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Improving Students' Mathematical Communication Through Differentiated Learning Implementing the MERDEKA Class VII Flow

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Abstract

Students' mathematical communication abilities are crucial for acquiring mathematical concepts during mathematics learning. The MERDEKA route offers differentiated learning and is an excellent tool for helping students develop these abilities. This research aims to determine how much-differentiated learning can be contributed by applying the MERDEKA pathway to enhance students' mathematical communication skills. This type of research is Quasi-Experimental with a pretest-posttest control group design. The sample for this research was students of class VII-D and class VII-F, who were selected using cluster sampling techniques from all class VII of SMPN 5 Tanjungpinang. The Independent Sample T-test was used to analyze the data at a 5% significance level. According to this study, students' mathematical communication abilities increase through differentiated learning using the MERDEKA route rather than regular group learning techniques.
Keywords: Differentiated Learning, MERDEKA Low, Student Mathematical Communication, Regular Learning

Abstrak

Kemampuan komunikasi matematis siswa sangat penting untuk memperoleh konsep matematika selama pembelajaran matematika. Jalur MERDEKA menawarkan pembelajaran yang berbeda dan merupakan sarana yang sangat baik untuk membantu siswa mengembangkan kemampuan tersebut. Penelitian ini bertujuan untuk mengetahui seberapa besar kontribusi pembelajaran terdiferensiasi dengan penerapan jalur MERDEKA untuk meningkatkan kemampuan komunikasi matematis siswa. Jenis penelitian ini adalah Quasi-Experimental dengan desain pretest-posttest control group design. Sampel penelitian ini adalah siswa kelas VII-D dan kelas VII-F yang dipilih dengan teknik cluster sampling dari seluruh kelas VII SMPN 5 Tanjungpinang. Uji Independent Sample T-test digunakan untuk menganalisis data pada tingkat signifikansi 5%. Berdasarkan penelitian ini, kemampuan komunikasi matematis siswa meningkat melalui pembelajaran berdiferensiasi dengan menggunakan jalur MERDEKA dibandingkan dengan teknik pembelajaran kelompok biasa.
Kata kunci: Pembelajaran Terdiferensiasi, Alur MERDEKA, Komunikasi Matematis Siswa, Pembelajaran Biasa

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INTRODUCTION

The process of conveying information to other people orally or in writing with certain aims and objectives is called communication. The ability to communicate well with other people is also the key to a person's success. This is also included in the learning process; if students can less communicate with each other or teachers, then the learning process will be less than optimal. Students' communication skills are also key to an effective educational process. According to (Prabaningrum, 2019), communication developed for each individual in the 21st century will be effective, including several things such as conveying information, a sense of responsibility between people, good cooperation skills, interpersonal skills, communication with those around them, and interactive communication. According to (Rahmawati et al., 2017), factors that can influence mathematical communication are learning and evaluation that only emphasize the result rather than the

existing process and do not provide an understanding regarding the benefits for students of having good mathematical communication.

Students must become proficient in mathematical communication abilities as markers of accomplishment during the mathematics learning process. (Sugandi I & Benard M, 2018) Explain that these indicators are: 1) students visualize images in the form of a mathematical model, 2) express a mathematical idea in written form or verbally into a mathematical model, 3) create a mathematical symbol based on everyday events, 4) be able to exchange ideas about mathematics, 5) explain again a mathematical idea using personal language. Meanwhile, according to (Berliana & Sholihah, 2022), indicators of students' mathematical communication abilities are 1) linking a real object to a mathematical idea, 2) understanding and evaluating mathematical ideas, 3) expressing mathematical ideas in writing and orally, 4) expressing a conclusion. the answer corresponds to the mathematical question. From the mathematical communication indicators above, there are no significant differences.

