedural skills are also related to attitude aspects such as self-regulated learning. Therefore, this study aims to analyze mathematical procedural fluency based on students' self-regulated learning. The research method used is descriptive qualitative. The subjects in this study involved 10 6th grade students at SDN 075061 Balodano. The data analysis technique was carried out descriptively through analysis text. The description of students' self-regulated learning and its relation to mathematical procedural fluency was also analyzed descriptively through a graphical display of data. The results showed that the general description of students' mathematical procedural fluency was still relatively low. However, in general, students showed a positive attitude towards self-regulated learning. Overall, the results of this study indicate a relationship between mathematical procedural fluency and self-regulated learning.

INTRODUCTION

Mathematical procedural fluency is an important aspect of mathematical proficiency that builds on conceptual understanding, strategic competence, adaptive reasoning, and problem solving (Kilpatrick et al., 2001; Leinwand et al., 2014; NGA Center & CCSSO; 2010; Cartwright, 2018). This skill relates to the ability to transfer procedures to different problems and contexts, build or modify a procedure from another, and recognize when one procedure is more appropriate to apply than another (NCTM, 2014). Mathematical procedural fluency as the ability to apply procedures flexibly, efficiently, and accurately in solving a mathematical problem (Kilpatrick et al, 2001; Watson & Sullivan (2008). The procedure here can be interpreted as a specific description step by step carried out at one time (Sari et al, 2015). Thus, mathematical procedural fluency is an important skill to be mastered by students, because it involves students' understanding of a concept and solving mathematical problems. Through mathematical procedural fluency students can find out the level of students' understanding of a mathematical concept and solve mathematical problems. math problems well (Firdaus, 2019).

However, some research results show the fact in the field that mathematical procedural fluency is still rarely considered in mathematics learning, so students have difficulty in mastering this skill. Aprianti (2014) and Haryandika et al. (2017) in his research found that in the observed junior high school students there were no students who were included in the fluent category in applying procedures to fractional arithmetic operations. Asmida (2016) in his research, reported that only 68% of students had procedural fluency in the medium category in completing integer arithmetic operations. Sari et al. (2018) stated that most students have not been able to solve quadratic equations in at least two ways, have not been able to streamline steps and have not been able to do the correct calculations and do not write down the final conclusions from the

questions asked. Research conducted by Damayanti et al. (2018) shows that mathematical procedural fluency in aspects of students' knowledge about procedures in solving algebraic operations questions is still not smooth. The results of these studies indicate that students have difficulty in applying procedures smoothly on material related to algebraic operations.

The low procedural fluency in learning mathematics is also experienced by 6th grade students at SDN 075061 Balodano. This is observed from the behavior of students who often ask what steps are taken to solve the problems being worked on. This is supported by the results of interviews with students, which show that students do not know when and how to use procedures flexibly, efficiently and effectively, students can only work on the same questions as the examples explained by the teacher on the blackboard. This shows that students who lack mathematical procedural fluency are not able to learn independently. This indicates that there is a relationship between the achievement of mathematical procedural fluency and students' self-regulated learning.

Self-regulated learning is one of the important factors that determine students' mathematical procedural fluency. This is because self-regulated learning can encourage students to choose the right way of solving mathematical problems, so they are able to make decisions to deal with these mathematical problems (Susilo & Pancarani, 2020). Hidayati & Listyani (2010) students' self-regulated learning can be seen in several indicators, namely dependence on others, having self-confidence, behaving in a disciplined manner, having a sense of responsibility, behaving based on their own initiative, and exercising self-control. Self-Regulated Learning emphasizes individual autonomy and self-control to direct, monitor, and regulate learning to achieve goals and expertise (Nahdi et al, 2022; Siddaiah-Subramanya et al., 2017; Huh & Reigeluth, 2017).

Students who have self-regulated learning are able to manage and overcome the problems of their learning experiences to achieve the targeted goals (Amir & Risnawati, 2014). Therefore, a more in-depth study is needed and information related to students' mathematical procedural fluency based on self-regulated learning, so that it can be used as an evaluation for teachers in guiding students to use their procedural knowledge with confidence in their own abilities consciously, regularly and disciplinedly. mean it. Thus, this study aims to analyze students' mathematical procedural fluency based on students' self-regulated learning.

