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STUDENTS' SKILLS PERFORMING ON MATHEMATICAL REASONING AND COMMUNICATION THROUGH GROUP INVESTIGATION LEARNING MODEL

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ABSTRACT

The general purpose of learning mathematics formulated by the National Council of Teachers of Mathematics (NCTM) states that students must learn mathematical communication, mathematical reasoning, mathematical problem solving, mathematical connections, and mathematical representation. This study aims to describe and analyze students' mathematical reasoning and communication skills on linear programming material through the GI type cooperative learning model. This research is quasi-experimental design of the non-equivalent posttest only control group design. The research population was all students of class XI MAN 3 Banjar. The research sample is class XI IIS using cooperative learning model type GI and class XI MIA 1 using conventional learning. Data collection techniques was using observation, documentation, and tests. The results of the study shows that: (1) the mean score of the mathematical reasoning skills and the mathematical communication skills within the students of Grade XI State Madrasah Aliyah 3 Banjar on the learning materials of Linear Program through the GI-Type Cooperative Learning Model is 81.12 and 83.20, respectively belong to the "Very Good" qualification; (2) the mean score of the mathematical reasoning skills and the mathematical communication skills within the students of Grade XI State Madrasah Aliyah 3 Banjar on the learning materials of Linear Program through the Conventional Learning Model is 70.13 and 77.98 respectively belong to the "Very Good" qualification; (3) there have been differences on the mathematical reasoning skills on the learning materials of Linear Program between the students of Grade XI State Madrasah Aliyah 3 Banjar who have been exposed to the GI-Type Cooperative Learning Model and those who have been exposed to the Conventional Learning Model; and (4) there have been differences on the mathematical communication skills on the learning materials of Linear Program between the students of Grade XI State Madrasah Aliyah 3 Banjar who have been exposed to the GI-Type Cooperative Learning Model and those who have been exposed to the Conventional Learning Model.

Keywords: mathematical reasoning, mathematical communication, Group Investigation

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INTRODUCTION

Education is one of a lot of keys to the success of any person. With education, everyone can view the amazing world and get inspiration (Sukmawati, 2018). Mathematics is part of education. The general purpose of learning mathematics formulated by the National Council of Teachers of Mathematics (NCTM) states that students must learn mathematical communication, mathematical reasoning, mathematical problem solving, mathematical connections, and mathematical representation. Learning mathematics means learning to hone reasoning skills. Based on the statement, it can be assured that mathematics and reasoning skills are two interrelated aspects (Permana, Setiani, & Nurcahyono, 2020). When an individual learns mathematics, it means that the individual shall habituate himself or herself to think critically and logically and shall also internalize the potentials for improving his or her creativity (Satriawan, 2017). At the same time, the reasoning skills that the individual has, especially in the case of students, shall define the results of the mathematics learning process (Astuti & Abadi, 2015). Based on an interview with a mathematics teacher in MAN 3 Banjar, we get information that learning mathematics there has been not improving reasoning mathematics and not increasing communication mathematics. Teachers were not usually giving more opportunities to the students to participate in the reasoning process from one or more problems or tasks. Recalling the importance of performing mathematical reasoning skills, teachers should have facilitated the efforts for establishing these skills. About the statement, there are many ways for developing these skills, for example, teachers might deliver test items related to relationships and patterns along with the ways to complete such test items (Satriawan, 2017). The reason is that the students especially in senior high school, should have internalized the perception that mathematics is part of activities that examine pattern and regularity, make assumptions, and assess whether the assumption has been true or false (Wibowo, 2017).

Learning mathematics is indeed a complex activity that demands numerous skills for learning concepts or the data variability, which provides the chance for each student to understand one concept to another (Satriawan, 2017). One of the aspects that will be necessary for the effort of understanding mathematics concepts is mathematical communication skills (Wilkinson, Bailey & Maher, 2018). Communication becomes an important part of transferring the knowledge from the lecture of the teacher in every Mathematics learning process (Planas, 2020). The reason is that one of the Mathematics essentials is language and symbols (Wood, 2011). At the same time, mathematical communication skills become one of the important mathematical skills that students should internalize (Sabirin, 2011), besides the other aspects consist of representation mathematics, literacy mathematics, reasoning mathematics, and mathematics connections (Fahradina, Ansari & Saiman, 2014).

