The Influence of Realistic Mathematics Education on Students' Mathematical Creative Thinking Enhancement in Elementary School

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Abstract. Creative thinking is one of 4.0. industrial revolution competencies that have to be mastered by an elementary school student to face future challenges. This research aims to find out the influence of Realistic Mathematics Education (RME) that begins with presenting problems that can be imagined by students or are a student's experience to improve creative thinking, especially in mathematics learning. This research is quantitative research with a quasi-experimental method. The design used is the one-group pretest-posttest design The population of this study was fourth-grade elementary school students taking a sample of 3 schools, where each sample consisted of two classes with a total of 144 students. The statistic test uses the Mann-Whitney test. The Statistic analysis shows that there is a significant difference between control and experiment classes in mathematics creative thinking enhancement and the enhancement of the experiment class (0,38) is higher than the control class (0,27). The results of the study show that realistic mathematical approaches have a significant impact on increasing the mathematics creative thinking of elementary school students. There are some differences in performance between students who have high, medium, and low competency in each indicator of creative thinking.

Keywords:RME, Creative Thinking, Quantitative

1 Introduction

Thinking is an activity that is literally carried out by humans as creatures who are endowed with reason and intelligence. With the developments in the world, the development of education leads to 21st Century abilities, namely Collaborative, Critical Thinking and problem-solving, Creative Thinking, and communication skills (Communication) that are built through higher order thinking skills or known as Higher Order Thinking Skills (HOTS) [1], which is a new paradigm of Education on the emphasis on thinking skills [2]. Mathematics learning in elementary schools has emphasized the four HOTS abilities, one of which is the ability to think creatively.

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The cerebral hemisphere theory states that the function of the human brain is actually divided into two hemispheres, namely: the left and right hemispheres [3]. Mathematics as a science that is seen as timid, systematic, and logical makes the learning that has been carried out so far more mechanistic, a function of the left brain. However, in addition to being timid and systematic, mathematics has flexibility in the process of understanding it as long as it still adheres to the mathematical rules that have been set. Creativity in the right hemisphere tends to think divergently, the thought process spreads by placing an emphasis on conformity [3]. Therefore, it is important for students to practice creative thinking skills so that students are able to think flexibly in solving the mathematical problems they face.

Guilford [3,4,5,6] suggests the characteristics of creativity, among others:

1. Fluency of thinking, namely the ability to generate many ideas that come out of one's mind quickly. In fluency of thought, the emphasis is on quantity, and not quality.
2. Flexibility, namely the ability to produce a number of ideas, answers, or varied questions, can see a problem from different perspectives, look for alternatives or different directions, and be able to use various approaches or ways of thinking. . Creative people are people who are flexible in thinking. They can easily leave the old way of thinking and replace it with a new way of thinking.
3. Elaboration, namely the ability to develop ideas and add or detail the details of an object, idea or situation so that it becomes more interesting.
4. Originality, namely the ability to generate unique ideas or the ability to generate original ideas.

One of the most important concepts in the field of creativity is the relationship between creativity and self-actualization. According to humanistic psychologists such as Maslow and Rogers [7], self-actualization is when a person uses all his talents and talents to become what he is able to actualize or realize his potential. A person who can actualize himself is someone who is mentally healthy, can accept himself, is always growing, fully functioning, democratically minded, and so on. According to Maslow, self-actualization is a fundamental characteristic, a potentiality that exists in all humans at birth, but which is often lost, hampered, or buried in the process of civilizing. Students who have the ability to think creatively are expected to be able to keep up with the fast-changing times and be able to solve the problems they face carefully, correctly, and creatively. In the process of mathematical creative thinking, elementary school students must be taught according to the stage of cognitive development. This is so that students can train to think critically and creatively so that abstraction problems in learning mathematics are no longer an obstacle, but students are able to see the meaning of certain abstract symbols. However, because this change is still in the induction stage in every line of education, today's classrooms are very lacking attention to developing skills related to creativity. Part of the lack of emphasis on creativity may be based on the common misperception that creativity is only of the artistic kind and is something one is born with and cannot be taught [8]. This also makes mathematics in schools narrowly conceptualized by mathematics teachers [9]. In fact, creativity in mathematics has traditionally been seen as one of the most important characteristics. The low achievement of creative thinking skills of elementary school students in one of district in Riau shows the profile of the creative thinking abilities of fourth-grade students as follows:

Table 1. Pretest of Mathematic Creative Thinking Skill

Indicator	Skor (Max 3)	Presentage	SD
Fluency	0,82	27,21	0,74
Elaboration	0,61	20,34	0,76
Flexibility	0,74	11,41	0,61
Originality	0,44	5,76	0,63

NCTM [10] recommends that students solve problems creatively and sensibly. However, NCTM does not clearly define the definition of creativity, both in general and creativity in mathematics in particular. Haylock [11] uses two approaches to identify mathematical creative thinking. First, he observes students' answers to solving problems which are considered as characteristics of creative thinking. Second, it determines the criteria for products that are indicated as the result of creative thinking, also called divergent products. At the basic level of mathematics learning, students are taught to solve problems in one way and one solution or known as a convergent mindset. This mindset is intended to provide students with the initial ability to solve problems and work on procedural questions so that initial concepts can be embedded in students. However, at this time students are not only required to be able to solve problems but also determine other solutions with different ways and perspectives so that if routine procedures do not give results, then the problem can be solved in a different way. Such patterns are called divergent patterns. This mindset is also called higher-order thinking skills or HOTS.

From the results of the researcher's interviews with classroom teachers, it was found that teachers tend to still use expository learning models with strategies that according to teachers are comfortable for students to learn. The lack of intensity of students to explore their own knowledge, especially in solving non-routine problems, makes students tend to only accept lessons without understanding and interpreting what they learn. This is very unfortunate because mathematics is an abstract language whose meaning must be known so that it can be understood and communicated properly. In addition, high-level mathematical thinking skills are something that must be trained, not just learned. The development of creative thinking skills can be implemented through learning oriented to the development of higher-order thinking. In an effort to train students' creative thinking skills, learning conditions are needed that provide freedom in developing creative thinking and creativity so that students can see that solving mathematical problems can be done in various ways as long as they comply with the established mathematical rules.

Learning mathematics, which is abstract and mechanical, makes Freudenthal [12,13,14] state that mathematics is not only mechanical but is a human activity and his view of learning as a new discovery. He adds that "the problem has to arise from a situation, and the child has to learn to recognize the problem in that situation. So raising a problem is math too.

Mathematization according to the Dictionary of the English Language "mathematize: to treat or regard mathematically" or mathematization is treating or assuming something mathematically. Mathematically can be interpreted as modeling a phenomenon mathematically (in the sense of looking for mathematics that is relevant to a phenomenon) or building a mathematical concept of a phenomenon. De Lange [15] defines mathematization as organizing activities in finding regularities, relationships, and structures. In general, mathematization in RME involves two main processes, namely generalizing and formalizing. Generalization is concerned with finding patterns and relationships, while formalization involves modeling, symbolizing, schematizing, and defining.

Realistic Mathematics Education (RME) is a special learning approach to mathematics. This approach departs from Freudenthal's opinion which says that mathematics must be associated with reality and mathematics is a human activity (16,7,18,19,20). Freudenthal added that providing formal mathematical information before the practical stage was an anti-didactic learning method. Realistic Mathematics Education (RME) is a theory of mathematics education that offers a pedagogic and didactic philosophy of learning and teaching mathematics and designing teaching materials for mathematics education (21).

RME was introduced as a didactic phenomenology method by translating mathematical concepts, structures, and ideas into everyday phenomena so that students reflect on mathematical mental objects, how students learn mathematics, and how mathematics should be taught during the learning process (3,20,22). Realism is one of the philosophies in mathematics learning that can be applied vertically and horizontally. In realistic learning, students are given tasks (problems) from real situations, namely, from within the student's growing world of life, which in the first example

RME has five characteristics, there are (14,24):

1. Using contextual problems (the use of context) In general, in RME, context is useful for concept formation: access and motivation to mathematics, model formation, providing tools for thinking using procedures, notations, images and rules, reality as a source and application domain, and practice specific skills in certain situations. Mathematics learning begins with contextual problems and does not start with a formal system so it allows students to use their previous experience or knowledge. Contextual problems not only serve as a source of mathematization but also as a source for re-applying mathematics. Contextual problems that are raised as the initial topic of learning should be simple problems that are recognized by students.
2. Using models (use models, bridging by vertical instruments) In learning with the RME approach, a model developed by students from the actual situation is used (model of). The model is used as a bridge between one level of understanding to another level of understanding. After class interaction and discussion occurred, this model was further developed and directed to become a formal model.