METHODS

This research uses a descriptive qualitative research method. Arikunto (2010) descriptive research is research that aims to determine the circumstances and conditions in which the results are explained and in the form of a research report. According to Bogdan and Taylor (Moleong, 2000), qualitative research is a research procedure that produces descriptive data in the form of written or spoken words from people and observable behavior. The selection of the method was adapted to the problems that became the focus of this research, namely to examine descriptive descriptions of students' mathematical procedural fluency based on self-regulated learning. The instruments used were in the form of tests and questionnaires. The mathematical procedural fluency test instrument consists of five questions that measure three aspects, namely efficiency, flexibility, and accuracy. students in applying mathematical procedures to algebraic material. The questionnaire instrument consists of six statements that measure indicators of self-regulated learning. The self-regulated learning indicators refer to Hidayati and Listyani (2010), which include: (1) dependence on others; (2) having self-confidence; (3) behaving in a disciplined manner; (4) having a sense of responsibility; and (5) behave on their own initiative, and (6) exercise self-control.

The subjects in this study were carried out in the odd semester on October 23, 2021, involving 10 students of class VIII at SMP Negeri 1 Kutawaluya Karawang. The data analysis technique was carried out descriptively through analysis text. The text of this analysis is carried out through the elaboration of the results of students' answers to the students' mathematical procedural fluency test. It aims to analyze the condition of students' mathematical procedural fluency as it is. The description of students' self-regulated learning and its relation to mathematical procedural fluency was also analyzed descriptively through a graphical display of data.

RESULTS AND DISCUSSION

Description of students' mathematical procedural fluency

This section describes the results of the procedural fluency test of class VIII students on algebraic material. Russell (Bahr & Garcia, 2010:137-138) there are three indicators that are measured, namely flexibility, efficiency, and accuracy. Efficiency implies that students do not get stuck in too many steps or lose the logic of the strategy. Furthermore, a student is said to be flexible if he has a variety of knowledge and involves more than one strategy to solve a mathematical problem. While this accuracy involves several aspects of the mathematical problem-solving process, including careful recording and re-examination of results (Graven & Scoot, 2012; Waldis et al., 2019). The achievement of procedural fluency indicators, namely efficiency, flexibility, and student accuracy is presented in Figure 1.

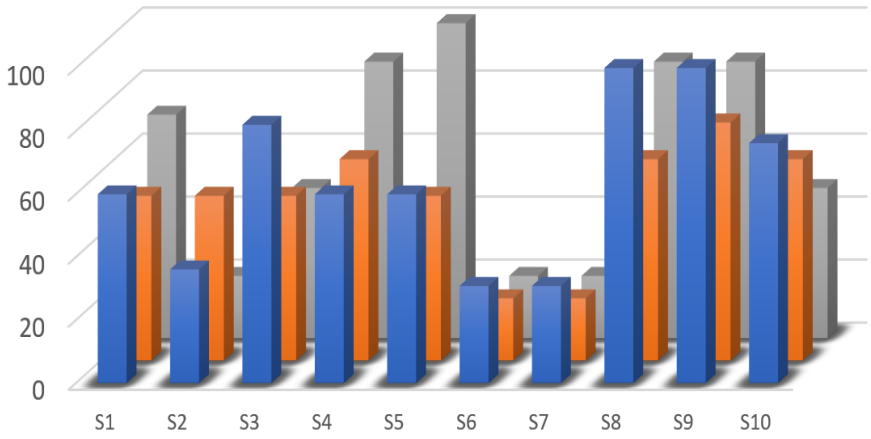
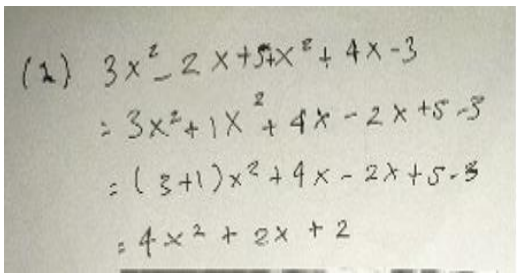


Figure 1. Mathematical procedural fluency test scores are based on the measured indicators.

Figure 1 shows the distribution of students' procedural fluency scores based on three aspects, namely efficiency, flexibility, and accuracy. In general, the average score of students based on the three aspects of the indicator is 64, 52, and 59, respectively.

a.