Baroody & Ginsburg (1990) mention that mathematical communication is one of the fundamental objects in Mathematics education because mathematical communication links cognitive activities and social activities. Mathematical communication becomes an implementation from reasoning mathematics skills. Through mathematical communication, an individual can trade ideas and insights about a mathematical concept with his or her peers; therefore, it makes sense that mathematical communication skills become the part of crucial skills that students should internalize and hone (Yang et al., 2016). Through mathematical communication skills, students can organize and consolidate their mathematical thinking, both in an oral and written manner, so that they will be able to achieve an in-depth understanding of the mathematical concepts that they have learned (Sabirin, 2011). Therefore, it also makes sense that the students' mathematical communication skills should be improved in addition to their learning results (Qohar & Sumarmo, 2013). When teachers encourage students to speak or to communicate, it means that teachers facilitate students to learning Mathematics meaningfully and actively (Darkasyi, Johar & Ahmad, 2014); consequently, students will be able to understand the learning materials of Mathematics. The reason is that when students are encouraged to complete test items through logical reasons they are encouraged to establish their mathematical communication skills (Qohar & Sumarmo, 2013).

Based on the explanation in the previous paragraphs, it can be concluded that mathematical reasoning skills and mathematical communication skills are two important skills that should be improved, recalling that two objectives of learning Mathematics in school are to implement the mathematical reasoning skills and to implement the mathematical communication skills. Then, to improve the mathematical reasoning skills and the mathematical communication skills of the students, teachers should habituate themselves to perform exploration and experimentation (Satriawan, 2017). In each learning opportunity of Mathematics, teachers facilitate students to explore their ideas, to explore their insights, and to deliver both of their ideas and insights under oral and written manners. The researcher chose the GI model for this research because the characteristic of this model have more probability for children to investigate some topic, and more chances to discuss with the group. So, can facilitate children to increasing their reasoning and communicating mathematics.

Still, the implementation of the GI-Type Cooperative Learning Model is more esteemable to indirectly exercise the mathematical reasoning skills and the mathematical communication skills of the students. The reason is that this kind of learning model demands the students to have good skills performing both reasoning and communication within the group process skills (Fahradina, Ansari & Saiman, 2014). In addition, this learning model also facilitates students to develop themselves optimally since they are provided with the flexibility to share their opinions (Zaini & Marsigit, 2014). Furthermore, the GI-Type Cooperative Learning Model demands students to be able to perform communal investigations by implementing the already internalize knowledge in group works. Through such a situation, it is expected that students can mutually help each other within their group and are also able to provide their original arguments, that similar to the result of research by Afri & Rahmadani (2020).

METHODS

Types, approaches, and research designs

The study was field research. Through this field research, the researchers were demanded to get down on the research site and start collecting information on the mathematical reasoning skills and the mathematical communication skills of Grade XI students in State Madrasah Aliyah 3 Banjar on the learning materials of Linear Program through the Group Investigation (GI)-Type Cooperative Learning Model. Then, the method that had been implemented in the study was the experimental method, whereas the design that had been chosen for the study was the quasi-experimental design.

Within the study, the samples were not gathered randomly because the characteristics of the population members had not been homogenous. In addition, the samples were already completely clustered in the form of a classroom. Therefore, it was impossible for the researchers to randomize or to establish a new cluster of samples since the formation of such a new cluster might ruin or obstruct the learning process. Therefore, the researchers decided to take the Non-Equivalent Post-Test Only Control Group Design for the study. Within this design, the researchers selected two groups of samples. The first group was provided with the (X) treatment. The group that had been provided with the (X) treatment was named the experimental group, while the group that had not been provided with the (X) treatment was named the control group. Afterward, both groups were provided with the post-test (O). This design could be described further through the following Table 1.

Table 1. Design

X	**O**
	O

In which : X = GI-Type Cooperative Learning Model
O = Provision of a mathematical reasoning skills test and mathematical communication skills test

Population and sample

The population in the study was all Grade XI students in State Madrasah Aliyah 3 Banjar. The composition of the population was provided in Table 2.

Table 2. Research Population

Grade	Male	Female	Total
XI Natural Science 1	9	21	30
XI Natural Science 2	8	22	30
XI Social Science	14	20	34
XI Religion Science of Islam 1	10	17	27
XI Religion Science of Islam 2	10	16	26
Total			147

The consideration that underlay the above sample composition was that the five parallel classrooms had been taught by two different teachers. Grade XI Social Science, Grade XI

Natural Science 1, and Grade XI Natural Science 2 were taught by Teacher A, while Grade XI Religion Science of Islam 1 and Grade XI Religion Science of Islam 2 was taught by Teacher B. To define the sample number, the researchers relied on the scores of the students' daily tests in the previous chapter. These scores were put into the test of normality and the test of homogeneity. The summary of both tests was provided in Table 3 and Table 4.

