EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 10 Issue. 1, July 2025, pp 281-292
http://ejournal.uki.ac.id/index.php/edumatsains

The Effect of The Learning Cell Model on Students' Mathematical Communication Skills

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Article Info

Article history:
Received : May 15th 2025
Revised : July 28th 2025
Accepted : July 28th 2025
Available online : July 31st 2025

https://doi.org/10.33541/edumatsains.v8i1.4576

Abstract

This study aims to determine the effect of The Learning Cell model on students' mathematical communication skills. The population in this study consists of all eighth-grade students of SMP Negeri 16 Bandar Lampung in the 2024/2025 academic year totaling 264 students distributed across nine classes. The sample in this study includes class VIII E as the experimental class with 30 students and class VIII G as the control class with 29 students selected using purposive sampling technique. The type of research used is quasi experimental research. The design used is the pretest-posttest control group design. The data in this study is quantitative data obtained through a mathematical communication skills test. Based on the result of hypothesis test using t-test, it was found that the average gain score of mathematical communication skills for students who participated in The Learning Cell model was 0.72, which was higher than the average gain score of 0.58 achieved by students who participated in conventional learning. It can be concluded that the implementation of The Learning Cell model has an effect on students' mathematical communication skills.

Keywords: effect, mathematical communication, the learning cell

1. Introduction

Mathematics is a science that plays an important role in education and is always present at every level of the education unit. This is because mathematics is needed to support other sciences, such as physics, chemistry, accounting, and so on (Davita & Pujiastuti, 2020). In fact, mathematics is called the queen and servant of other sciences (Mailani & Wulandari, 2019). Mathematics as a queen means that learning mathematics only requires mathematics itself, while the meaning of mathematics as a servant is mathematics as a science that is always there and serves other sciences (Kurniawati & Ekayanti, 2020)

One of the objectives of mathematics learning stated in the Keputusan Kepala Badan Standar Kurikulum dan Asesmen Pendidikan Kemendikbudristek number 33 of 2022 is that students are able to express their mathematical ideas in symbols, tables, diagrams, or other media (Hutneriana et al., 2022). Thus, students are required to master mathematical communication skills in order to achieve the goals of learning mathematics. Mathematical communication skills are the ability to express mathematical symbols or concepts, the ability to interpret images or graphs, and the ability to use mathematical terms and notations in writing or orally (Mulbar et al., 2022). This ability is needed in learning mathematics because students are required to be able to think and then communicate various ideas that can be conveyed orally, in writing, through graphs or diagrams so that what is being learned can be meaningful to students (Jusniani & Nurmasidah, 2021). Mathematical communication skill indicators according to (Elvianika & Aini, 2023) include: 1) the ability to express problems into written mathematical ideas; 2) the skill of conveying problems into pictures, tables, diagrams or mathematical modeling accurately and completely; 3) the skill of presenting problem solutions in a structured and systematic manner; 4) the ability to evaluate mathematical ideas in written form. Indicators of mathematical communication skills according to (Hodiyanto, 2017) include: 1) writing (written text), namely giving explanations of mathematical concepts or solving problems using their own language; 2) drawing, namely conveying ideas or solving problems into images; 3) mathematical expression, namely expressing routine problems into mathematical language or models.

In actuality, the level of mathematical communication skills of Indonesian students is low. This is shown by the results of the Asesmen Kompetensi Minimum (AKM) study which aims to evaluate the ability of Indonesian students in literacy and numeracy. The Indonesian Education Report Card 2024 shows that the accumulated Learning Outcomes of students from all junior high schools based on AKM results are only 53.45% of students who reach the minimum limit of numeracy competence (Kemdikbudristek, 2024). According to (Sholehah et al., 2022) one of the difficulties of students when solving this AKM problem is the difficulty in interpreting the problem into the form of a mathematical model. In addition, it is known that students often make mistakes when analyzing information in the form of graphs, diagrams, tables, and so on (Yusuf & Ratnaningsih, 2022).This indicates that students have not been able to communicate ideas or concepts into mathematical models and interpret graphs or tables which are included in the indicators of mathematical communication skills. From the description above, it can be said that the ability of Indonesian students for mathematical communication still needs to be improved.

