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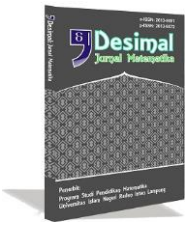

Group investigation and rotation trio exchange learning model: The impact on students' mathematical problem-solving abilities

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ABSTRACT

Mathematics is a basic science that has an important role. So, to achieve the objectives of learning mathematics, mathematical problem-solving abilities are needed. The mathematical problem-solving ability of the students of SMP PAB 3 Saintis at Deli Serdang is still very low. It is suspected that the Group Investigation and Rotation Trio Exchange learning models can improve students' mathematical problem-solving abilities. The purpose of this research was to determine the effect of students' problem-solving abilities taught using Group Investigation and Rotation Trio Exchange. Data collection techniques in this research use tests. The tests carried out were students' mathematical problem-solving abilities (pretest and post-test). The data that has been collected is then analyzed using the validity test, reliability test, normality test, homogeneity test, and t-test. Based on the results of the analysis, it was found that the problem-solving abilities of students taught using Group Investigation were more effective because students using the Group Investigation model had higher learning outcomes with an average score of 83.83 compared to those using Rotation Trio Exchange which obtained an average score of 75.32. Therefore, students' mathematical problem-solving abilities are more appropriate to be taught using Group Investigation rather than Rotation Trio Exchange.

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INTRODUCTION

Mathematics is a very important science and is used as a compulsory subject at every level of education, from elementary school to college (Somawati, 2018). In learning mathematics, several abilities should be grown, one of the mathematical abilities to be developed is the problem-solving ability.

Mathematical problem-solving ability is an ability where students try to find a way to achieve goals, it also requires readiness, creativity, knowledge and abilities, and their application in everyday life (Yarmayani, 2016).

The importance of solving mathematical problems is an integral part of learning mathematics, so problem-solving and learning cannot be separated as emphasized in (NCTM, 2000). Problem-solving is not only the goal of mathematics education but is also the main instrument used by mathematicians in their daily work (Asnawati et al., 2018). Students who have a strong understanding of the problem at hand, are able to articulate their thoughts clearly, are able to make good judgments, and recognize the need to revisit and re-examine their discoveries (Tarigan & Irwan M.Pd, 2021).

Based on the observations that have been made by researchers at SMP PAB 3 Saintis in class VII students in odd semesters by giving 30 students problem-solving skills questions about number material. Based on the results of the tests given, it was found that 10 students (33.33%) did not understand the problem, 8 students (26.6%) did not plan a solution, 5 students (16.6%) did not solve the problem according to the plan, and 7 students (23.3 %) did not re-check the completion procedure. The low problem-solving ability of these students will affect the quality of student learning. This is in line with the research of (Rambe & Afri, 2020) conducted at MAN Labuhanbatu in January 2020. Based on the results of these initial observations, the problem-solving abilities of MAN Labuhanbatu students are not optimal. In addition, the research of (Putra et al., 2018) conducted on class VII students at one of the SMPN in Cimahi can be concluded that the students' mathematical problem-solving abilities are still low.

The difference between this research and the research conducted by (Putra et al., 2018; Rambe & Afri, 2020) lies in the learning model used. In their research, they did not use a learning model, while this research used 2 learning models.

Lack of mathematical problem-solving ability in students can be attributed to various factors, including lack of enthusiasm and desire to learn, lack of strong interaction between teacher and students in the learning process, and the fact that students are never taught how to solve problems in problem-solving form so they are not accustomed to solving problems in a certain way (Fauza et al., 2020). There are many students who find it difficult to complete math assignments. The thing that causes students' poor problem-solving skills is the fact that students can solve arithmetic problems without considering how they arrived at their solutions (Fadhly, 2017). Because of this, teachers have an important role in helping students develop the ability to solve math problems through the techniques they use in class and the support questions they ask during assessments.

One solution to improve students' mathematical problem-solving skills requires a learning model. Teaching methods that encourage student participation in the learning process, as well as a discussion-based approach to problem-solving, can help students understand the material better. As a result, students will be able to understand the information on their own and ask high-level questions that teach them to think critically.

The application of a learning model that is able to improve student learning activities by using the Group Investigation and Rotation Trio Exchange learning model is one of the possible improvement efforts.

In Pranata (2016) view, Group Investigation is a group-based learning style that gives students the opportunity to engage in critical thinking and debate.