3. Using student contributions Students are given the widest opportunity to develop various informal strategies that can lead to the construction of various procedures for solving problems. In other words, a major contribution to the learning process is expected to come from students, not from teachers. This means that all thoughts or opinions of students are highly considered and appreciated. Contributions can be in the form of various answers, various ways, or various opinions from students
4. Interactivity The interaction between students and teachers, students and students, and students with learning tools is very important in RME so that students get positive benefits from these interactions. Forms of interaction such as: negotiation, explanation, justification, agreement, questioning, or reflection are used to achieve formal mathematical knowledge forms from informal mathematical knowledge forms found by students themselves.
5. Integrated with other topics (intertwining) The structure and concepts of mathematics are interrelated, therefore the interrelation and integration between topics (subject units) and across disciplines must be explored to support the occurrence of a more meaningful teaching and learning process so that simultaneous understanding emerges. Intertwin can be seen through the given contextual problem.

The word “real” or “real” often creates misconceptions about RME (14,25). The term "realistic" comes from the Dutch term "zich REALISEren" which means "imaginable". Thus, the word "realistic" can mean: (1) real contexts that exist in everyday life; (2) the formal mathematical context in the world of mathematics; or (3) an imaginary context that does not exist in reality but can be imagined. These three meanings are seen as the meaning of the term "realistic" as long as these contexts can be imagined in the minds of students who are studying mathematics (14, 20, 25). emphasizes RME offers students any imaginable problem.

Sitorus [3] also explains that the concept of reality is the context of children's knowledge that is known in their lives, and then becomes a component of thought schemes. The schema component connects various mathematical contexts and concepts. When students work on real problems they can develop mathematical ideas/concepts and their understanding, and they develop strategies that are close to context. Then these aspects of the real situation can become more general, meaning that the model or strategy can be used to solve other problems. Even the model gives students access to formal mathematical knowledge. To bridge the gap between the informal and formal levels, the model/strategy must be upgraded from “model of” to “model for” (7). Related to this situation, creative thinking can involve various dimensions of knowledge in each stage of the creative thinking process. Thus, reality and relatedness as RME principles can be used to encourage one's a creative thinking process.

2 Research Method

This research is quantitative research with a quasi-experimental method (27). The design used is the one-group pretest-posttest design The population of this study was fourth-grade elementary school students taking a sample of 3 schools, where each sample consisted of two classes with a total of 144 students

3 Results And Discussion

The results of the average difference in the achievement of mathematical creative thinking skills are as follows:

Table 2. Result of Difference Posttest Statistic Analyst of mathematical creative thinking skills

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Nilai Post Test is the same across categories of Grup.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

From the table above, it can be concluded that the average achievement of students' mathematical creative thinking skills who learned with RME is higher than students who learned using conventional methods.

Table 3. Result of Average of N Gain in Mathematics Creative Thinking

Group	Experiment	Control
Average of N Gain	0,38	0,27
SD	0,13	0,20

Meanwhile, there is also a significant difference between the students who learned using the RME method and the students who learned using conventional learning.

Table 4. Result of Difference Posttest Statistic Analyst of enhancement creative thinking skills

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Skor N Gain is the same across categories of Grup.	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

From the table above, it can be concluded that the average increase in students' mathematical creative thinking skills who are taught with RME is higher than students who learn with conventional methods. As for the improvement for each indicator of students' mathematical creative thinking abilities, the comparison of the achievements of each group is presented in the following bar chart:

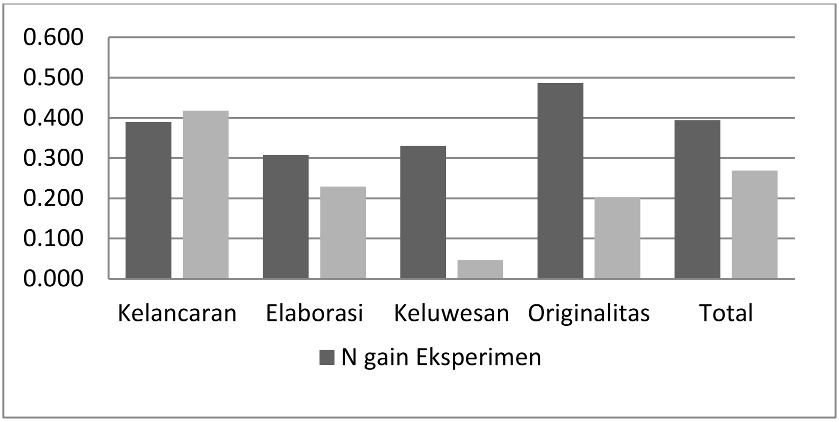

Fig. 1. Picture **1**. Bar Diagram Mathematics Creative Thinking Skill Enhancement

From the results above, it can be seen that for the fluency indicator, the increase in the control class is higher than the experimental class. Meanwhile, for the indicators of elaboration, flexibility, and originality, the increase in the experimental class is higher than the control class, so it can be seen that for all indicators, the increase in the mathematical creative thinking ability of the experimental class is higher than that of the control class. The most distinct improvement result is flexibility (flexibility).

Based on the answers given by the students, the researcher found some information. The achievement of indicators of mathematical creative thinking ability can be seen from the answers given by students. The first indicator in mathematical creative thinking ability is fluency. The achievement of this indicator is marked by students being able to take as much information as possible from the problems given. From the results of the work, students are able to show comparisons (less, more, the least or the most) in the information they write. Some students have also been able to add other relevant information that is implied from the context of the given problem. Another thing that was found in this study was that because students were given the freedom to write information, some students wrote information that was not relevant to the problems presented.

The elaboration indicator requires students to be able to develop ideas and add or detail the details of an object, idea or situation so that it becomes more interesting. This indicator also requires students to be able to describe problems and their solutions appropriately and sensibly. For the experimental class, some students start solving problems by writing down the information contained in the questions first. In solving problems, students are less able to explain the usefulness of the information in the problems presented. This is in line with the results of the answers on the fluency indicator where some students are less able to understand and write down the information in the problem. The lack of students' ability to elaborate on problems makes it difficult for them to solve problems.

In the indicator of flexibility, students are asked to show their flexibility of thinking in solving open-ended questions. This indicator requires students to provide solutions that are out of the ordinary by utilizing the knowledge they already have, then looking at the solutions and compiling solutions from various points of view. some students who are able to use the information that has been previously owned, students tend to be able to answer correctly. Students with high flexibility ability are able to give more than 1 correct answer. Most of the results given by students show that students are still less motivated or find it difficult to give more than one correct answer. This is because they are used to getting a single solution so they are not ready if they are given open questions. Students still assume that for the correct answer there is only one solution and the other is wrong. This is a paradigm that must be changed during the learning process.

The achievement of the fourth indicator of mathematical creative thinking ability, namely originality, is marked by generating unique ideas or the ability to generate original ideas. The results obtained in the experimental class, even though there are answers that are not perfect, some of the requested parts have been able to make their new work in accordance with the conditions or limitations given by the context of the problem. This shows that students with high authenticity abilities are able to solve problems well and provide new ideas that are relevant to the problems at hand.

4 Conclusion

Based on the data analysis and discussion of the research results that have been described previously, it is concluded that the achievement of mathematical creative thinking skills in students who apply learning with a realistic mathematics education (RME) approach is higher than students who apply conventional learning. from the comparison results for each indicator, it can be seen that the average value of the experimental class is higher than the control class. The increase in the mathematical creative thinking ability of students who use realistic mathematics education (RME) learning is higher than students who apply conventional learning. Based on the results of the N-gain data analysis per indicator, it can be seen that the improvement in the experimental class is still lower than the control class on the fluency indicator, but on the indicators of elaboration, flexibility and originality, the increase in students' mathematical creative thinking skills who use RME learning is higher than students who use RME learning. conventional learning.

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