The low ability of students in mathematical communication also occurs in one of the secondary schools in Bandar Lampung, namely SMPN 16 Bandar Lampung. Based on preliminary observations and teacher interviews at SMPN 16 Bandar Lampung, it is known that students have not been able to communicate their ideas in learning mathematics. According to information from one of the 8^{th} grade mathematics teachers, most (80%) students have difficulty conveying ideas into the form of pictures, tables, graphs, or vice versa. Learners also find it difficult to solve story problems that need to be converted into mathematical models.

One of the factors that influence the high or low ability of students in mathematical communication is the process of carrying out mathematics learning activities in the classroom. If learning activities do not involve the participation or activeness of students, then the ability of students to communicate mathematically can be hampered (Ziana & Ristontowi, 2020). As in the learning activities that are usually carried out at SMPN 16 Bandar Lampung, students tend to only receive information and material that has been presented directly. Interaction between students is limited so that it can make their communication skills not developed.

To improve students' ability in mathematical communication, it is necessary to design learning activities that can train students to get used to constructing their ideas and ideas on the topics or materials they face. One of the learning models that hopefully can improve the quality of students' ability to communicate mathematically is The Learning Cell model. The Learning Cell model is learning through discussion in pairs (Wahyuni, 2017). According to (Satriawati et al., 2017), the stages in The Learning Cell model are as follows: 1) openness, which is the provision of stimuli to trigger student responses at the beginning of learning; 2) social, which is the formation of several odd-even groups. Odd group learners study different content with even groups, then each group prepares questions for groups that study different content; 3) evolvable & context-Aware, namely question and answer activities between each pair of odd-even groups from the questions that have been made; 4) cohesive, all learners make a summary and conclusion of the results of their work then presented through a presentation. The series of activities in this model requires students to actively express their ideas, ideas and thoughts to the teacher or other students (Wati & Linuhung, 2019). Therefore, the author chose to apply The Learning Cell model in the hope of creating an active and effective learning atmosphere so that there is an increase in students' skills in mathematical communication

2. Methods

The approach used in this research is a quantitative approach. The type of research is a quasi-experiment, this research is carried out to see if there is an influence by giving different actions to each class or group. This study uses two variables, namely the independent variable and the dependent variable. The independent variable in this study is The Learning Cell model while the dependent variable is the mathematical communication skills of students. The research design used is pretest-posttest control group design. Pretest was conducted to measure students' mathematical communication skills before learning, then posttest was conducted to measure students' mathematical communication skills after learning in both sample classes. This research design is expressed by (Sugiyono, 2017) in the following table.

Table 1.
Research Design

Group	*Pretest*	Treatment	*Posttest*
Experiment	O_1	X	O_2
Control	O_1	C	O_2

Description:
O_1 : student mathematical communication skills pretest (experimental class and class control)
O_2 : posttest of students' mathematical communication skills (experimental class and class control)
X : The Learning Cell learning model
C : conventional learning

The population in this study included all VIII grade students at SMP Negeri 16 Bandar Lampung in the 2024/2025 school year as many as 264 students spread across nine classes ranging from VIII A to VIII I classes. Of these nine classes, two classes were selected to be the research sample using purposive sampling technique. So that VIII E class was chosen as the experimental class which was given the treatment of learning using The Learning Cell model while VIII G class became the control class which was given the treatment of learning using the conventional model.

The research was conducted 3 stages, including the preparation stage, the implementation stage, and the final stage. The preparation stage was carried out by carrying out observations along with collecting preliminary data to find out the condition of the school, determining the population and research samples, and determining the material being taught. At this stage, the preparation and testing of instruments were also carried out. In the implementation stage, a pretest was conducted before being given treatment, mathematics learning using The Learning Cell model in the experimental class and mathematics learning using the conventional model in the control class, and the implementation of the posttest after receiving treatment. In the final stage, processing and analysis of research data results obtained from experimental and control classes were carried out.

