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The Effectiveness of a Realistic Mathematics Education to Increase Higher Order Thinking Skill (HOTS) of Secondary School Students

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Abstract*. This study aims to determine the effectiveness of using a realistic mathematical approach to the Higher Order Thinking Skill (HOTS) of SMA Negeri 2 Majene (SMAN 2 Majene), Indonesia. The subjects of this research were four students of class XI at SMAN 2 Majene. This research used a descriptive qualitative method. The instrument used was PISA-based HOTS questions developed based on a realistic mathematical approach to test students' HOTS. The average score obtained by students in answering test questions ranged from 61-80. It was concluded that the HOTS of SMA Negeri 2 Majene students were good. It showed that the realistic mathematics education effectively increased students' HOTS.*
Keywords: *realistic mathematics education, higher order thinking skill (HOTS), senior high school.*

INTRODUCTION

Educational factors strongly influence the progress of a nation. Everyone's potential can be developed through education, which will make it easier to solve a problem or find a solution to the problem at hand. One of the sciences that underlies the development of technology in mathematics (Haleem et al., 2022). Mathematics plays a role in advancing human thinking and can help students to think logically (Cresswell & Speelman, 2020).

Mathematics is a knowledge that is relevant to everyday life. Mathematics plays a vital role in human life (Abd Algani, 2022). Puspitawedana (2019) explains that the role and place of mathematics in human life include that mathematics is a way of thinking and asking questions. It relates to how students plan, organize, analyze, and solve a problem in the learning process. Mathematics is all about patterns and relationships, and students will be able to identify concepts and relate them to their knowledge (Siregar & Daut Siagian, 2019).

Indonesia's learning process expects students to play an active role in the learning process rather than the teacher (Revina & Leung, 2018). The rapid development of science and technology in the 21st century coincides with new challenges and problems, so critical and creative thinking skills are needed to solve various problems (Tan, 2003). It is called Higher Order Thinking Skills (HOTS). Several research results show that modern society in the 21st century needs more than just knowledge. It also needs HOTS and problem-solving, creativity and self-direction, social and cross-cultural, productivity and accountability, leadership and responsibility, and information literacy (Tan, 2003; Wiguna et al., 2021).

In describing the characteristics of education on its impact on society, the government monitors the education system's performance through the results of PISA (Program for International Student Assessment) research. PISA is an international study conducted by the OECD (Organization for Economic Cooperation and Development) to assess students' literacy abilities (Stacey, 2011). According to Stacey (2011), assessment in PISA determines whether students can create knowledge and how they extrapolate and apply the knowledge they have acquired

both inside and outside of school. The PISA results show that Indonesian students' mathematical literacy is still low (Stacey, 2011). Indonesia scored 379 points in the 2018 PISA study, ranking 73 out of 78 participating countries, with an international average of 489 points (OECD, 2019). Students' mathematical literacy can be improved by training students to solve HOTS-type questions. HOTS questions help students develop critical, logical, metacognitive, reflective, and creative thinking skills because students are required to think at a higher level and use reasoning processes. Train students to think in the analysis, evaluation, and creation phases of HOTS questions (Wiguna et al., 2021).

The currently implemented educational curriculum is the independent curriculum, a development of the 2013 curriculum. In mathematics lessons, students are not only given reinforcement in understanding the material, calculations, and formulation of formulas but are also involved in solving problems in everyday life (Zulkardi & Putri, 2019). By involving students in this matter, it will be seen that they have high order thinking skills.

Freudenthal's (1905-1990) perspective on mathematics informed the Realistic Mathematics Education (Zulkardi & Putri, 2019). Since 1971, the Freudenthal Institute has created Realistic Mathematics Education (RME), a theoretical method of learning mathematics. RME encompasses perspectives on mathematics, how students acquire mathematics, and how mathematics ought to be taught. Freudenthal thought that students should not be considered passive recipients of prefabricated mathematics.