Table 3. Summary of Normality Test on the Research Population

Grade	Sig.	α	Status
XI Natural Science 1	0,054		Normal
XI Natural Science 2	0,000		Abnormal
XI Social Science	0,058	0,05	Normal
XI Religion Science of Islam 1	0,047		Abnormal
XI Religion Science of Islam 2	0,040		Abnormal

Table 4. Summary of Homogeneity Test on the Research Population

Grade	Sig.	α	Status
XI Natural Science 1 XI Natural Science 2	0,528		Homogeneous
XI Social Science XI Religion Science of Islam 1 XI Religion Science of Islam 2	0,010	0,05	Heterogeneous

The preliminary skills data of the Grade XI Natural Science 1 students and the Grade XI Social Science students were normally distributed and homogeneous. On the contrary, the preliminary skills data of the Grade XI Natural Science 2 students, the Grade XI Religion Science of Islam 1, and the Grade XI Religion Science of Islam 2 had not been normally distributed and had been heterogeneous as well. As a result, the classrooms that had been selected as the sample for the study were the Grade XI Natural Science 1 (30 students) and the Grade XI Social Science (34 students). In sum, the total number of the sample was 64 students. In the meantime, to define the experimental group and the control group between Grade XI Natural Science 1 and Grade XI Social Science, the researcher defined Grade XI Social Science as the experimental group and the Grade XI Natural Science 1 as the control group. The definition of the experimental group and the control group was performed randomly since the mean score of the preliminary skills between both classrooms was similar based on the results of the differential test that had been conducted.

Instrument development, data collection, and data analysis technique

The data gathering techniques that had been administered in the study were observation, documentation, and test. The observation was performed by directly observing the research site to gather the supporting data. Then, the documentation was performed to find the data about the aspects of the variables in the form of records, minutes of the meeting, and agendas. The results of the documentation were also used to identify the name of the students who had been the sample in the study. Next, the test was administered to attain the data on the Mathematics learning results from the students especially with regards to the mathematical reasoning skills and the mathematical communication skills on the learning materials of Linear Program both for the experimental group and the control group. There were eight items within the test and these items were divided into two sets of test items and were arranged based on the indicators that referred to the mathematical reasoning skills and the mathematical communication skills of the students. The composition of the test items based on the indicators was detailed in Table 5 and Table 6.

Table 5. Indicators of Mathematical Reasoning Skills Test Item Composition

No.	Indicators	No. of Test Item		$\sum$
		Set I	Set II	
1	Proposing assumption	1 and 2	1 and 2	4
2	Performing manipulation	1 and 2	1 and 2	4
3	Providing reason or evidence for solution	1 and 2	1 and 2	4
4	Drawing conclusion	1 and 2	1 and 2	4

Table 6. Indicators of Mathematical Communication Skills Test Item Composition

No.	Indicators	No. of Test Item		$\sum$
		Set I	Set II	
1	Using mathematical symbol / notation and performing mathematical operation	3 and 4	3 and 4	4
2	Illustrating mathematical ideas into the relevant form of a discourse	3 and 4	3 and 4	4
3	Drawing conclusion on the final answer	3 and 4	3 and 4	4
4	Stating the test item into a mathematical model or describing the data in the graphical form	3 and 4	3 and 4	4
5	Presenting mathematical ideas/relationships with algebra and solving problems	3 and 4	3 and 4	4

Then, the scoring guidelines for both the mathematical reasoning skills test and the mathematical communication skills test were provided in Table 7 and Table 8.

Table 7. Scoring Guidelines of Mathematical Reasoning Skills Test

No.	Indicators	Response	Score
1.	Proposing Assumption	Students are unable to propose assumptions.	0
		Students can propose assumptions but the assumption is still inaccurate.	1
		Students can propose assumptions accurately but the assumption is incomplete.	2
		Students can propose assumptions accurately and completely.	3
2.	Performing mathematical manipulation	Students are unable to perform mathematical manipulation.	0
		Students can perform mathematical manipulation but the mathematical manipulation is still inaccurate.	1
		Students can perform mathematical manipulation accurately but the mathematical manipulation is incomplete.	2
		Students can perform mathematical manipulation accurately and completely.	3

No.	Indicators	Response	Score
3.	Arranging evidence, providing a reason, or providing evidence for the solution	Students are unable to provide a reason or evidence for their solution.	0
		Students can provide a reason or evidence for their solution but the reason or evidence is still inaccurate.	1
		Students can provide reason or evidence for their solution accurately but the reason or evidence is incomplete.	2
		Students can provide reason or evidence for their solution accurately and completely.	3
4	Drawing logical conclusions based on given rules	Students are unable to draw a logical conclusion.	0
		Students can draw logical conclusions but the logical conclusion is still inaccurate.	1
		Students can draw logical conclusions accurately but the logical conclusion is incomplete.	2
		Students can draw logical conclusions accurately and completely.	3