The instrument used in this study is a test instrument. The test form is an essay or description question with the material of Linear Equations and Inequalities of One Variable as many as 4 items. The test instrument is given individually to students as a means of measuring mathematical communication skills in experimental classes and control classes. The test questions given during the pretest were retested during the posttest in both classes. The instrument must meet the test requirements, including having validity and reliability. Then the measurement of distinguishing power and the test of the difficulty level of the test items are also carried out.

The data obtained from the pretest and posttest scores were then analyzed to measure the improvement (gain) of students' mathematical communication skills in experimental and control classes. Data analysis was carried out using statistical tests on the gain score data of mathematical communication skills. Before conducting statistical tests on the gain score data of mathematical communication skills, a prerequisite test was carried out first. This prerequisite test includes normality test and homogeneity test.

After carrying out the normality test and homogeneity test, it was found that the results of the gain data came from a normally distributed population and both groups of gain data had the same variance. Furthermore, hypothesis testing was carried out using the equality test of two means of gain in mathematical communication skills of experimental and control class students using t-test statistics

3. Result and Discussion

3.1 Initial Data Analysis of Mathematical Communication Skills

The initial data of mathematical communication skills is the pretest score obtained from the experimental class and the control class. The results of the initial data processing of mathematical communication skills in experimental and control classes are presented in Table 2.

Table 2.
Initial Data of Students' Mathematical Communication Skills

Class	Many Students	Average	Standard Deviation	Lowest Score	Highest Score
Experiment	30	19,87	2,56	14	26
Control	29	20,59	3,96	14	29

Ideal Maximum Score (AMS) = 60

In Table 2, it is known that the average initial mathematical communication skills of students in the experimental class is not much different from the average initial mathematical communication skills of students in the control class. However, the standard deviation of students' initial mathematical communication skills in the experimental class is lower than the standard deviation of students' initial mathematical communication skills in the control class. This shows that the distribution of data on the initial mathematical communication skills of students in the control class is more diverse than the distribution of data on the initial mathematical communication skills of students in the experimental class.

3.2 Final Data Analysis of Mathematical Communication Skills

The final data of mathematical communication skills is the posttest score obtained from the experimental class and the control class. The results of the final data processing of mathematical communication skills in experimental and control classes are presented in Table 3

Table 3.
Final Data of Students' Mathematical Communication Skills

Class	Many Students	Average	Standard Deviation	Lowest Score	Highest Score
Experiment	30	48,50	4,33	38	57
Control	29	43,21	5,34	30	52

Ideal Maximum Score (AMS) = 60

In Table 3, it is known that the average final mathematical communication skills of students in the experimental class is higher than the average final mathematical communication skills of students in the control class. The standard deviation of students' final mathematical communication skills in the control class is higher than the experimental class. This shows that the distribution of data on students' final mathematical communication skills in the control class is more diverse than the distribution of data on students' final mathematical communication skills in the experimental class. The lowest score and the highest score of students' final mathematical communication skills in the experimental class were higher than the lowest score and the highest score in the control class.

3.3 Data Analysis of Gain in Mathematical Communication Skills

The recapitulation of students' mathematical communication skills gain data obtained from experimental and control classes is presented in Table 4 below.

Table 4.
Gain Data of Students' Mathematical Communication Skills

Class	Many Students	Average	Standard Deviation	Lowest Score	Highest Score
Experiment	30	0,72	0,10	0,52	0,92
Control	29	0,58	0,12	0,19	0,76

In Table 4, it can be seen that the average gain of students' mathematical communication skills in the experimental class is higher than the average gain of students' mathematical communication skills in the control class. The standard deviation of students' mathematical communication skills gain data in the control class is higher than that in the experimental class. This shows that the distribution of data on the gain in mathematical communication skills of students in the control class is more diverse than students in the experimental class. The lowest score gain and highest score gain obtained by the experimental class were higher than the lowest score gain and highest score gain in the control class.

3.4 Achievement of Mathematical Communication Skills Indicators

The achievement of students' mathematical communication skills indicators before and after learning activities with The Learning Cell model and conventional learning is presented in Table 5.