The researcher tries to examine students' higher order thinking skills by using HOTS questions which are a development of PISA-type math problems and using a realistic mathematics education on students of SMAN 2 Majene. Examining students' HOTS is necessary by giving HOTS questions with a realistic mathematics education. Therefore, this study aimed to determine the effectiveness of using a realistic mathematics education to the Higher Order Thinking Skill of students of SMAN 2 Majene in learning mathematics.

METHODS

This study used a descriptive qualitative approach. This study involved four students of SMAN 2 Majene. The data were used to determine students' high-order thinking skills based on their ability to solve PISA-type questions. Observation and tests were used to collect data to examine the relationship between student performance and higher-order thinking skills. The test consisted of 10 open-ended, PISA-based items and has a processing time of 120 minutes.

The data analysis technique used was descriptive. The first step in analyzing the data was determining student test scores. Score 4 for the category of students who answered correctly with full completion. Score 3 for the category of students who understand existing problems and formulate solutions that are used with the formulation to the end experience at least one error. Score 2 for the student category as in score three but has more than one error. Score 1 for the category of students who only understand the problem, but in formulating the solution, there are still errors. While a score of 0 is given to students who cannot comprehend and formulate problems. Then determine the student's score by multiplying the score obtained by the student by 25. The next step determines the category of students' higher-order thinking. Based on the International Center for the Assessment of Higher Order Thinking (Wiguna et al., 2021), students who score 81-100 are included in the very good category, 61-80 good category, 41-60 moderate category, 21-40 poor category, 0 –20 categories is very less.

TABLE 1. Student HOTS Score Categories

No	Score	Category
1	$0 \leq score \leq 20$	Very less
2	$21 \leq score \leq 00$	Not enough
3	$41 \leq score \leq 60$	Enough

4	$61 \leq score \leq 80$	Good
5	$81 \leq score \leq 100$	Very good

RESULTS AND DISCUSSIONS

The subjects of this study were students of SMAN 2 Majene class XI with a sample of 4 people. Furthermore, the research subjects took the PISA-based HOTS test questions using a realistic approach. The test results obtained from the results of students' answers in doing the test are used to determine the level of students' higher-order thinking skills (HOTS). From the results of student tests covering logic, reasoning, analysis, and evaluation, the highest and lowest scores were 40 and 90, respectively. The average scores of the four students were also categorized into higher-order thinking skills (HOTS), presented in table 1, based on the International Center for the Assessment of Higher Order Thinking (Wiguna et al., 2021).

TABLE 2. Research result

Name	Score	Category
A	82,5	Very good
B	42,5	Enough
C	85	Very good
D	92,5	Very good

Based on the research results table in Table 2 were obtained from 4 subjects, there were no students with inferior and insufficient HOTS categories, student B with sufficient HOTS, and students A, B, and C with very good HOTS categories. Student B in the HOTS category cannot analyze and evaluate when solving problems. Besides that, student B already has sound logic and reasoning skills. While students A, B, and C with very good categories are classified as having sufficient logic, reasoning, analysis, and evaluation abilities to solve problems. The student still has an error in solving the final problem given.

The average score obtained from 4 students is 76. It shows that class XI students of SMAN 2 Majene have entered the HOTS level in a good category. In general, students already have the correct logic and reasoning to solve the PISA-based questions presented. The difference in the categories for each HOTS level of class XI students of SMAN 2 Majene is only in analysis and evaluation abilities.

Based on the research results described, using a realistic mathematical approach effectively improves students' higher order thinking skills. The level of effectiveness can be seen from the level of effectiveness index. The effectiveness index is a percentage that describes: 1) the level of mastery achieved by students for each learning objective and 2) the average achievement of objectives by all students. The measure of effectiveness can be known through the scores achieved by students, namely by comparing the average scores achieved by students with specific standard scores that have been set. Implementing learning using a realistic mathematical approach begins with a real context in everyday life.