Table 8. Scoring Guidelines of Mathematical Communication Skills

No.	Aspects under Assessment	Score	Information
1	**Grammatical Skills** Using mathematical symbol/notation and performing mathematical operations accurately	0	Students do not use the mathematical symbol/notation and the mathematical operation.
		1	Students make errors in using the mathematical symbol and the mathematical operation.
		2	Students accurately use the mathematical symbol/notation but make an error in performing mathematical operations accurately and vice versa
		3	Students use mathematical symbols/notation and mathematical operations accurately.
2	**Discursive Skills**		
	a. Illustrating mathematical ideas into the relevant form of a discourse	0	Students are unable to write down what they have attained from and what has been asked by the test item.
		1	Students can write down what they have attained from the test item but they have not written down what has been asked by the test item.
		2	Students can write down what has been attained from the test item but they make an error in writing down what has been asked by the test item and vice versa.
		3	Students can write down what has been attained from and what has been asked by the test item accurately and appropriately.
	b. Providing a rational reason to a statement (concluding the final answer)	0	Students are unable to conclude their answers.
		1	Students can conclude their answer but the conclusion is inaccurate.
		2	Students can conclude accurately.
3	**Sociolinguistic Skills**	0	Students are unable to describe the data in graphical

No.	Aspects under Assessment	Score	Information
	Describing the data into the graphical form		form.
		1	Students can describe the data in the graphical form but the description is incomplete or suffers from error.
		2	Students can describe the data in the graphical form accurately but the description is incomplete.
4	**Strategic Skills:** Presenting mathematical ideas/relationships with algebra and solving problems coherently	0	Students can write down the formula and the completion procedures but they arrive at the incorrect final answer.
		1	Students correctly write down the formula but they make an error in completing the test items and thus they arrive at the incorrect final answer.
		2	Students correctly write down the formula and complete the test items accurately, but they arrive at the incorrect final answer.
		3	Students correctly write down the formula, complete the test items accurately, and arrive at the correct final answer.

The method that had been used for scoring the learning results of the students:

$$N = \frac{Attained\ Score}{Maximum\ Score} \times 100$$

Information: N = final score

The final score of the students' mathematical reasoning skills and mathematical communication skills were interpreted using the adaptation guidelines that had been proposed by Riduwan. The adaptation guidelines were detailed in Table 9.

Table 9. Interpretation on the Students' Mathematical Reasoning and Communication Skills

No.	Score	Qualification
1	81.00 – 100.00	Very Good
2	61.00 ≤ 81.00	Good
3	41.00 ≤ 61.00	Moderate
4	21.00 ≤ 41.00	Poor
5	0 ≤ 21.00	Very Poor

The data analysis technique that had been used in the study were descriptive statistics and analytical statistics. Then, specifically, the analytical statistics that had been used as the differential test, namely the two-sample t-test or the Mann-Whitney test (U-test). Before administering the test, the researcher performed the statistical calculations, which consisted of the mean score, standard deviation, and variance. The t-test was later administered when the data had been normally distributed or homogenous, whereas the Mann-Whitney test (U-test) was administered when the data had not been normally distributed or had not met the parametric requirements.

RESULT AND DISCUSSION

Results

Learning Activities using GI Model

In the first or the preliminary stage, the learning process of the experimental group was conducted by implementing the Group Investigation (GI)-Type Cooperative Learning Model. This learning model consisted of two activities namely identifying learning materials and organizing students into groups that shown in Figure 1. In the beginning, the researchers explained that that the materials that they were about to study were the “Linear Program.” On this occasion, the researchers introduced the learning materials and then the researchers assigned the students into several groups before proceeding to the learning activities.