Table 5.
Achievement of Mathematical Communication Skills Indicators

Indicator	Experiment Class		Control Class	
	Initial	End	Initial	End
Written Text	51%	89%	53%	77%
Mathematical Expression	22%	87%	23%	73%
Drawing	2%	63%	2%	45%
Average	25%	80%	26%	65%

In Table 5, it can be seen that in the experimental class and control class there was an increase in mathematical communication skills. Based on Table 5, it is obtained that the final average achievement of mathematical communication skills indicators of students in the experimental class is higher than the control class students. The average achievement of mathematical communication skills indicators in the experimental class increased by 55% while the control class increased by 39%. Overall, the average achievement of mathematical communication skills indicators of experimental class students was higher than control class students with an average difference of 16%. This shows that the increase in the achievement of indicators of mathematical communication skills of experimental class students is higher than the control class.

3.6 Hypothesis Test Results of Mathematical Communication Skills

Based on the results of the normality test of students' mathematical communication skills gain data, it was found that the gain data in the experimental class came from a normally distributed population and the gain data in the control class also came from a normally distributed population. Next, the homogeneity test was carried out until it was found that the two populations had the same variance. Therefore, the hypothesis test carried out is a parametric statistical test using the t-test.

Based on the results of the t-test with a significance level of 0.05, it is obtained that $t_{\text{score}} = 4.196 > t_{\text{table}} = 1.672$ then H_0 is rejected and H_1 is accepted. This means that the average score of improvement (gain) of mathematical communication skills of students who follow The Learning Cell model higher than the average score of improvement (gain) of mathematical communication skills of students who follow conventional learning. This result shows that, the improvement of mathematical communication skills of students who follow The Learning Cell model is higher than the mathematical communication skills of students who follow conventional learning.

3.7 Discussion

The results of hypothesis testing showed that the improvement of mathematical communication skills of students who followed The Learning Cell was higher than the improvement of mathematical communication skills of students who followed conventional learning. In addition, the increase in the achievement of indicators of mathematical communication skills of students who follow The Learning Cell is also higher than the increase in mathematical communication skills of students who follow conventional learning. This means that the use of The Learning Cell model can improve students' mathematical communication skills. The results of this study are in line with several research results (Nurintan & Julyanti, 2020); (Masyitho, 2023); (Satriawati et al., 2017)which show that there is an increase in the mathematical communication skills of students who follow The Learning Cell model. The results of this study are also supported by the results of research by (Septia, 2019) and (Zuana, 2024) which show that there is an increase in each indicator of mathematical communication skills of students who follow The Learning Cell model.

The stages in The Learning Cell model have a higher chance of improving students' communication skills. In learning with The Learning Cell model, the initial stage carried out is the openness stage. Students are given a stimulus in the form of problems about the material to be studied. Based on observations, students look enthusiastic about providing various responses to the problems given based on their understanding or linking them to everyday problems, so that students are trained to convey ideas and explain their arguments. This is in line with the opinion of (Purwanti, 2017) which states that providing stimulus regarding the material to be taught can encourage students to practice communicating things related to their initial understanding. Thus, at this stage students develop mathematical communication skills on mathematical expression indicators or compile mathematical expressions by stating problems into mathematical models.

The next stage, namely the social stage, students discuss with their groups about the content being studied by each group. Based on observations, students can construct their knowledge by seeking information from various sources to solve the problems in the LKPD. Students are seen actively conveying their ideas in group discussions and organizing existing ideas to find the right solution to the problem. In addition, students with their groups also write questions about the content studied by other groups, so that through this stage students can develop ideas and convey them in questions. This is in line with the opinion of (Perta et al., 2017) and (Purba & Rajagukguk, 2024) that discussion activities train students to construct their knowledge in solving problems and the questions made can familiarize students to convey their ideas. This activity develops mathematical communication skills in mathematical expression indicators or compiling mathematical expressions and written text indicators or writing mathematical ideas.

