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Collaborative Learning's Effect on Mathematical Communication Skill

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Abstract- This study aims to determine the increase in mathematical communication skills through Collaborative Learning. This study is an experimental study with a pre-test post-test control group design. Researchers randomly selected two groups of 30 students each from 183 Grade 8 students at a junior high school in Lembang, Indonesia. The mathematical communication skills test is used as a measuring instrument. Quantitative data analysis was performed using t-test, Mann-Whitney, and Rank-Spearman. The results showed that the increase in the mathematical communication skills of students who received Collaborative Learning was better than students who received conventional learning.

Keywords- Collaborative Learning, Mathematical Communication Skill

INTRODUCTION

Collaborative learning (CL) is a pedagogical technique in which students learn cooperatively in a group environment with the assistance of others(Oxford, 1997). Collaborative learning (CL) is a frequently used pedagogical technique in recent years, particularly in STEM areas such as mathematics and physics(Jeong et al., 2019). Students employ their knowledge and abilities in teams to tackle open-ended issues(Nurhayati, 2016;Hobri et al., 2019). This methodology encourages active learning and strengthens peer relationships(Shokri & Dafoulas, 2015).

The three main components of CL are student collaboration, cooperative learning, and scaffolding(Hornby & Greaves, 2022). CL helps students to be more successful by fostering these three key components. Those three components work together to help students achieve academic success.

Student collaboration: The first component of CL is collaborative learning, which consists of group activities in which students work together to solve a problem or accomplish a task. Students are encouraged to discuss and share their ideas in a collaborative learning atmosphere. This atmosphere is accomplished with the assistance of a leader and a facilitator. The leader conducts the discussion by providing the class with direction, while the facilitator keeps track of time and ensures that everyone has an opportunity to speak. This system allows all students to participate in the discussion and better understand the topic.

Cooperative learning: The second component of collaborative learning is collaborative learning, which is closely related to student collaboration. In a cooperative learning environment, students do assignments as a team. In addition, they are broken into smaller groups for practical exercises. Then, these groups convene to exchange their experiences and consolidate their knowledge. In addition, they encourage one another by contributing fresh ideas and providing other resources that may be useful to their project. Students enhance their communication skills and learn how to operate effectively as a team

through this type of collaboration. It also allows students to acquire important life skills, such as problem-solving, decision-making, leadership, and teamwork.

Scaffolding: The third component of CL is scaffolding, which provides students with advice and support when working on a challenging project or tackling a complex problem. The instructor provides pupils with step-by-step instructions or rules to assist them in finishing the assignment. This characteristic permits individuals to make modest progress toward the desired objective without feeling overwhelmed or disheartened by its immensity. By offering students this type of assistance, the teacher enables them to build the abilities and self-assurance necessary to face more difficult tasks in the future.

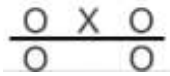
CL has gained popularity in many school systems based on its many potential benefits for students, including enhancing their communication and problem-solving skills and improving their critical thinking abilities(Li & Campbell, 2008;Khan, 2012). Mathematical communication ability is a vital talent for mathematical success. Students must communicate their mathematical thoughts and ideas effectively to solve problems, comprehend concepts, and interact with their peers and teachers.

Multiple studies have demonstrated that collaborative learning can enhance students' cognitive engagement in mathematics and their ability to apply arithmetic knowledge in real-world settings(Swan, 2006;Kollar & Fischer, 2010;Aliyu, 2017). Despite this, research on collaborative learning and its effect on students' mathematical communication skills is limited. This study seeks to fill this gap in the literature and investigate the potential effect of collaborative learning on students' mathematics communication skills.

Therefore, the objective of this study was to examine the impact of CL on students' mathematical communication skills. This paper uses an experimental design to compare the performance of two groups of eighth-grade students in a math class following participation in a collaborative learning activity and a traditional lesson to determine the effect of collaborative learning on students' mathematical communication skills. Before and after the activities, the performance of the two groups was measured by administering a mathematical communication test. The researchers expected that students who participated in CL lessons would have stronger mathematical communication skills than students who did not participate in CL programs.

METHOD

This study applied an experimental method of research using a pre-test post-test control group design(Gersten et al., 2000). The experimental group receives Collaborative Learning instruction, whereas the control strengthens peer relationships receives traditional instruction. The subjects of this study were two groups of randomly selected eighth graders from SMP Negeri 4 Lembang. A pre-and post-test was administered to both groups to determine the improvement in mathematics communication skills. This study's methodology is outlined as follows:



O : pre-test dan pos-test

__ : subject groups were randomly selected

X : learning mathematics with CL

A test instrument was developed to acquire comprehensive data and information regarding the topics to be investigated. This research employed a test of mathematics communication skills. The

grading criteria for each item are guided by indicators derived from Cai, Lane, and Jacabesin's Holistic Scoring Rubrics (Nuringsih, 2013, p. 31).

Table 1 Mathematical Communication Skill Scoring Criteria

Score	Student Response
4	Explanations are systematically complete, clear, and correct.
3	The mathematical explanation is almost complete, draws a picture, and the use of the algorithm is complete and correct, but there are a few errors.
2	Mathematically explanations make sense, but are only partially correct, draw a picture but are incomplete, and make mathematical models correctly but get wrong solutions.
1	Only some of the explanations, drawings, or mathematical models are correct.
0	No answer or misinterpreted.

To determine the test's viability, the researcher assessed the items' validity, reliability, discriminating power, and complexity. This examination was administered to students outside the research sample who had studied the subject matter.

