

## Improved Mathematical Representation of Students With The Open-Ended Approach

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Article Info	ABSTRACT
<p><b>Article History</b> Received : 10 Oktober 2022 Accepted : 26 Oktober 2022 Published : 29 Oktober 2022</p> <p><b>Keywords:</b> Mathematical representation of students, Open-ended approach</p>	<p>The innovative design of this study was to create a non-equivalent pre-test and post-test control group. The population of this study includes all Class IX students at PGRI 3 Medan Private Secondary School, consisting of 116 students, and the selected sample consists of two classes. The tools used are descriptive forms of mathematical representation tested and validated. The results of these studies showed that students who received open methods were much better at expressing themselves accurately than students who received traditional methods. Show that the open-ended approach can improve students' mathematical expression, even if the results are suboptimal because students' grades are still poor. This happens because the open-ended approach allows students to solve problems in different ways and create multiple representations of the problem.</p>

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### INTRODUCTION

The mathematical ability developed after learning mathematics is to develop skills: 1) mathematical communication; 2) mathematical thinking; 3) mathematical problem solving; 4) mathematical relationships; 5) mathematical representation (Posamentier, A. S., & Smith, B. 2020; Hafidzah, N. A., et al., 2021).

All mathematical skills are expected to be able to meet the needs of today's students and the needs of future students (Amoako, I., et al. 2019; Tanjung, D. F., et. Al. 2020). The current need is for students to understand the concepts needed to solve mathematical and other science problems while students are still attending school, while the future needs are students having the reasoning skills that are needed in society so that they can compete with other nations (McLure, F., Won, M., & Treagust, D. F. 2020). Thus, learning mathematics at any school level is expected to develop students' mathematical abilities through mathematical tasks that can support the above objectives. The success of students can be influenced, one of which is the success of their learning (Hidayat, 2000, 2022).

Attention plays a crucial role in the learning process without unknowingly leading to high performance (Syahputra, E., & Utami, D. R. 2019). In fact, with a good mathematics education, students can make various arrangements to meet the challenges of the global age. In the 2013 course itself, the use of technology in learning is strongly encouraged. The learning process for the 2013 course requires active student participation and provides ample space for students' creativity, interests and talents.

Attention plays an essential role in the learning process, without full notice and is impossible to get high achievements (Fitri, S., et al. 2019; Yusni, H., et al.2022). Through good mathematics education, students can indeed obtain various kinds of provisions in facing challenges in the global era. In the 2013 curriculum itself, the use of technology in learning became something that was highly recommended. The learning process in

the 2013 curriculum requires students to participate actively and provide sufficient space for students' creativity, interests, and talents (Fitri, S., et al. 2019).

One of the math skills that students need to solve math problems is representation. A representation is an expression of mathematical ideas that students present as a surrogate for a model or problem situation for finding a solution to the problem they are working on by explaining their thinking. A question can be represented by pictures, words (oral), tables, concrete objects, or mathematical symbols. Problem solving is an integral part of learning mathematics and should not be separated from learning mathematics. The construction of an appropriate mathematical representation will facilitate students in solving problems. A complicated problem will become simpler if using representations that are following the problem; on the contrary, the erroneous construction of representations makes the problem difficult to solve. The Representation Standard by Posamentier, A. S., & Smith, B. (2020) states that pre-K through 12th grade learning programs must enable students to (1) create and use representations to organize mathematical thought, note-taking, and communication; (2) select, apply, and translate mathematical representations to solve problems; (3) Use representations to model and explain physical, social and mathematical phenomena.

Students' mathematical representation needs to be improved, because to think mathematically and to communicate mathematical ideas, they must be represented in different forms of mathematical representation. Having said that, it is undeniable that objects in mathematics are abstract, so learning and understanding abstract concepts naturally requires representation. Phonapichat, P., et al. (2014) states that representation is part of the standard process for three reasons, namely:

1. The ability to translate fluently between different types of representations is an essential skill for students to develop concepts and think mathematically,
2. Mathematical ideas put forward by teachers through various forms of expression have a significant impact on students' mathematical learning,
3. Students need to practice building their representations so that they can understand and understand excellent and flexible concepts that can be used to solve problems.

Quality equipment is learning equipment that meets the criteria of being effective, functional and adequate. It can be emphasized that improving the learning process through the selection of appropriate and innovative learning models in the school mathematics curriculum is a necessary precondition to achieve this goal (Yusni, H., ET AL. 2022). What happened at this point was not what was expected; with math learning still more textbook-oriented, and math teachers still aligned with their classroom habits, it was not uncommon to use the following learning steps: present study material, give example questions, and ask Students complete practice questions. Textbooks they use in class and then discuss with students. It can be concluded that the limitations of teacher knowledge and students' learning habits in the classroom by conventional means have not made it possible to develop students' representational power optimally. Mathematical representations are only learned or taught as a supplement to solving mathematical problems. As an essential learning content, students' mathematical expression ability must be continuously trained in the process of learning mathematics in school.

Choosing the right study method can help improve students' mathematical expression ability. A method is a way, manner, or wisdom in which a teacher or student achieves a teaching goal by dealing with a teaching process or topic. One approach to mathematical learning that promises to improve representational abilities is the open-ended approach. An open-ended approach is a learning method that uses open-ended questions that can be answered with many different solutions/methods or correct answers. With a variety of possible solutions and answers, it provides flexibility for students to solve problems (Hafidzah, N. A., et al. 2021;

Tanjung, D. F., et al. 2020).

