THE EFFECT OF INDONESIAN REALISTIC MATHEMATICS EDUCATION (IRME) APPROACH ON STUDENTS' LEARNING ACHIEVEMENT AND CRITICAL THINKING ABILITY

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Abstract

The student's critical thinking process can lead to the achievement of critical thinking skills, which is also helpful for improving student achievement in mathematics. However, critical thinking skills and learning achievements have often not been achieved because the learning process is less supportive. So a solution is needed. One solution is to use the Indonesian Realistic Mathematics Education (IRME) approach for students. This study aims to determine the effect of the IRME approach on student achievement and critical thinking skills. This study uses a quasi-experimental design method that compares student achievement and critical thinking skills in the experimental and control classes. The instruments distributed were tests to measure learning achievement and questionnaires to measure students' critical thinking skills. The study's results prove that learning with IRME affects student achievement and critical thinking skills. The obtained significance value is lower than the p-value, which is 0.012, in statistical tests using MANOVA that support this conclusion.

Keywords: IRME Approach, Learning Achievement, Student's Critical Thinking Ability, MANOVA

INTRODUCTION

Based on the findings of observations and interviews conducted by researchers, the mathematics teacher at the school stated that student's critical thinking skills remained relatively low, as only a small number of students could solve math problems. Still, many students are unable to solve the provided problems. The lack of critical thinking in students also lowers their academic performance. The benchmark for learning achievement is the (numerical) value of student learning outcomes in answering queries. Constant or permanent knowledge, comprehension, skill values, and attitudes constitute learning achievement (Heriyati, 2017: 24). The low learning achievement is evident in the teaching and learning activities in the classroom; some teachers still use outdated methods in learning activities in the classroom, indicating that mathematics learning is still limited to knowledge that has not enhanced the ability to apply and connect mathematics learning to real-world situations.

Thinking is a human activity that generates inventions for specific applications. Faced with the current era of globalization, each individual must think at a high level due to the accelerated growth of the nation's economy and technological competition in education. One strategy for overcoming this requirement is critical thinking (Taubah et al., 2018: 190). Critical thinking is a process that is conducted using the scientific method, namely formulating problems, understanding, analyzing, and searching for various pertinent information, carefully examining problems, drawing conclusions, and evaluating (Abdullah, 2016: 73). Students' ability to think critically can be developed by assigning them math problems to solve.

Mathematics is an abstract science that plays a crucial role in everyday life. Mathematics is indispensable to the existence of contemporary technological developments. Mathematical aptitude enables one to develop systematic thinking, reasoning, making assumptions, and making cautious, exhaustive, inquisitive, innovative, and creative decisions. However, school learning activities frequently consist solely of providing answers, preventing students from

exercising their ability to think critically by generating original ideas. Students cannot develop critical thinking because they cannot express their perspectives on problems (Taubah, 2018: 190).

One method to ensure the success of learning activities is to select the appropriate learning approach and activities that train students' critical thinking skills, or to employ the IRME approach when learning mathematics. an approach that integrates real-world experience and mathematical application (Suggesti in Taubah, 2018: 191). The Freundenhal Institute in the Netherlands introduced and developed RME as a learning theory in mathematics education in 1970 (Aristiyo et al., 2014: 111). According to research conducted by Devrim and Uyangor in Taubah (2018: 191), realistic problems are the source of the emergence of mathematical concepts, thereby influencing the improvement of student performance.

This research aims to determine the impact of the IRME approach on students' learning achievement and critical thinking abilities. This research employed a quasi-experimental design with unequal control subjects. A posttest-only control design and a questionnaire were utilized as the research design. This design includes both a control and an experimental group. In addition, statistical analysis and data collection must be used to test the hypothesis to achieve this objective. MANOVA is the hypothesis test used in this study. Hotelling's Trace is a multivariate statistic computed by the MANOVA procedures.