Table 2 Feasibility Test Results for Each Question Item

Item	Validity	Reliability	Discriminating Power	Difficulty Index
1	0,742 (High)	0,88 (High)	0,438 (Good)	0,688 (Moderate)
2	0,781 (High)		0,344 (Good enough)	0,516 (Moderate)
3	0,786 (High)		0,438 (Good)	0,281 (Hard)
4	0,833 (High)		0,500 (Good)	0,281 (Hard)
5	0,771 (High)		0,656 (Good)	0,453 (Moderate)
6	0,690 (Moderate)		0,906 (Very good)	0,453 (Moderate)
7	0,798 (High)		0,406 (Good)	0,578 (Moderate)

To determine the effectiveness of enhancing mathematical communication skills, the normalized gain is calculated. The formula for calculating normalized gain is as follows (Hake, 1999):

$$Normalized\ Gain\ (g) = \frac{postes\ score - pretes\ score}{maximum\ score - pretes\ score}$$

With the following criteria:

Table 3Normalized Gain Interpretation Criteria

Value	Interpretation
$g > 0{,}7$	High
$0{,}3 < g \leq 0{,}7$	Medium
$0{,}3 \geq g$	Low

Figure 1 illustrates the processes of the statistical tests conducted for this investigation.

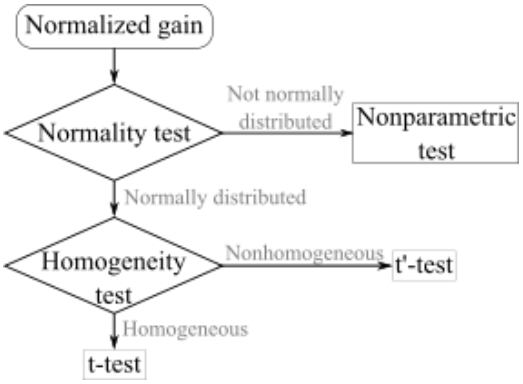


Figure 1 Statistical Test Flowchart

RESULTS AND DISCUSSION

The experimental group's average normalized gain was 0.85 with a standard deviation of 0.08, while the control group's average normalized gain was 0.59 with a standard deviation of 0.18. The data description reveals that the average normalized gain in the experimental group differs from that of the control group. Additional statistical tests are conducted to determine whether the difference is significant.

After determining the descriptive statistics of the normalized gain data from the experimental and control group, a test of normality will be conducted on both groups. The test for normality was conducted using the Shapiro-Wilk test with a 5% significance level. The experimental group's significance value was 0.010, while that of the control group was 0.303. This value indicates that the population from which the normalized gain score for the experimental group was derived is not normally distributed. In contrast, the normalized gain score for the control group is derived from a population with a normal distribution. Furthermore, the homogeneity of variance test was not carried out, but the two mean difference test was carried out using the Mann-Whitney test.

The difference test of two average normalized gains with Mann-Whitney was used to determine whether or not the improvement in the experimental group's mathematical communication skills was greater than that of the control group. Because a two-tail test is employed, a significance value of 0.000/2 = 0.000 is obtained; this value is less than 0.05. Thus, the improvement in mathematical communication abilities of students who study using Collaborative Learning is significantly more than the improvement with traditional learning approaches.

This study demonstrates that student engagement in mathematics collaborative learning (CL) improves mathematical awareness and communication skills. Those students who are more mathematically skilled and have a higher academic drive improved the most after participating in CL. Teachers who want to

implement collaborative learning in their classrooms must discover strategies to foster a suitable learning environment. This condition can be accomplished by providing students with the resources they need to collaborate effectively.

Collaboration refers to the interaction of two or more individuals or organizations working towards a common objective. Collaboration in the classroom entails students working on a task or project together (Robbins, et.al., 2012). Teachers may help students develop the skills they need to be great collaborators in a range of contexts and situations by promoting cooperative learning in the classroom (Holmes & Thornhill, 2006).

CONCLUSION

The author uses the data collected from pre- and post-tests of the students in the participating schools and compares them to determine if there is any significant difference between the students' performance in the two types of classrooms. The paper concludes that the students in the collaborative classrooms have improved their mathematical communication skills as compared to the students in conventional classrooms. The quality of improving the mathematical communication thinking skills of students who receive mathematics learning using the Collaborative Learning approach is categorized as high. In contrast, students who receive mathematics learning through conventional learning are categorized as moderate.

Research indicates that one of the ways to improve student's skills is through collaborative learning, which is a group-based learning environment in which the students learn from other students and develop strong relationships with each other. This method improves students' skills and enhances their learning experience through discussions and collaborative projects which promote active learning and engagement among students. The author also identifies several factors that may have an impact on the effectiveness of the method, such as the preparation and management of teachers, selection of an appropriate topic for learning, and setting appropriate objectives for the activities. These factors are important in designing an effective collaborative classroom.

The implementation of collaborative learning can be more effective if the teacher demonstrates a positive attitude towards the collaborative environment. The teacher should develop a positive relationship with all the students and encourage them to work together to solve problems and share their knowledge. There should be adequate interaction between the teacher and the students to promote engagement among the students and encourage active participation in the classroom.

Another way to enhance the effectiveness of a collaborative classroom is to allow students to develop their own objectives and goals based on their own interests. This will encourage greater participation in classroom activities and provide them with an opportunity to become actively involved in the learning process. It is important to set realistic goals and provide students with constructive feedback on their performances throughout the course so that they can improve their performance and reach their goals by the end of the term.

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