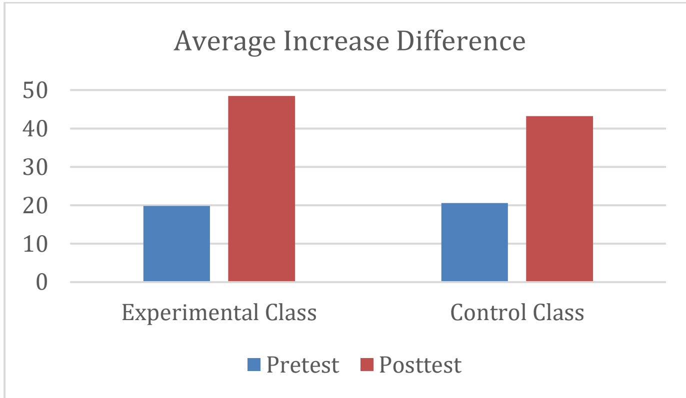
Next is the evolvable & context-aware stage, which is a question and answer activity between each pair of students from each group. Students convey the questions they have made with their groups. Based on observations, students get new information through the answers given by their partners so that they can strengthen their understanding. In addition, students also respond to questions given by their partners so that students are accustomed to communicating their ideas in answering the questions given. This is in accordance with the opinion of (Sari et al., 2018) which states that students can strengthen their understanding through question and answer activities with other students. This stage develops mathematical communication skills in mathematical expression indicators or compiling mathematical expressions, drawing indicators or conveying mathematical ideas in the form of images, and written text indicators or writing mathematical ideas or solutions to problems.

The last stage is the cohesive stage. At this stage students return to their respective groups to complete the worksheet. The problems that students work on are designed to increase students' understanding of the material. Based on observations, it appears that students can solve various kinds of problems with the knowledge they already have. In line with the opinion of (Siti Patimah et al., 2024) that students solidify their understanding to solve various problems. Students also present the results of work with their groups so that students are increasingly accustomed to conveying ideas and explaining their answers. This activity develops mathematical communication skills in drawing indicators or conveying mathematical ideas in the form of images, mathematical expression indicators or compiling mathematical expressions, and written text indicators or writing mathematical ideas or solutions to problems.

Unlike the class that uses The Learning Cell model, the class that uses conventional learning conducts teacher-centered learning using Direct Instruction model. The teacher explains the material directly to students, gives example problems, and demonstrates how to solve a problem. However, this makes students in the control class rarely ask questions or express their opinions because they think the material provided is sufficient. When working on practice problems, students are accustomed to seeing examples first and solving problems according to the solutions to the example problems. In line with the opinion of (Dewi, 2018) and (Sundawan, 2016) that students who are accustomed to receiving concepts directly tend to be more passive because they are not used to conveying their own ideas.

From the comparison of the learning process using The Learning Cell model and conventional learning, it is known that the learning process in the classroom using The Learning Cell model has a higher chance of improving students' mathematical communication skills. This is supported by (Fitriyani, 2019) which states that The Learning Cell model can familiarize students to convey their ideas accompanied by logical and systematic explanations and improve students' communication skills compared to conventional model. Figure 1 below illustrates the distinction in average gain between pretest and posttest scores for both the experimental and control classes.

Figure 1
Average Increase Difference



Based on the discussion above, it can be seen that the use of The Learning Cell model has a higher chance in improving students' mathematical communication skills than conventional learning. This is supported by the results of hypothesis testing which shows that the increase in mathematical communication skills of students who follow The Learning Cell model is higher than the increase in mathematical communication skills of students who follow conventional learning. Thus, it can be concluded that the use of The Learning Cell model affects the mathematical communication skills of students in grade VIII of SMP Negeri 16 Bandar Lampung even semester of the 2024/2025 academic year.

4. Conclusion

Based on the results of research and discussion, it can be concluded that The Learning Cell model has an effect on the mathematical communication skills of students in class VIII of SMP Negeri 16 Bandar Lampung even semester of 2024/2025 academic year. This is based on the research results which show that the increase in mathematical communication skills of students who follow The Learning Cell model is significantly higher than the increase in mathematical communication skills of students who follow conventional learning models.

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