Literature Review

IRME (Indonesian Realistic Mathematics Education Approach)

Learning approach as a starting point or one's perspective on the learning process. This is essentially related to the occurrence of learning that is more general. And in this case it reveals, stimulates, enhances, and supports various learning approaches with certain theoretical content (Festiawan, 2020: 14). Whereas in Rahim et al., (2021: 2) says that the learning approach is a tool that can be used by teachers to carry out learning so that learning is more effective and efficient.

The realistic approach to mathematics is known as RME (Realisic Mathematics Education) which was first initiated by Hans Freudenthal in 1970 (Zanten and Heuvel-Panhuizen, 2021). The development of RME explains the true meaning of mathematics, how students learn mathematics, and how to teach mathematics. Freudenthal thinks that students are not passive individuals who only accept whatever is ready, but students are someone who can develop where students can relate to the real world. Therefore, education must guide students to use various situations and opportunities in order to be able to reinvent mathematics in their own way (Johar, 2020: 1-2).

IRME is a learning theory that starts from something real or something students go through. Putting more emphasis on students in the learning process by means of discussion, collaboration and argumentation among classmates, so that students can find their concepts in learning. And finally, students can solve problems in everyday life with the help of mathematics either individually or in groups (Yuniawatika et al., 2016: 238). Learning activities that use the IRME approach help students develop their potential. Students have knowledge and experience of environmental initiatives. In learning activities based on the IRME approach, the teacher only acts as a facilitator, while students have a major role in learning with the intention of activating students' critical thinking skills (Sarbiyono, 2016: 165).

An example of an approach to learning mathematics in real life is the IRME approach. Septika (2012) states that realistic mathematics education methods in Indonesia are able to improve students' mathematics learning outcomes. So it can be concluded that IRME is a learning method that is close to everyday life and allows students to understand and discover mathematical concepts.

In IRME, mathematics learning must be linked to the real world, in mathematics learning there are three realistic principles according to Gravemeijer in Fauziyah (2017: 2), namely (1) ways of reinventing and progressive mathematization, (2) didactic phenomenology, (3) models self-developed. According to these principles, learning mathematics should give students the opportunity to understand and process the discovery of mathematics itself. Mathematics is not given to solve something, but through mathematical activity which is called mathematization. Situations used in learning mathematics must start from real situations before formal mathematics. Then, the principle of building students' independent strategies from the real to the abstract. The strategy first connects to the real world and then gradually solves the problem. Sometimes strategies can also be given to students but in terms of helping move from students' thinking processes to more formal mathematics (Fauziah et al., 2017: 2).

LEARNING ACHIEVEMENT

Learning achievement has an essential factor for students and teachers. Good learning achievement is the goal and hope for every student and educator because student performance is a measure of the success of the learning process. If students achieve good grades, the teaching and learning process is successful. However, if students' academic achievement is still relatively low, the learning process can be said to be unsuccessful (Purnama, 2016, pp. 235 – 236). Learning achievement is a benchmark in the form of a (numeric) value for student learning outcomes in answering questions. Learning achievement is knowledge, understanding, skill values and attitudes that are constant or permanent (Heriyati, 2017: 24).

In general, two factors affect a student's performance: internal and external. Internal factors that come from students are physical health (physiological) and talents, interests, intelligence, emotions, malaise, and learning styles (psychological). External factors come from outside the student's self, influenced by the family, community, school and natural environment. These factors need to work together synergistically because they affect learning outcomes and help students achieve the best results. (Rosyid et al., 2019: 10). So it can be concluded that learning achievement is the result obtained through effort and hard work in learning activities; in this case, learning achievement can be seen from changes in behaviour and learning ability every time you take tests and exams. Learning achievement includes cognitive, affective, and psychomotor factors after participating in learning activities which are measured through relevant instruments (Rosyid et al., 2019, p. 8).

CRITICAL THINKING SKILLS

Critical thinking is a process that is carried out using the scientific method, namely formulating problems, understanding, analysing and searching for relevant information, scrutinising problems, making conclusions, and evaluating (Abdullah, 2016, p. 73). Rositawati (2018: 77) also says critical thinking is a process of interpretation and evaluation that is oriented, clear, proficient, and active towards a problem, including observing, asking questions, deciding, and analysing, ultimately producing a concept.