Students can explore the knowledge or resources needed to complete it, develop a plan and choose a way or method to solve a problem, and apply their mathematical skills so that students gain knowledge through the experience of discovering new things in the process of problem solving[8] Emotional skills embodied in creative thinking include experiencing problems and opportunities, tolerating uncertainty, understanding the environment and creativity of others, openness, courage, risk-taking, self-control, curiosity, expressing and responding to feelings and emotions, and anticipating the unpredictable things. And metacognitive skills are embodied in creative thinking, strategy setting, goal setting and decision making, making predictions based on incomplete data, understanding creativity and things others don't understand, diagnosing incomplete information, making multiple judgments, Control emotions and develop problem-solving skills and plan (Triana, R., Azis, Z., & Irvan, I. 2021)

In addition to the opportunity to develop students' mathematical thinking, an open-ended approach also benefits teachers. Said that the use of open-ended questions in an open-ended approach often requires students to explain their ideas so that teachers can gain insight into their learning styles, gaps in understanding, and the language they use to describe mathematical ideas (Ali, D., et al. 2021). Explanation of mathematical situations. Teachers can learn from the paths students choose, so teachers can better understand students' math skills (Nohda, N. 2000). This certainly opens up possibilities for students to use different representations to find solutions to the problems they face, and can help students find creative problem solutions, so taking an open-ended approach to learning is expected to improve students' mathematical representation.

## RESEARCH METHOD

This study compares open method and traditional methods of treatment, so an experimental study is the right choice as the sample group is tested and measured in it. The experimental design in this study was a non-equivalent pre-test and post-test control group design. The population for this study was all students in class IX at PGRI 3 Medan Private Middle School, consisting of 116 students, and the selected sample consisted of two classes. The tools used are tests of mathematical representation in descriptive form and are validated.

## RESULTS AND DISCUSSION

This research reveals the difference in increasing mathematical representation between students who get the open-ended approach with conventional approaches. The following is a description of students' mathematical representation data presented in Table 1.

Table 1. Description of Data Mathematical Representation

Statistic	Open ended			Konvensional		
	Pretest	Posttest	<i>N-Gain</i>	Pretest	Posttest	<i>N-Gain</i>
Max	32	88	0,82	39	72	0,54
Min	30	78	0,68	30	65	0,50
$\bar{x}$	30,83	75,3	0,64	28	67,5	0,54
s	5,18	1,43	0,14	5,91	1,68	0,18

As can be seen in Table 1, the students who used the open-ended method of learning improved their mathematical representation skills higher than the students who received the traditional learning method. Post-test values support these results; it can be seen that the post-test mean of the experimental class is higher than that of the control class. If viewed as a whole, the increase in the representation of the two classes is in

the same category, namely at a moderate level. If viewed based on sex between men and women, the fact is obtained that the mathematical representation ability of women is higher than men in each class. The following is a bar diagram of students' mathematical representation abilities in each learning based on gender.

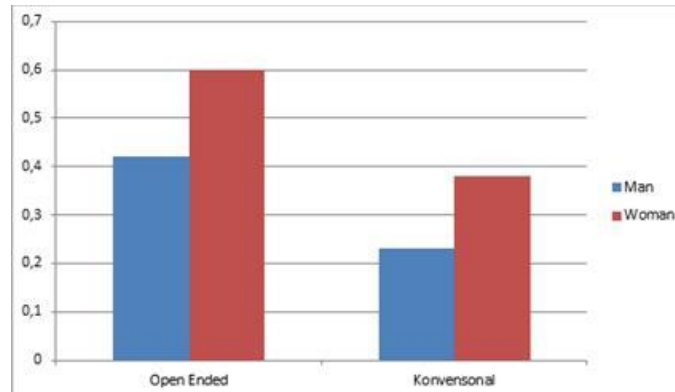


Figure 1. Mean increase in the mathematical representation of students by gender

Next, to show whether there are differences in students' representational abilities, a difference test is performed. A summary of the results of the t-test calculation of students' mathematical representation is presented in table 2.

Table 2. T-test results of mathematical representation of students based on learning

Average Posttest	t-test value	Sig.	Ho
Open ended : Convensional			
75,3 : 67,5	3,87	0,000	Ditolak

According to the t-test results in Table 2, the information obtained shows that the mathematical representation ability of the students who received the open-ended method was significantly better than that of the students who received the traditional method. These results show that even when the results are suboptimal, the open-ended approach can improve students' math ability because students' scores remain low. This happens because the open-ended approach allows students to approach the problem in different ways, resulting in different representations of the problem. Provide students with open-ended questions that not only focus on getting answers, but put more emphasis on the process of how students get answers. This gives students the opportunity to work harder to develop their mathematical thinking and encourages students to be creative in problem solving using a variety of notations.

## CONCLUSION

Based on the results of the research and data analysis, it can be concluded that learning with an open-ended approach results in a higher improvement in mathematical representation compared to students who received traditional learning. The open-ended approach can improve students' math abilities even if the results are not optimal because students still get low grades. This happens because the open-ended approach gives students the opportunity to approach the problem in a different way, leading to different representations of the problem. Teachers can learn from the paths students choose, thus helping teachers better understand students' math skills.

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