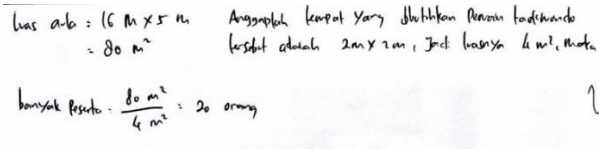
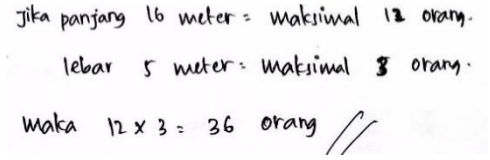
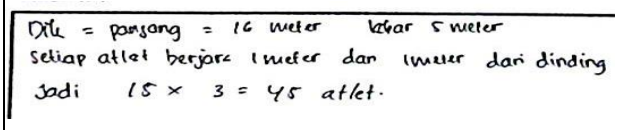
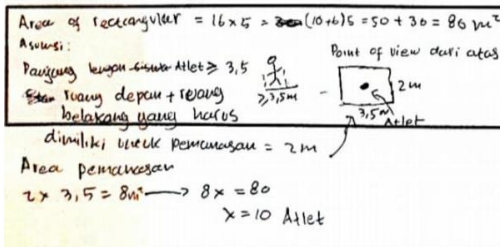
Taekwondo training hall

Taekwondo National Training Camp will hold a series of warm-up training before participating in the 2017 Asian Games in Kuala Lumpur. It will be held in a rectangular hall measuring 16 meters in length and 5 meters wide. What is the maximum number of taekwondo athletes who can exercise in the hall?

FIGURE 1. PISA-based Open-Ended Questions

A realistic mathematics education combines perspectives on mathematics, how students learn mathematics, and how mathematics ought to be taught. Realistic mathematics education has the following characteristics (Suherman et al., 2021): 1) Use of context: the learning process begins with student involvement in contextual problem solving; 2) Vertical instruments: mathematical concepts or ideas are reconstructed by students using vertical instrument models that move from informal to formal forms; 3) Student contributions: students actively develop mathematical content based on the teacher-provided facilities and learning environment; 4) Interactive activities: learning activities are interactive, which may involve student negotiating; and 5) Topic relevance: acquiring mathematical content relevant to a variety of mathematical topics in an integrated manner. In addition, Towe & Julie (2020) asserted that the humanistic approach to mathematics was influenced by Hans Freudenthal's assertion that mathematics is a human activity. Freudenthal (Towe & Julie, 2020) argues that pupils should not be viewed as passive users of "ready-made mathematics" but rather that education should provide guidance for students to use various settings and chances to reinvent mathematics in their way.

TABLE 3. Student test results

A Student	B Student
	
C Student	**D Student**
	

Based on the student's answers above, it can be concluded that students can analyze the problems in the questions presented by relating them to everyday life, change to the form of mathematical equations, and solve mathematical equations that have been made. All students use the same steps in assuming the size of the field. Student A uses the area of the field to determine the maximum number of taekwondo athletes who can use the field. Student B, for instance, utilizes the possible number of athletes in the field based on length and width. In

contrast, student C uses the distance of each athlete in the field to decide the result, and student D uses the area warm-up for each athlete to determine the result. Higher Order Thinking Skills (HOTS).

CONCLUSION

This study was conducted to determine the effectiveness of realistic mathematics education in improving students' higher order thinking skills. This study used an instrument in the form of PISA-type math problems in the context of daily life, which are valid and practical and have the potential to influence students' higher order thinking skills. Test analysis showed that students could formulate questions in mathematical form, then determine the completion of the problem and obtain the results. Students reasoning and higher order thinking skills increase when facing real problems through realistic mathematics education. From this study, we recommend using realistic mathematics education in conducting teaching and learning mathematics in the classroom in order to increase the higher order thinking skills of students. Besides, another further study needs to be conducted to determine the effectiveness based on the experimental study.

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