Critical thinking skills are reflective thinking skills, the ability to evaluate evidence of ability, statements in applying concepts to new things, identify gaps in knowledge and evaluate errors in an opinion. Critical thinking focuses on reflective thinking that is more directed to analysing specific arguments, admitting an error, and drawing conclusions according to the best possible evidence and considerations (Shanti et al., 2017, p. 52). According to Setyawati in Rachmantika (2019: 441), every individual who has the characteristics of critical thinking skills can solve problems with clear goals, can analyse problems according to existing facts, and can make conclusions as well as solve problems correctly. According to John Dewey in Sihotang (2019: 35), critical thinking involves favourable and careful consideration of beliefs and knowledge that do not seem to be taken for granted. Edward Glaser revealed that there are

two methods of critical thinking, namely deductive thinking and inductive thinking. Deductive thinking means that someone can improve his reasoning ability by applying the principle of syllogism in arguing. Through inductive thinking, a person is trained to increase his accuracy in observing something and grouping it as a basis for concluding. So, according to Glaser, someone who thinks critically does not only speak from origin but also has a rational basis for concluding (Sihotang, 2019, pp. 36-37).

According to the opinions that have been described above, it can be concluded that the ability to think critically is the expertise of each individual in solving a problem, namely by analysing, evaluating the results of a problem, being thorough and careful in distinguishing and dealing with problems, and being able to conclude according to the results best possible consideration. Critical thinking indicators expressed by Fisher in (Fristadi and Bharata, 2015: 599), namely: (1) identifying problems, (2) obtaining correct information, (3) developing various ways of solving problems, (4) concluding, (5) put forward arguments, (6) discuss and evaluate.

DISCUSSION

Before administering the posttest and questionnaire to the control and experimental classes, the tests and questionnaires were tried out in class VIII-C SMPN 13 Kota Tangerang with a total of 30 students to determine the level of validity and reliability of the questions. The validity test was carried out on the post-test questions of learning achievement using the product moment correlation formula with the number of respondents n = 30 and α = 0.05, and then it was determined thatt $r_{tabel} = 0{,}374$. Items are declared valid if $r_{hitung} > r_{tabel}$.

Table 1. Correlation Validity Test Product Moment Posttest Learning Achievement

Question number	r_{count}	r_{table}	Information
1	0.356	0.374	No Valid
2	0.443	0.374	Valid
3	0.778	0.374	Valid
4	0.483	0.374	Valid
5	0.713	0.374	Valid
6	0.692	0.374	Valid

Furthermore, the Posttest reliability test was carried out using SPSS, with the following results.

Table 2. Posttest Reliability Test of Learning Achievement

Item	Variance (σ_b^2)	Total Variance (σ_t^2)
2	0.424	7.955
3	0.42	
4	0.506	
5	1.085	
6	1.564	
amount of variance ($\sum \sigma_b^2$)	3.999	
r_{11}	0.622	
Criteria	0.600 – 0.799	

Test the validity of the critical thinking skills questionnaire with the number of respondents n = 30 and α = 0.05 and determined r_table = 0.374. The items in the questionnaire are declared valid if r_count > r_table.

Table 3. Validity Test of Product Moment Correlation Critical Thinking Ability Questionnaire

Question number	r_{count}	r_{table}	Information
1	0.670	0.374	Valid
2	0.844	0.374	Valid
3	0.522	0.374	Valid
4	0.546	0.374	Valid
5	0.706	0.374	Valid
6	0.521	0.374	Valid
7	0.416	0.374	Valid
8	0.486	0.374	Valid
9	0.720	0.374	Valid
10	0.513	0.374	Valid
11	0.513	0.374	Valid
12	0.475	0.374	Valid
13	0.388	0.374	Valid
14	0.376	0.374	Valid
15	0.382	0.374	Valid
16	0.437	0.374	Valid
17	0.385	0.374	Valid
18	0.498	0.374	Valid
19	0.437	0.374	Valid
20	0.476	0.374	Valid

Furthermore, the reliability test of the student's critical thinking ability questionnaire was carried out using SPSS, with the following results.