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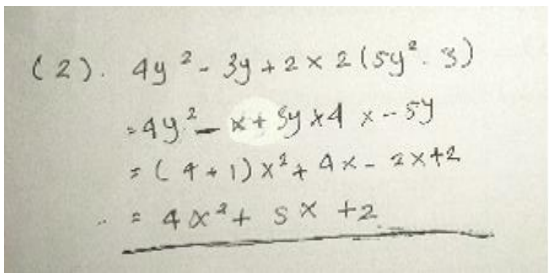

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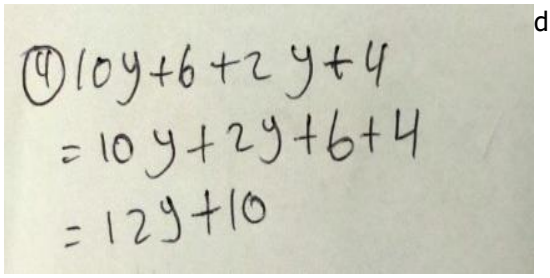

d.

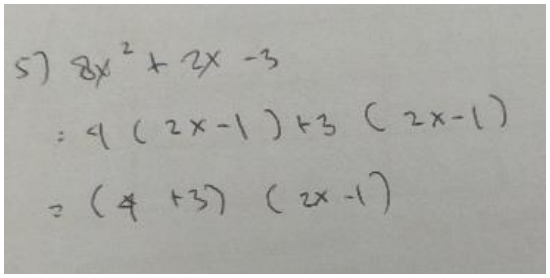

Figure 2. Students' answers to the procedural mathematical fluency test.

From several students' answers, 4 samples of students' answers were taken on the procedural mathematical fluency test. In Figure 2.a. it can be seen that students can solve algebra problems flexibly and accurately (accurately), but are not efficient in applying procedures, where students take a long stage of

completion when what is needed is fast. Figure 2.b. shows inaccurate student answers, where students do not re-check what is meant in the question. In this question, students are asked to determine the result of subtraction $4y^2 - 3y + 2$ dari $2(5y^2 - 3)$, but the student actually performs multiplication operations. This shows that the student did not take careful notes and re-check the answers/results obtained. Figure 2.c. shows that the student is able to simplify algebraic forms efficiently and accurately, but it is not flexible because it only involves one solving strategy, which should be more than one strategy. Figure 2.d shows the answers of students who are able to factor algebraic forms efficiently, flexibly and accurately (exactly) according to the three indicators of procedural fluency.

Description of students' self-regulated learning

Students' responses to the self-regulated learning questionnaire were seen based on six indicators, namely dependence on others, having self-confidence, behaving in a disciplined manner, having a sense of responsibility, behaving on their own initiative, and exercising self-control . The self-regulated learning questionnaire data were then tabulated, then converted into a Likert Scale. Furthermore, the frequency and percentage of student responses for each answer choice were also determined, as well as a comparison of the percentage of attitude scores, and neutral scores to determine the general attitude of students, so that the results of the description of student self -regulated learning questionnaire data were obtained (see table 1).

Table 1. Description of student self-regulated learning questionnaire data

Indicator	Frequency				Percentage				Attitude score	Neutral score	Respon
	SA	A	DS	SDS	SA	A	DS	SDS			
1	2	4	4	0	20	40	40	0	2,8	2,5	+
2	3	7	0	0	30	70	0	0	3,3		+
3	6	4	0	0	60	40	0	0	3,6		+
4	4	5	1	0	40	50	10	0	3,3		+
5	0	0	2	8	0	0	20	80	1,2		–
6	4	5	1	0	40	50	10	0	3,3		+

Based on the questionnaire data on students' self-regulated learning in Table 2, the percentage of students' attitudes based on the six indicators of self-regulated learning observed were: (1) dependence on others; (2) having self-confidence; (3) behaving in a disciplined manner; (4) have a sense of responsibility; and (5) behave on their own initiative, and (6) exercise self-control. The tabulated data is then transformed into rank data using the method of successive intervals (MSI). The data is then analyzed simultaneously with the data from the mathematical procedural fluency test results, in order to obtain a graphical depiction of the data as presented in Figure 3.