Certain researchers have used the Group Investigation Model to examine problem-solving abilities in groups. On the probability material for class X SMA Negeri 1 Singkawang, (Hija et al., 2016) found that the GI learning model had a significant impact on students' mathematical problem-solving abilities, with an average of 84.31% in the very active category, and a strong response to the model. GI learning in the opportunity material is 77.94%. As for the shortcomings in this research, too many introductions are included and do not go directly to the topic of discussion.

Students' critical thinking and scientific attitude can be fostered, and their mathematical problem-solving abilities can be improved, using the Group Investigation learning paradigm (Saraswati & Saefudin, 2017). The advantages of the GI learning paradigm, such as the shift from teacher-centered to student-centered teaching, are more than evident.

The research of (Linuhung & Sudarman, 2016) states that the mathematical reasoning ability of students who receive GI Type Cooperative learning is higher than students who receive conventional learning. In addition, there is also research of (Siregar, 2019) that states that there is an influence of the Group Investigation learning model on the ability to understand mathematical concepts of class X students of SMK Swasta Abdi Negara Binjai for the 2018/2019 academic year. From their research, it has differences with this research which lies in its ability.

The Rotation Trio Exchange cooperative learning approach was developed to keep students engaged from the start of learning, where students can work together and support each other to increase their attention and arouse their interest, and encourage students to think (Yahya & Bakri, 2020). The RTE learning approach is designed to educate students in one class to work together in groups to complete assigned tasks in a predetermined order (Hazuar et al., 2020). Whenever a new subject is proposed, students engage in conversation with different groups of peers (Utami et al., 2019). By using this paradigm, students are encouraged to engage with their own thoughts to obtain information and share it with others (Isfayani et al., 2018). By using the RTE approach, students can practice problem-solving, understanding topics, and student-centered learning by repeating content (Karim & Haris Saputera, 2016). Therefore, it can be stated that this RTE learning model is a comprehensive approach for students to actively engage in learning and debate difficulties with some of their classmates in class. According to (Wangi et al., 2019), students' mathematical problem-solving abilities can be improved by using the RTE learning methodology. One weakness of this study is that it does not cover all aspects of RTE.

The research of (Karim & Haris Saputera, 2016) mentioned the RTE type cooperative learning model has an influence on students' mathematical communication skills. The research conducted by (Purnawati et al., 2013) states that the understanding of mathematical concepts of students who take RTE type learning is higher than students who take conventional learning.

From previous research, it is stated that using the RTE model is better than the conventional model, therefore the difference between this research and previous research lies in its ability where previous research discussed students' mathematical communication skills and students' mathematical concept understanding abilities, while this research discussed problem-solving abilities.

The purpose of this research is to determine the differences between the Group Investigation and Rotation Trio Exchange models on students' mathematical problem-solving abilities.

METHOD

This research is a type of quantitative research using an experimental approach. Experiments can simply be interpreted as tests or experiments. Experimental research is research in conducting objective, systematic, and controlled research to predict or control phenomena.

This research was conducted on 7th-grade students at SMP PAB 3 Saintis during the odd semester of 2021/2022. There are 30 students in class VII-5 and 31 students in class VII-1, both randomly selected as the experimental group and control group, respectively in the sample of this research, which includes students of grade 7. The Group Investigation and Rotation Trio Exchange is two cooperative learning strategies used in these two courses.

The independent variable is the use of the Group Investigation type of cooperative learning model and the Rotation Trio Exchange type of cooperative learning. The dependent variable is the students' mathematical problem-solving ability.

Cooperative learning was used to teach the sample in the first experimental group, which consisted of two groups. The group investigation learning model has the following steps: Identifying subjects, dividing students into several groups, organizing learning assignments, conducting investigations, producing final reports, submitting final reports, and conducting assessments (Khairuddin & Hajeniati, 2020).

In contrast, the cooperative RTE model was used to instruct the second experimental group. By using the RTE method of teaching students, the teacher forms groups at random and then provides discussion material to help students overcome Trio's problems. After they have finished working on it, they present their discoveries in front of the class, and then based on how long it has been since their last presentation, the students who have symbols 1 and 2 rotate clockwise and counterclockwise, respectively, to form a new group.

The design plans in this research are in Figure 1.