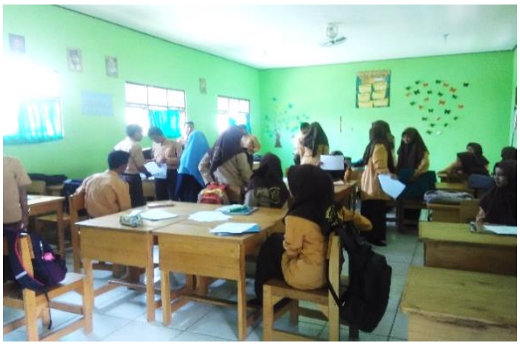
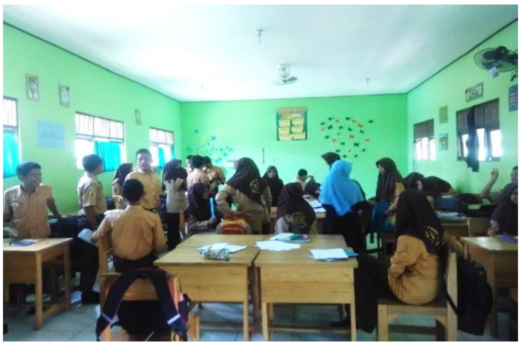



Figure 1. Students moving forward to the groups

Then, in the second stage, the researchers planned the learning assignments. After the students had been organized into groups, the students should discuss the parts that they should work on within the assignments that had been given like shown in Figure 2.

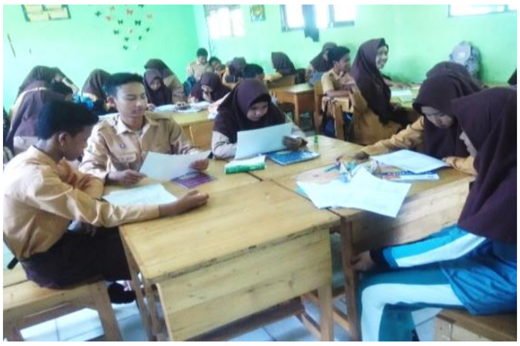



Figure 2. Cooperative Planning

Next, in the third stage, the researchers asked the students to do some kind of investigation. In this stage, the students investigated the problems that had been given by the learning materials by the researchers within the groups. Before the investigation, the researchers provided the students with the investigation sheet. Afterward, the researchers provided the students with the Group Activity Sheet that had contained several problems. The assignment that the students should complete in this stage was investigating the problems that had been presented.

In the meantime, within this stage, the researchers served as the facilitators for the students' investigation in case if the students encountered difficulties in carrying out their investigation. In this step, have any discussion about teacher and student in front of this classroom like shown in Figure 3.

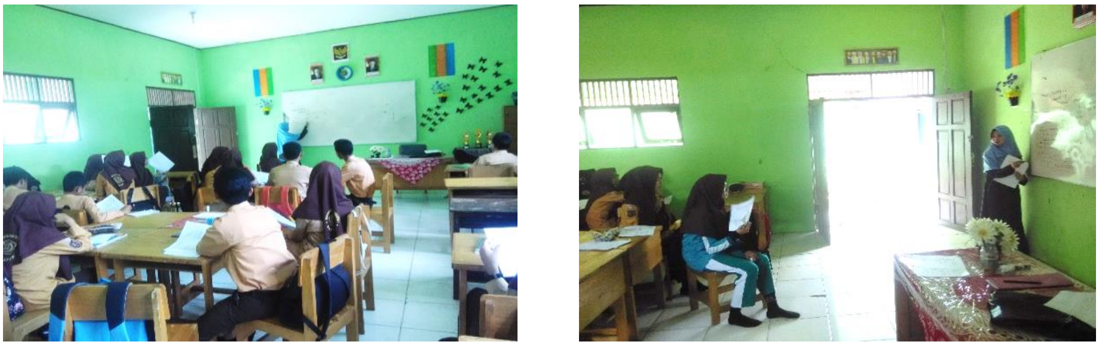


Figure 3. Implementation

The student has the opportunity to present, moving forward, in the fourth stage the students should compile their final report. In this stage, every student within the groups had prepared part of the Group Activity Sheet Report. All of the group members had solved the problems that had been given in the Group Activity Sheet and had also reported it within the Sheet like shown in Figure 4.