Table 4. Critical Thinking Ability Questionnaire Reliability Test

Item	Variance (σ_b^2)	Total variance (σ_t^2)
1	0.516	7.955
2	0.576	
3	0.648	
4	0.478	
5	0.924	
6	0.671	
7	0.764	
8	0.464	
9	0.792	
10	0.461	
11	0.723	5.481
12	0.654	
13	0.621	
14	0.878	

15	0.534	
16	0.34	
17	0.254	
18	0.461	
19	0.395	
20	0.621	
amount of variance ($\sum \sigma_b^2$)	11.777	
Information	high	

The next step is to test the prerequisite analysis, namely the normality test and homogeneity test. First, a normality test was carried out using the Kolmogorov-Smirnov test with the following results.

Table 5. Kolmogorov Smirnov Normality Test Results

Dependent variable	**Class**	**Sig.**
learning achievement	Control	0.052
	Experiment	0.060
Critical thinking skills	Control	0.200
	Experiment	0.087

Table 5 shows that the significance value of Kolmogorov Smirnov's learning achievement in the control class is 0.052 > 0.05, and the significance value of learning achievement in the experimental class is 0.060 > 0.05, so the data is normally distributed. Likewise, the data is normally distributed for the critical thinking ability variable in the control class, namely 0.200 > 0.05 and the significance value of the experimental class' critical thinking ability, namely 0.087 > 0.05. After carrying out the normality test, the homogeneity test was carried out using the box's M test. The covariance variant matrix homogeneity test results can be seen in the following table.

Table 6. Box's M Test Results

Box's M	2.048
F	0.658
df1	3.000
df2	648000.000
Sig.	0.578

Based on calculations with the SPSS application, the Box's M value is 2.048, and the significance value is 0.578. The same as the existing criteria, namely, if the sig value > 0.05, then H0 is accepted, it can be concluded that the variance-covariance matrix of learning achievement and critical thinking skills of students in the experimental and control groups is the same/homogeneous.

The research data used is normal and homogeneous. Then a hypothesis test is carried out using the MANOVA (Multivariate Analysis of Variance) test with the help of the SPSS application. This test has two results: a multivariate test on the dependent variable and a test on the dependent variable separately. The results of the MANOVA test will be explained in the following table.

Table 7. T-Hotelling MANOVA Test Results

Effect		**Sig.**
Intercept	Hoteling's Trace	0.000
X	Hoteling's Trace	0.012

From table 7, it is explained that the results of the analysis show that the Hotelling's Trace value has a significance of 0.012, which is smaller than the predetermined significance level of 0.05. According to the criteria, H0 is rejected, or H1 is accepted. So there are differences between the learning process using the IRME approach and those using conventional learning models on student achievement and critical thinking skills.Next is testing of each dependent variable with the following results.

Table 8. Partial Test Results

dependent variable	Test Statistics t	Sig.
learning achievement	2.107	0.039
Critical thinking skills	2.229	0.030

Table 8 shows that the IRME approach affects learning achievement because the significant value is 0.039, with a significance value smaller than the predetermined significance level of 0.05 (0.039 <0.05). Apart from that separately, the IRME approach also influences students' critical thinking skills, as evidenced by its significant value of 0.030 is smaller than the predetermined significance level of 0.05 (0.030 <0.05).

CONCLUSION AND CLOSING

The conclusions obtained based on the results of data analysis and discussion are that learning using the IRME approach is more effective and influences student achievement and critical thinking skills. It can be seen from the MANOVA test which obtained a sig. of 0.012 where the value is smaller than the predetermined significance level, namely 0.013 <0.05. So it can be concluded that H0 is rejected and H1 is accepted. it is known that students who use the IRME learning approach tend to be more active and are able to achieve four aspects of critical thinking skills, namely interpretation, analysis, evaluation, and giving appropriate conclusions. With high critical thinking skills, student achievement also increases. To train critical thinking skills in learning, teachers must familiarize students with giving problems and creating groups to present their work and paying attention to the mathematical self-efficacy of each student.

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