According to the explanation offered, students can communicate and provide explanations based on their interpretations, actions, and arguments in mathematical abilities, as demonstrated by their mathematical communication skills (OECD, 2016). Moreover, based on preliminary research conducted by (Sazali, 2023) and research conducted by (Maharani et al., 2021), there is still a need to strengthen mathematics communication abilities, particularly for junior high school pupils. The researchers also gathered similar information from interviews with SMP Negeri 5 Tanjungpinang mathematics subject instructors. To analyze students' mathematical communication skills, researchers administered preliminary research three algebra exam questions to students in class VII. It is employed since algebraic material corresponds with the material utilized in this study. According to research conducted (Amalliyah et al., 2022), algebra is an abstract structure that contains symbols to determine the value of a variable in a problem. So, from the results of the preliminary research analysis, the researcher identified issues that occurred in class VII students at SMPN 5 Tanjungpinang, namely:

1. The ability to relate images to mathematical ideas still needs to be improved.
2. Students still need to be able to express and present everyday life problems using mathematical ideas such as numbers, symbols, and mathematical languages.
3. Students must pay more attention to the importance of sound and correct mathematical communication in solving mathematical problems.

Many things that have been explained occur due to various aspects, one of which is that the teacher carries out the learning process. Therefore, teachers must be able to design appropriate designs for students during the learning process. However, since the curriculum system is still one of the most essential parts of education, teachers must also pay attention to it. However, the curriculum changed several times in Indonesia until the Ministry of Education and Culture, Research, and Technology eventually proclaimed the Merdeka curriculum in 2022. Teachers can consider using a Merdeka curriculum as an alternative when creating a learning process that can enhance students' mathematical communication skills. A merdeka curriculum is learning that applies various intracurricular activities,

content, and processes so that students can understand concepts and improve competence. Teachers are free to choose teaching tools in the learning process that can be adapted to students' interests and needs (Khorurrijal et al., 2022). Putting the Merdeka curriculum into practice presents the research school with some difficulties. The school's teachers feel that meeting the criteria of the Merdeka curriculum can be achieved by employing standard teaching techniques and group learning procedures.

According to (Nasution, 2023), implementing the Merdeka curriculum presents challenges for teachers at the research school, such as limited exposure to Merdeka learning, restricted access to learning resources, and time management issues. Differentiated learning can also be implemented, where students can learn according to their learning style (Puspitasari et al., 2020). According to Gusteti and Neviyarni (2022), because differentiated learning can be tailored to each student's interests, learning preferences, profiles, and level of readiness, it can meet all of the demands of kids studying mathematics. Differentiated learning, a collection of instructional strategies that meet each student's unique learning requirements, is an attempt to expand on the idea of autonomous learning as envisioned by the National Education System. Therefore, differentiated learning aligns with the philosophy of changing education to become more advanced and modern (Fitra, 2022).

Differentiated learning strategies consist of 1) Content; according to (Fitriah & Bisri, 2023), content will be taught to students. 2) The process is centered on helping pupils comprehend the significance of the lessons they have learned. 3) Product is a form of learning outcome that has been carried out to demonstrate the knowledge, skills, and understanding abilities of each student who has completed the learning process of a material.(Maulidia & Prafitasari, 2023) Explains that the differentiated learning process meets three learning needs, namely: 1) learning readiness, 2) interest, and 3) learning profile (learning style). The MERDEKA flow can also be used throughout the learning process with differentiated instruction. MERDEKA flow is a learning process that has seven learning steps where each activity is in line with the MERDEKA flow acronym, namely, Starting from Self; Concept Exploration; Collaboration Space; Conceptual Demonstration; Elaboration of Understanding; Connections Between Matter; and Real Action. Research conducted by (Wulandari et al., 2023) this paper demonstrates how the MERDEKA pathway can enhance students' capacity for creative thinking and academic performance. In this research, researchers will use differentiated learning by implementing the MERDEKA pathway to enhance students' mathematical communication.