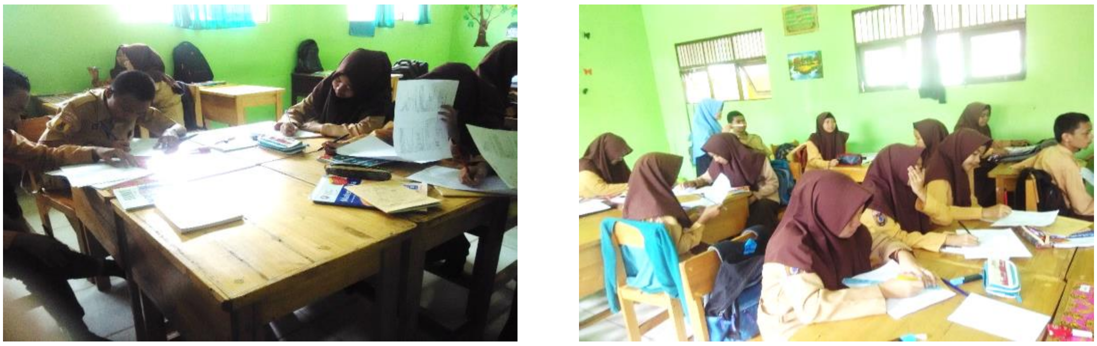
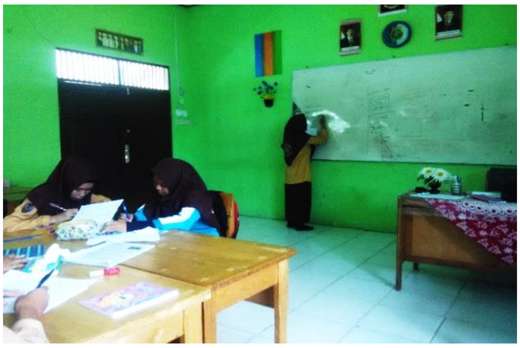


Figure 4. Students do the test

Subsequently, within the fifth stage, the students should present the final report that their group had compiled like shown in Figure 5. In this stage, the researchers selected one of the groups to present the results of their investigation. Through the presentation, the researchers allowed one of the group members to write down the results of their investigation following the part that they had taken in the second stage. But, we cannot zoom out the final answered, because we haven't this picture. But, overall, the final answered showing step by step students be done the group task.



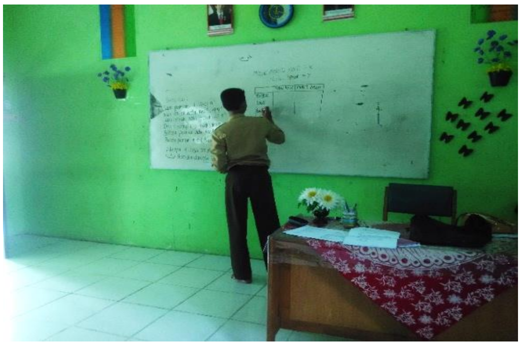


Figure 5. Students write answers in front of the class

Last but not least, in the sixth stage or the final stage, the students should undergo evaluation like shown in Figure 6. In this stage, the teacher evaluated the learning results that the students had achieved from the group investigation until the final report presentation.

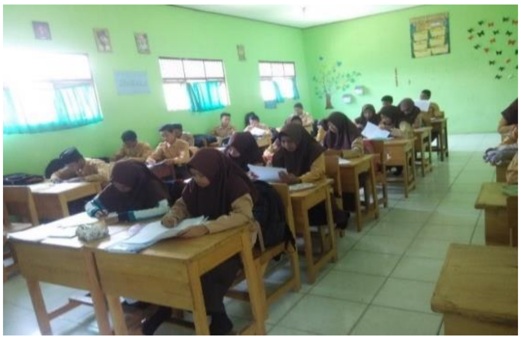


Figure 6. Exercise (Left) and Evaluation (Right)

Students' Mathematical Reasoning Skills

A final test was administered to identify the students' mathematical reasoning skills in both the experimental group and the control group. The test was administered in the third meeting for both groups. The distribution of the students' mathematical reasoning skills for both the experimental group and the control group was provided in Table 10.

Table 10. Distribution on the Test Results of Mathematical Reasoning Skills

Score	Experimental Group			Control Group		
	Frequency	(%)	Qualification	Frequency	(%)	Qualification
81.00 – 100.00	19	55.89%	Very Good	6	20.00%	Very Good
61.00 ≤ 81.00	12	35.29%	Good	17	56.67%	Good
41.00 ≤ 61.00	3	8.82%	Moderate	7	23.33%	Moderate
21.00 ≤ 41.00	0	0.00%	Poor	0	0.00%	Poor
0 ≤ 21.00	0	0.00%	Very Poor	0	0.00%	Very Poor
Total	34	100%		30	100%	

The mean score of mathematical reasoning skills from the students in the experimental group was 83.20, which belonged to the "Very Good" qualification. On the contrary, the mean score of mathematical reasoning skills from the students in the control group was 70.14, which belonged to the "Good" qualification.

The example task for ensuring both abilities is below.

A fried food vendor sells fried bananas and bakwan. The purchase price for one fried banana is Rp. 1,000.00 and one bakwan is Rp. 400.00. The capital is only Rp. 250,000.00 and the load of the cart does not exceed 400 seeds. If fried bananas are sold for Rp. 1,300.00/seed and bakwan Rp. 600.00/seed. Determine the objective function and the vertices around the solution area.