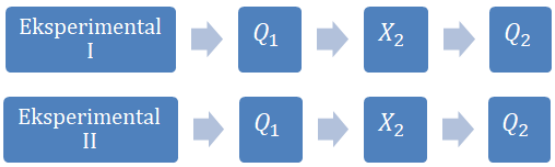

Figure 1. Treatment Design

Remarks :
Q1 = Pre-Test
X1 = Treatment with GI model
Q2 = Final Test
X2 = Treatment with RTE model

The procedure for this research is divided into three stages as in Figure 2.

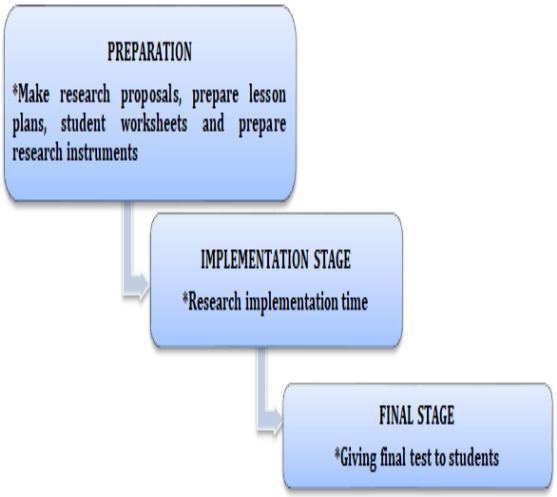

Figure 2. Research Procedure

The research technique is divided into three stages, namely preparation, execution, and conclusion. The initial stage begins with the development of research ideas, the creation of learner-centered learning modules and worksheets, and the creation of research

instruments. The implementation stage is when the research is conducted. While the last step involves giving final exams to students. To ensure the students' initial ability, a pretest (Pretest) is given. After that, students were treated using the Group Investigation model for experimental class 1 and the Trio Rotation exchange model for experimental class 2. Students will take the final exam after learning at the end of the study (posttest). In this research, the following indicators of mathematical problem-solving ability were used: (1) ability to understand the problem, (2) planning the solutions, (3) solving the problem according to plan, and (4) re-examine the method for solving results. Before giving the exam to the sample class, a test question test was conducted. Tests are carried out to ensure the instrument is of high quality. The test results were analyzed by calculating the problem differentiation index, the difficulty index of the questions, assessing the validity of the questions, and calculating the reliability of the test.

Giving pretest questions to the two research samples, namely experimental class students 1 and experiment 2, as many as four questions regarding the number material in the form of an essay test with a period of 40 minutes and a score of 25 for each question, the use of this test is to assess students' problem-solving abilities before instruction. After the pretest, the experimental course was taught using GI and RTE cooperative learning. The material given at each meeting is as in Figure 3.

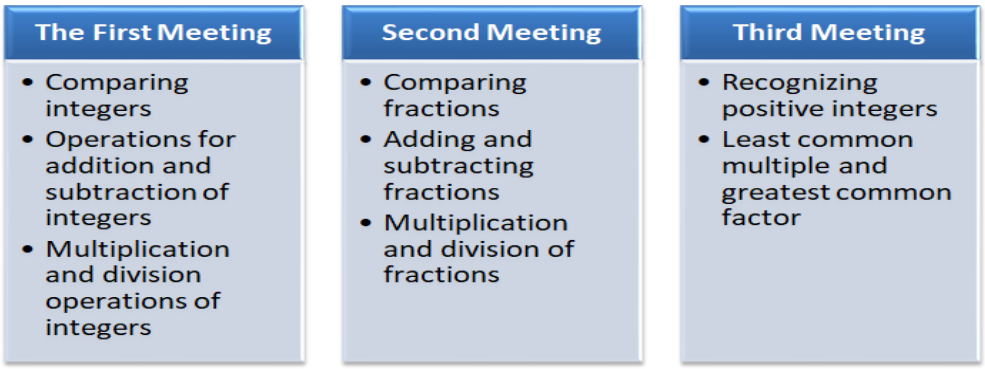

Figure 3. Meeting Material

Therefore, the data collection technique in this research is to use a test for solving students' mathematical problems. The two texts were given to all students in the GI learning group and the RTE learning group. The data collection techniques are as in Figure 4.