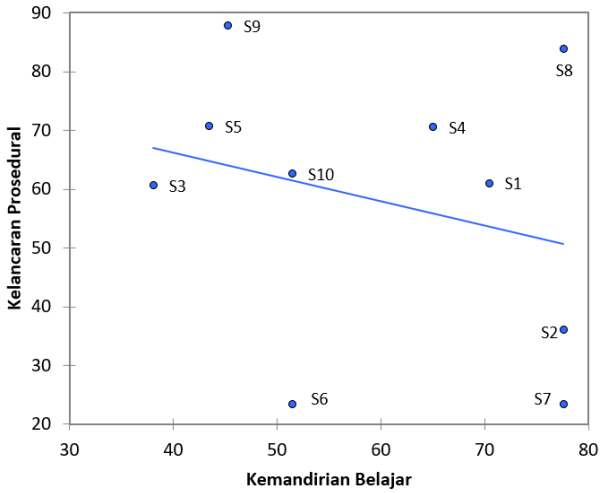

Figure 3. Scatter plot of mathematical procedural fluency based on students' self-regulated learning.

Based on the results of data processing, the average score of the procedural mathematical fluency test of 10 students was 58, with an average score per indicator, namely (1) efficiency of 64; (2) flexibility of 52; and (3) accuracy of 59. The highest average achievement of the indicator is the aspect of efficiency (Figure 1). However, both the overall average and the average per indicator are measured, show that the score is below the minimum learning completeness criteria, which is 77.

Furthermore, based on the results of the student self-regulated learning questionnaire in Table 2, students showed positive responses to the five observed indicators, which showed that students (1) were not dependent on other people (friends) in solving math problems; (2) have confidence in their own learning abilities; (3) behave in a disciplined manner by paying attention to the teacher's explanation when learning mathematics; (4) have a sense of responsibility by submitting assignments on time; and (5) exercise self-control by dividing study time well. Meanwhile, students' negative attitudes were shown in the aspect of behaving based on their own initiative, where 80% or almost half of the students strongly disagreed (rarely) working on other math problems that were not ordered by the teacher. The highest percentage of achievement indicators of self-regulated learning is in the aspect of indicator (2) having confidence in their own learning abilities, where 90% of students have confidence in their own learning abilities, the next highest aspect is self-confidence, a sense of responsibility and self-control, respectively. -each by 82.5%. Meanwhile, the scatter plot in Figure 3 shows that there is a linear relationship between mathematical procedural fluency and self-regulated learning. This finding is understandable because the ability of self-regulated learning makes students the ability to regulate themselves in learning. This is in accordance with the opinion of Nahdi et al. (2022); Siddaiah-Subramanya et al. (2017); Huh & Reigeluth (2017) which states that Self-Regulated Learning emphasizes individual autonomy and self-control to direct, monitor, and regulate learning to achieve goals and expertise. Students have the readiness to learn on their own initiative, with or without the help of other parties in terms of determining learning objectives, learning methods, and evaluating learning outcomes (Tahar, 2006; Prayuda et al., 2016; Janah, 2016). However, to find out the relationship more deeply, it is necessary to conduct further research on a larger (larger) sample size, in order to obtain general conclusions (generalization).

Overall, the findings of this study indicate that the level of students' mathematical procedural fluency is still below the expected completeness criteria. These results are similar to those of Aprianti (2014), Haryandika et al. (2017), and Damayanti et al. (2018) who state that students' mathematical procedural fluency is still not fluent. However, in this study, the average percentage of the six self-regulated learning indicators observed was 72.92%. This shows that students have a tendency to respond positive attitude toward self-regulated learning. In other words, descriptively, mathematical procedural fluency has a positive relationship with self-regulated learning. Students who have good self-regulated learning will have good procedural fluency as well. This finding is in accordance with the opinion of Susilo & Pancarani (2020) who states that self-regulated learning can encourage students to choose the right way of solving mathematical problems so that they are able to make decisions to deal with these mathematical problems.

CONCLUSION

Based on the results of research and discussion, it can be concluded that in general the students' mathematical procedural fluency is still below the KKM and is relatively low. The achievement of the highest average indicator is the aspect of efficiency, followed by the aspect of accuracy. The achievement of the flexibility aspect is in the last order, this is because based on the results of students' answers, most students lack extensive (diverse) knowledge and only involve one strategy in problem solving. Meanwhile, the results of the questionnaire data analysis can be concluded that in general students have a tendency to respond/positive attitude towards self-regulated learning. However, the negative attitude shown by students in the aspect of behaving based on their own initiative. Overall, the results of this study indicate a relationship between mathematical procedural fluency and self-regulated learning. However, this relationship has only been studied descriptively through a graphical display of data in a scatter plot. Therefore, further research on this relationship is highly recommended in order to optimize mathematical procedural fluency through aspects of students' self-regulated learning.

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