Specifically, the mean score of the students' mathematical reasoning skills is based on the indicators that had been defined as provided in Table 11.

Table 11. Mean Score of Students' Mathematical Reasoning Skills

Indicators of Mathematical Reasoning Skills	Mean Score		Qualification	
	Experimental	Control	Experimental	Control
Proposing assumption	78.43	67.22	Good	Good
Performing manipulation	84.31	75.00	Very Good	Good
Providing reason or evidence for the solution	84.80	77.78	Very Good	Good
Drawing conclusion	76.96	60.56	Good	Moderate
Total Mean Score	81.13	70.14	Very Good	Good

Looking at the results in Table 11, for the students in the experimental group it could be stated that: (1) the mean score of proposing assumption had been 78.43, which belonged to the "Good" qualification; (2) the mean score of performing manipulation had been 84.31, which belonged to the "Very Good" qualification; (3) the mean score of providing a reason or evidence for a solution had been 84.80, which belonged to the "Very Good" qualification; and (4) the mean score of concluding had been 76.96, which belonged to the "Good" qualification. In general, the mean score of the students' mathematical reasoning skills for all indicators in the experimental group had been 80.13, which belonged to the "Very Good" qualification.

Figure 7 is an example of the student's answer.

Known

- Modal of 1 fried banana is IDR 1,000
- Modal of 1 bakwan is IDR 400
- Owned capital IDR 250,000
- Cart load of 400 seeds
- The selling price of 1 fried banana is IDR 1,300
- The selling price of 1 bakwan is IDR 600

Asked

The objective function and the vertices around the solution region

Answer

Let fried banana is x and bakwan is y

	Banana	Bakwan	Load
Total	x	y	400
Modal	IDR 1,000	IDR 400	IDR 250,000
Selling price	IDR 1,300	IDR 600	

- Mathematical Model
  $x + y \leq 400$
  $1{,}000x + 400y \leq 250{,}000$ which is simplified to $10x + 4y \leq 2{,}500$
  $x \leq 0$
  $y \leq 0$
  Thus, the mathematical model is $x + y \leq 400$, $10x + 4y \leq 2{,}500, x \leq 0, y \leq 0$
- Objective function
  $f(x, y) = 300x + 200y$
- Point of intersection $x + y = 400$

x	0	400
y	400	0
(x, y)	$(0{,}400)$	$(400{,}0)$

- Point of intersection $10x + 4y = 2{,}500$

x	0	625
y	250	0
(x, y)	$(0{,}250)$	$(625{,}0)$

Figure 7. Student's answered

Based on these answers, we can see that student's reasoning abilities have worked. However, the final step was not optimum yet. As well as, their communication skills.

Students' Mathematical Communication Skills

In addition to the students' mathematical reasoning skills, a final test was also administered to identify the students' mathematical communication skills in both the experimental group and the control group. The distribution of the students' mathematical communication skills for both the experimental group and the control group was provided in Table 12.

Table 12. Distribution on the Test Results of Mathematical Communication Skills

Score	Experimental Group			Control Group		
	Frequency	(%)	Qualification	Frequency	(%)	Qualification
81.00 – 100.00	22	64.71%	Very Good	18	60,00%	Very Good
61.00 ≤ 81.00	4	11.76%	Good	9	30,00%	Good
41.00 ≤ 61.00	8	23.53%	Moderate	3	10,00%	Moderate
21.00 ≤ 41.00	0	0.00%	Poor	0	0,00%	Poor
0 ≤ 21.00	0	0.00%	Very Poor	0	0,00%	Very Poor
Total	34	100%		30	100%	

From the results in Table 12, it was apparent that in terms of mathematical communication skills in the experimental group 22 students (64.71%) had belonged to the "Very Good" qualification and 4 students (11.76%) had belonged to the "Good" qualification. On the other hand, from the same results as well it was apparent that in terms of mathematical communication skills in the control group 18 students (60.00%) had belonged to the "Very Good" qualification and 9 students (30.00%) had belonged to the "Good" qualification.

Specifically, the mean score of the students' mathematical communication skills is based on the indicators that had been defined as provided in Table 13.