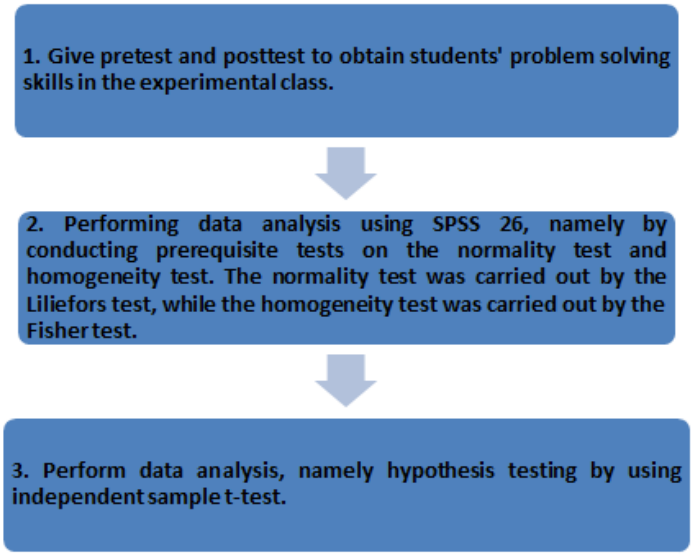

Figure 4. Data Collection Techniques

RESULTS AND DISCUSSION

From the results of research that have been carried out in class VII-5 and VII-1 of PAB 3 Saintis, produced data from student answers on the problem-solving ability test using the Investigation and Rotation exchange group learning model obtained from the results of the pretest and post-test which were tested covalently. The following is the summary research data analysis.

Table 1. Description of Data Pretest-Posttest of Problem-Solving Ability

	Descriptive Statistics				
	N	Min	Max	Mean	Std. Deviation
Pretest RTE	31	20	50	35.48	8.598
Posttest RTE	31	55	90	75.32	9.569
Pretest GI	30	20	50	37.33	8.782
Posttest GI	30	65	95	83.67	8.604
Valid N (listwise)	30				

Based on Table 1, it can be concluded that the average pre-test scores of students' mathematical problem-solving abilities in the experimental group taught using the Investigation Group and the experimental group taught using the rotating trio exchange were nearly identical. Where the experimental class on average Group Investigation is greater than the average experimental class Rotation Trio Exchange. Then the data will be tested for normality, pretest and post-test normality tests are very important to do to see whether the data is normally distributed or not. The following is a table of normality test results.

Table 2. Normality Test Results

	Class	Shapiro-Wilk		
		Statistic	Degree of Freedom	Significant
Problem-Solving Ability Test	Pretest RTE	.952	31	.180
	Posttest RTE	.943	31	.097
	Pretest GI	.939	30	.084
	Posttest GI	.936	30	.072

Based on Table 2, it can be seen that the results of the Shapiro-Wilk normality test are: the value of Sig. Pre-test GI of 0.084, and the value of Sig. Post-test GI of 0.072. While the value of Sig. RTE Pre-test is 0.180, the value of Sig. Post-test RTE is 0.97. So, it can be concluded that the data is normally distributed. This is because of the results of the normality test > 0.05. After the data is said to be normal, then the homogeneity test is carried out. The homogeneity test was carried out to see the diversity of the pretest and posttest values in the GI experimental class and the RTE experimental class. Here are the results of the homogeneity test.

Table 3. Homogeneity Test Results

	Levene Statistic	Degree of Freedom1	Degree of Freedom2	Significant
Problem-Solving Ability Test	.318	1	59	.575

From these data, the results of the homogeneity test of the variance of the data from the two classes are homogeneous. Because of the result of the value of Sig. > 0.05. Then to find out an increase in the experimental class using the GI model and the RTE model, can be seen in Table 4.

Table 4. Hypothesis Test Results

		Levene's Test for Equality of Variances				
		Frequency	Significant	T	Degree of Freedom	Significant (2-tailed)
Problem-Solving Ability Test	Equal Variances Assumed	.318	.575	-3.711	59	.000
	Equal Variances not Assumed			-3.720	58.274	.000