Researchers used One Variable Linear Equations material to see students' mathematical communication skills. This was done because previous research (Solihat, 2023) showed that students' mathematical communication skills in one-variable linear equations were still low. Therefore, this research uses differentiated learning with the MERDEKA pathway to improve students' mathematical communication. The research aims to determine whether the increase in students' mathematical communication skills through differentiated learning applying the MERDEKA flow is higher than that of students who use regular learning. Based on the researcher's explanation, it is important to carry out this research to find out whether the improvement in mathematical communication of students who

use differentiated learning with the MERDEKA pathway is higher than that of students who learn using regular learning, which is formulated with the title "Improving Student's Mathematical Communication Through Differentiated Learning Implementing the MERDEKA Class VII Flow."

METHOD

This type of research is quasi-experimental, with qualitative and quantitative data types. It uses a pretest-posttest control group design. Cluster sampling was the method used to collect the research sample. Thus, out of all the classes in VII at SMPN 5 Tanjungpinang, class VII F was the control group, and class VII D was the experimental group, and both classes had a sample of 30 students. Data collection techniques consist of (1) a Learning style test. The learning style test uses a questionnaire to collect data on student learning style groups, classified as visual, auditory, and kinesthetic. The questionnaire was adopted from the Akunpintar.id website and had 30 questions. (2) Observation technique, using an observation sheet which will be carried out directly by the observer, namely the class VII mathematics teacher at SMPN 5 Tanjungpinang. (3) Test technique: In this study, the test was carried out as essay test questions using test instruments prepared based on CP (Learning Outcomes). Table 1 lists the indicators utilized in the mathematical communication ability test.

Table 1. Indicators of Mathematical Communication Skills

No	Indicators of Mathematical Communication Skills
1.	Expressing natural objects and images into ideas, symbols, or mathematical models.
2.	Explain ideas, situations, and mathematical relationships in writing with natural objects, pictures, graphs, and algebraic expressions.
3.	Presenting mathematical information from everyday problems in excellent and correct mathematical language.

Data analysis techniques consist of (1) Qualitative descriptive, obtained through observation sheets of learning implementation; (2) Calculating the student's pretest and posttest normalized gain, using the following formula:

$$g = \frac{skor\ pretest - skor\ posttest}{skor\ maksimal\ ideal - skor\ posttest} \quad (1)$$

(3) Inferential Test: If both data groups are typically distributed, use the Independent Simple T-test, which is tested at a significance level of 5%. However, if the data is not normally distributed, use the Mann-Whitney U test.

RESULT AND DISCUSSION

Result

1. Learning In the Experimental Class

The research method clarifies that the experimental group conducts differentiated learning through the MERDEKA pathway, with an observer monitoring the learning activity throughout the process. Two meetings were held to carry out the learning activities. The observer watches the learning process and fills out an observation sheet to provide feedback to the researcher about how the differentiated learning process is implemented using the MERDEKA flow. The observer's examination of this first meeting showed that differentiated learning in the MERDEKA flow was demonstrated, and the assessment of the student activities produced good results. The meeting consisted of learning activities, including an introduction, core, and conclusion adapted to the MERDEKA stream's learning syntax.

Researchers have carried out all learning activities, including using relevant context before starting learning, guiding and directing students to discuss with groups according to their learning styles, motivating pupils to engage in the process of learning actively and guiding students to ask questions, explore ideas, understand, and discover the concept of matter. Researchers also direct students to check what they have done and relate the material taught to previous concepts or material. So, differentiated learning by implementing the MERDEKA pathway at the first meeting is clearly illustrated in this research.