Table 13. Mean Score of Students' Mathematical Communication Skills

Indicators of Mathematical Communication Skills	**Mean Score**		**Qualification**	
	Experimental	**Control**	**Experimental**	**Control**
Using mathematical symbol/notation and performing a mathematical operation	87.25	84.44	Very Good	Very Good
Illustrating mathematical ideas into the relevant form of a discourse	90.69	88.89	Very Good	Very Good
Drawing conclusion on the final answer	76.47	56.67	Good	Moderate
Stating the test item into a mathematical model or describing the data in the graphical form	75.49	73.89	Good	Good
Presenting mathematical ideas/relationships with algebra and solving problems	83.82	78.89	Very Good	Good
Total Mean Score	83.19	77.98	Very Good	Good

Looking at the results in Table 13, for the students in the experimental group it could be stated that: (1) the mean score of using mathematical symbol/notation and performing mathematical operation had been 87.25, which belonged to the "Very Good" qualification; (2) the mean score of illustrating mathematical ideas into the relevant form of discourse had been 90.69, which belonged to the "Very Good" qualification; (3) the mean score of concluding the final answer had been 76,47, which belonged to the "Good" qualification; (4) the mean score of stating the test item into a mathematical model or describing the data into the graphical form had been 75.49, which belonged to the "Good" qualification; and (5) the mean score of presenting mathematical ideas/relationships with algebra and solving problems had been 83.82, which belonged to the "Very Good" qualification. In general, the mean score of the students' mathematical communication skills for all indicators in the experimental group had been 83.19, which belonged to the "Very Good" qualification.

Discussions

Based on the result of the research we know three-point. First, the mean score of the students' test results for their mathematical reasoning skills on the learning materials of "Linear Program" that have been taught through the implementation of Group Investigation (GI)-Type Cooperative Learning Model has been 81.12, which belongs to the "Very Good" qualification. Second, the mean score of the students' test results for their mathematical communication skills on the learning materials of "Linear Program" that have been taught through the implementation of Group Investigation (GI)-Type Cooperative Learning Model has been 83.20, which belongs to the "Very Good" qualification. Third, there have been differences in the mathematical reasoning skills and the mathematical communication skills between the experimental group and the control group.

Departing from the above findings, several interesting matters can be outlined. *First*, concerning the students' mathematical reasoning skills, it turns out that the characteristics of the Group Investigation (GI)-Type Cooperative Learning Model are relevant to the establishment or the development of the students' mathematical reasoning skills. The difference is that the mathematical reasoning skills of the students in the experimental group belong to the "Very Good" qualification whereas the mathematical reasoning skills of the students in the control group belong to the "Good" qualification. Indeed, the implementation of GI has made the differences between the experimental group and the control group (Napitupulu et al., 2016). As a learning model, GI has been able to make the students develop themselves more within the learning process and improve the students' reasoning pattern better since GI departs from the problems that require the students to think and to reason in solving the problems (Afri & Rahmadani, 2020). This finding is following the main characteristic of GI namely emphasizing assignment completion. Specific to the case of the Linear Program, the examples of the test items are usually in the form of non-routine test items, which have been developed to hone the students' mathematical reasoning skills (Putri & Mulyana, 2018). So, from the result in this research, we have any novelty, one of them is the children start with problem-solving mathematics, not LOTS problem, but HOTS problem. However, it needs more time for this process, and more habits to integrated more problems in the level analyse, evaluate, or create, so the children get more reasoning and communication ability. In another result, the student who get the highest result can communicate fluently to help another friend. This condition appears that the students who have more ability cognitive can be good communication ability.

Based on the result of research, we can see about the students' mathematical communication skills, and also in similarity with the perspective of the students' mathematical reasoning skills, it turned out that there have been differences in the mathematical communication skills between the students in the experimental group and those in the control group. The mathematical communication skills of the students in the experimental group belong to the "Very Good" qualification, whereas the mathematical communication skills of the students in the control group belong to the "Good" qualification. The reason is that as a learning model GI emphasizes the students' activeness and participation in solving mathematical problems (Ardiana, 2018). In addition, GI also demands students to internalize sufficient skills for performing communication through group process skills (Kunandar, 2011), and hope mathematics communication can increase (Apriyanti, Rahmawati, & Isnaningrum, 2020) because the result of learning students that low are impacted by communication skills (Cahyani, 2019).

CONCLUSION

Based on the results of the study and also the discussions within the study, it can be concluded that there have been differences in the mathematical communication skills on the learning materials of the Linear Program between the students of Grade XI State Madrasah Aliyah 3 Banjar who have been exposed to the GI-Type Cooperative Learning Model and those who have been exposed to the Conventional Learning Model. Departing from the conclusions, the researchers would like to recommend that the teachers should be able to implement the

Group Investigation (GI)-Type Cooperative Learning Model because the characteristics of GI as a learning model can establish or hone the students' mathematical reasoning skills and also the students' mathematical communication skills. Therefore, GI can serve as an alternative mathematical learning model for honing both types of skills. The researchers also would like to recommend that large of field that can be population and sample, so, more than large population may be a good generalization.

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