The hypothesis test yielded significant discoveries based on the data above (2-tailed), where the result is 0.000, which is equal to 0.05. Then, it can be concluded that the results of the pre-test and post-test on the mathematical problem-solving abilities of grade VII-5 students who are taught using the Investigation Group model and the mathematical problem-solving abilities of VII-1 students who are taught using the Rotation Trio Exchange are very different, with the problem-solving abilities of students who were taught using the Group Investigation Group learning were significantly higher than those who taught using the Rotation Trio Exchange. This is in accordance with the research of (Ningsih, 2019), which shows that students who learn using the Group Investigation learning model have a stronger problem-solving capacity than students who learn using the conventional learning model. This is because students are taught to understand the problem using the Investigative Group approach by gathering as much knowledge as possible about the current difficulties. Information can be gathered from a variety of sources, including books, instructors, and members of a group. By using the information gathered, the problem is defined, and strategies for dealing with it are developed, students in experimental classrooms may become more proficient in finding difficulties as a result of this

method. If students are faced with a dilemma, they will seek information that is known and requested. As can be observed from the student response sheets after solving the problems offered, the experimental class students first identified the problem before implementing the method to fix it. By defining the problem, it becomes clear what information is included in the question; This information will help students in understanding this problem. Along with gathering information about the problem, identifying the problem requires determining what the question is really asking; this makes it easier for students to design problems and establish the most effective techniques for solving them.

In addition, comparable discoveries were found in research on the use of group investigative learning to improve students' mathematical problem-solving abilities in SMP Negeri 27 Palembang grade VIII-4 (Anggraini et al., 2013). By using the group inquiry paradigm, students' ability to solve math problems increased dramatically, as shown by the average ability of students to solve math questions increased from 66 to 76 in the second cycle.

To carry out RTE learning, the researcher applied 6 meetings because the previous research conducted by (Wulandari et al., 2021), stated that the meeting to apply RTE learning only 4 times face to face also made no significant effect on students' problem-solving abilities. So for maximum results, you should increase the number of face-to-face hours. Furthermore, students have difficulty in moving groups so it takes longer in this learning process. The research results of (Wangi et al., 2019) stated that the RTE learning strategy is able to make a positive contribution to student learning outcomes if students can communicate mathematically well and can obtain high learning outcomes, students can discuss groups well and can together solve the given problem. The increase in student achievement results can be seen from the curiosity of students who have a positive response to learning mathematics. This is in accordance with research results of (Isfayani et al., 2018) which stated that the increase in learning ability results is also supported by the attitude of students who generally have a positive response to learning mathematics. Overall, students also think that learning with the Rotating Trio Exchange (RTE) type of learning model helps them better understand the math material they are studying. This can be seen from the students showing a sense of pleasure, and enthusiasm during the learning process, and are not afraid to express opinions.

In the research results of (Muttaqin, 2021), the influence of GI can occur because at each stage of learning the Group Investigation (GI) supports students' ability to solve problems, because learning activities are not only focused on efforts to gain as much knowledge as possible but also how to use all of the knowledge gained to deal with new situations or solve problems related to the field of study being studied. This is one of the most important things in the world of education where students have the ability to solve a problem. The use of the group investigation type of cooperative learning model has a positive impact on student learning outcomes because in this model the division of groups is carried out heterogeneously so that students can mingle with their friends. Students who are less intelligent can ask their group friends about material that they have not understood. Whereas in conventional learning, the delivery of material is fully carried out by the teacher, so that students who are smarter can quickly understand the material. Students who are less intelligent tend to be silent and shy to ask about the material they

have not understood (Yunita et al., 2018). The application of the group investigation learning model can improve students' mathematical problem-solving abilities because this learning directs students to be independent, and active in understanding material. So, in every learning, the more active role is the students (Gunawan et al., 2020).

So, from the results of previous research, both the GI and RTE learning models have a positive influence on students' mathematical problem-solving abilities, therefore what distinguishes them is the formation of groups on the RTE model that must have more time because in each problem solving-problem the RTE learning model forms new groups while the GI learning model only forms groups and the groups are fixed.

CONCLUSIONS AND SUGGESTIONS

According to this research, the Group Investigation and Rotation Trio Exchange methods vary in their ability to teach students math problem-solving skills. As a result of their good reactions, students feel compelled to participate more actively in their education. Learning with the Group Investigation model for teaching and learning activities makes students more comfortable if the group does not change in each question. Therefore, mathematical problem-solving ability using Group Investigation is better than mathematical problem-solving ability using Rotation Trio Exchange.

Based on the conclusions above, the researchers provide suggestions; (1) Teachers can use learning models that are in accordance with student needs; (2) Teachers should also actively involve students in carrying out the learning process; (3) Students should be more active in learning without needing to hesitate in completing a given mathematical problem; (4) For further researchers, it is recommended to develop this research by preparing other material presentations, using different strategies and being able to maximize time to improve students' mathematics learning outcomes.

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