At the second meeting, the observer observed and assessed the researcher through an observation sheet to assess whether the researcher was carrying out the learning. The results of the observer's assessment at this second meeting stated that the implementation of differentiated learning implementing the MERDEKA pathway was clearly illustrated, namely that the observer gave the items on the observation sheet a "yes" checklist, and the assessment of student activities also had good results. Specific results from observers regarding students are that students can actively develop ideas with group friends during discussions, answer questions asked by friends and researchers, ask researchers when the group experiences difficulties in finding solutions, pay attention to and correct the work of other groups who present the results of their work. Students complete homework presented to them by researchers both individually and in groups in front of the class. At this second meeting, the observer left a note with some advice. Regarding the simulation run by the kinesthetic group, the observer suggested using more comprehensive tools to make it simpler for the group and students to explore and comprehend the concepts of the material being studied. So, from these two meetings, it can be concluded from the observer's assessment that the researcher has implemented differentiated learning by implementing the MERDEKA pathway. This experimental class also carries out a summative evaluation in the form of a posttest.

2. Learning in Control Class

In this control class, researchers conducted learning similar to that done by school teachers. This involved group learning, with the teacher leading the process to facilitate student discussion and comprehension of the material. As a result of the observation sheet, the observer gave a "yes" checklist to all question items on the observation sheet, and this stated that everyday learning had been carried out. The activities carried out also adjusted the learning objectives and materials. The researcher delivered the material with the help of PowerPoint media and provided example questions, worksheets, evaluations, and homework for individual evaluation. This control class also carries out a summative assessment in the form of a posttest.

3. Normality Test and Homogeneity Test

The normality test was conducted using the Shapiro-Wilk test assisted by SPSS 23. The test criteria were based on the significance level (Sig.), namely 0.05. The results of the normality test are seen in Table 2.

Table 2. Normality Test Results

Shapiro-Wilk				
N-Gain Nilai	**Class**	**Statistic**	**df**	**Sig.**
	Experiment	.951	30	.181
	Control	.980	30	.822

The test shows that the sig value is > 0.05; namely, in the experimental class, it is 0.905 > 0.05, and in the control class, it is 0.744 > 0.05, which means that both classes have a normal data distribution. After it was stated that the N-Gain data was normally distributed from the results of the normalization test, a homogeneity test was then carried out. The homogeneity test was conducted using the Levene test assisted by SPSS 23. The test criteria were based on the significance level (Sig.), namely 0.05. The test shows that the sig value is > 0.05, namely 0.100 > 0.05, which means that the experimental and control classes come from a homogeneous variance population.

4. Hypothesis Testing

Hypothesis testing was done to substantiate the method's hypothesis. More specifically, students who used differentiated learning through the MERDEKA pathway significantly increased mathematical communication compared to traditional learning methods. Testing hypotheses with N-Gain data using the Independent T-Test. At a significance level of 0.05, the test conditions are as follows: If the $P - value = \alpha$, H_0 is rejected and H_a is accepted; if the $P - value > \alpha$, H_0 is accepted and H_a is rejected. What is needed is a one-sided (right-sided) test; therefore, the P-value (2-tailed) must be divided by two (Stanislaus, 2009). The results of the Independent T-test N-Gain data calculation can be seen in Table 2.

Table 2. Test results of differences in student mathematical communication improvement

	Levene's Test for Equality of Variances		*T-test for Equality of Means*			
Equal Variances assumsed	F	Sig.	t	df	Sig. (2-tailed)	Means Difference
	.002	.969	2.872	58	.006	.137

Based on Table 2, the Sig value is obtained. (2-tailed) which is .006. Because the test was carried out on one side (proper side test), the $p - value = \frac{1}{2} \times 0{,}006 = 0{,}003$. So, it is known that $0{,}003 < 0.05$, so H_0 is rejected, and H_a is accepted. If $thit > ttab$ is significantly different (H_0 is rejected), and if $thit < ttab$ is not significantly different (H_0 is accepted). So it is known, 2,872 > 1,672 because it is significantly different, then H_0 is rejected. This indicates that students in the experimental class have increased their mathematical communication on average more than students in the control class.

Discussion

According to Table 2 findings, students in the experimental class increased their mathematical communication faster than those in the control class. These results also show that students' mathematical communication improved more after implementing differentiated learning through the MERDEKA pathway than in ordinary learning. This is normal because, according to (Safarati & Zuhra, 2023), differentiated learning will pay attention to and accommodate students' learning needs. Learning instruments are also dominant in measuring student learning outcomes. Differentiated learning also has a varied teaching process, and teachers will use methods that suit students' needs. According to (Wahyuningsari et al., 2022), in the learning process, students will more easily feel comfortable and able to follow the process when learning according to their learning style and implementing differentiated learning where each student has the opportunity to learn according to their learning style (Wahyuningsari et al., 2022). Implementing differentiated learning, where students can learn according to their own learning style, (Puspitasari et al., 2020). Research conducted by (Gusteti & Neviyarni, 2022) showed that differentiated learning in the mathematics learning process can be used because it can accommodate all students' needs and be adjusted to their interests, learning styles, profiles, and readiness.

Researchers in the learning process also pay attention to students' learning needs by adjusting the MERDEKA flow in the learning process. This study also discovered variances in how well students communicated mathematical ideas due to variations in how the two classes approached the learning process. Differentiated learning implementing the MERDEKA pathway emphasizes that students achieve learning goals by understanding the material on linear equations in one variable and building their understanding with group collaboration from a learning process that addresses student needs.

In implementing differentiated learning with the MERDEKA pathway, researchers direct students to sit in groups that are tailored to the student's learning needs. Student learning groups consisting of visual, auditory, and kinesthetic groups understand the material using teaching materials provided by

researchers, which are tailored to each group where visuals use picture illustrations, auditory ones use learning videos displayed, and kinesthetics use tools. Each group is asked to fill in a worksheet adapted to the MERDEKA plot based on an understanding of the concepts from the teaching materials provided to determine the appropriate form and solution of a one-variable linear equation and explain ideas or ideas in finding answers to existing problems, as well as mathematical processes and operations contained in the worksheet correctly. The learning process also includes presentation activities, which have a good influence on students' mathematical communication. Students were also allowed to discuss and ask questions and exchange understanding, and researchers helped provide reflections on the learning. According to (Lestari & Utami, 2023) students' learning habits, each student's learning style can determine their learning outcomes, especially written mathematical communication skills.

The test instrument used in this research contains contextual questions adapted to students' mathematical communication indicators. The findings of studies carried out by (Ma'rifah et al., 2020) stated that students with good mathematical communication skills can solve story problems or contextual problems with the result that they meet all the indicators. In this research, students' mathematical communication increased, where one indicator was that students could present mathematical information from daily life problems in appropriate mathematical language.

On the other hand, ordinary learning is carried out by the learning stages designed by teachers at the research school. The researcher conveys the material that the students will study, and the researcher directs the students to sit in groups to complete the tasks given by the researcher through student worksheets. Difficulties occur in the learning process for students who are uncomfortable with the learning groups formed, so understanding the learning material is only partially achieved according to the learning objectives. The success of students from each group only depends on the dominant students in the group. So, students need more opportunities to communicate ideas from learning. Differentiated learning implementing the MERDEKA flow makes students actively involved in learning and makes learning more meaningful thereby increasing opportunities for students to improve communicate mathematical ideas. So in the learning process, the level of student activity can influence the success of the learning process. Therefore, it can be understood that the increase in mathematical communication of students who use differentiated learning implementing the MERDEKA pathway is higher than that of students who use regular learning.

CONCLUSION

The overall research findings show an average increase in mathematical communication between the experimental and control groups, as indicated by the higher average N-Gain in the experimental group compared to the control group. The researcher made several recommendations, including that differentiated learning with the MERDEKA flow may raise students' engagement in learning activities and give their education purpose. Thus, teachers are advised to incorporate differentiated learning through the MERDEKA pathway instead of regular math instruction to enhance

students' mathematical communication skills. This study focuses solely on students' written mathematical communication. Hence, future researchers must consider verbal and mathematical communication to enhance their research findings.

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