THE EFFECTIVENESS OF THE DISCOVERY LEARNING MODEL ASSISTED BY CONSTRUCT-BASED EDUCATIONAL GAME LEARNING MEDIA ON MATHEMATICAL COMMUNICATION SKILLS AND STUDENT LEARNING OUTCOMES

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Abstract

This research seeks to describe the differences between the Discovery Learning learning model assisted by Construct-based educational game media and the conventional learning model on students' mathematical abilities in communication and educational achievements, and assess the superiority of the Discovery Learning model in these aspects. Using probability sampling method with cluster random sampling technique, this study involved three sample classes: control, experimental, and trial. Data were collected through documentation and tests with instruments that had been tested for validity, reliability, differentiability, and difficulty level. Data analysis was conducted using one way manova test and right side t-test following the assessment of normality and homogeneity. The findings indicated a substantial difference in mathematical communication ability and learning achievements of students instructed with the Discovery Learning model assisted by Construct-based educational game media compared to conventional learning, with students in the Discovery Learning group showing higher results. This finding indicates the Discovery Learning model supported by Construct-based educational game media is more effective in improving students' communication in mathematics ability and educational outcomes.

Keywords: Discovery, construct, mathematical communication.

1   INTRODUCTION

Education is a process of transforming one's attitude in a conscious and directed self-development effort. This process takes place throughout life to enhance the standard of living (Nurhuda, 2022). According to the Indonesian Law Number 20 of 2003 regarding the National Education System, education is described as a deliberate and organized effort to establish a learning environment and process that encourages students to actively cultivate their abilities. In order to achieve these educational goals, learning systems in Indonesia are divided into several levels, comprising early childhood education, primary school, middle school, secondary school, and higher education institutions. Each level has a number of compulsory subjects, one of which is mathematics.

Mathematics has an important role in human life and is a required course at every stage of schooling. The existence of mathematics in the school curriculum has a major role in achieving national education goals and building insightful, creative, productive, and innovative characters for the Indonesian people. Mathematical abilities help students solve everyday problems and meet real-world needs (Indriany et al., 2023).

The ability to communicate mathematically is crucial in the process of acquiring knowledge in the classroom. The ability to communicate mathematically is the skill to convey concepts in mathematics via various forms, such as language, notation, or symbols, which help in understanding, interpreting, describing connections, and solving situational challenges through mathematical frameworks, both verbally and in written form. This skill in mathematical communication is the main indicator of the extent of students' understanding of mathematics (Lubis et al., 2023).

In addition to skills in mathematical communication, student educational outcomes are also important to consider in learning mathematics. Student learning outcomes are the outcome of the educational process carried out by teachers and students (Nurhasanah et al., 2019). From the perspective of students, the outcomes of learning reflect an improved level of cognitive development compared to their state before the educational experience. From the perspective of educators, the results of learning are

the completion of the lesson material. Learner learning outcomes can be measured through various instruments, such as tests, assignments, and portfolios.

However, the results of observations during the Introduction to School Field at SMP Negeri 1 Tegal showed the abilities of students to communicate mathematically and their academic results tend to be low. The analysis of UTS work showed several things, such as the lack of students' ability in mathematical grammar such as the use of symbols/notations and appropriate mathematical operations, difficulty in understanding mathematical discourse by explaining ideas in a relevant manner, providing rational reasons for a statement, and limitations in conveying mathematical ideas in algebraic form and solving problems sequentially.

Therefore, to enhance students' abilities in mathematical communication and their learning results, an appropriate learning model is needed. A learning model that can be utilized to enhance students' mathematical communication abilities and learning outcomes is the Discovery Learning model. The Discovery Learning educational model offers chances for students to discover for themselves how to use symbols, write clearly to explain concepts, draw mathematical ideas, and model mathematical problems correctly through the investigation process (Fahmi et al., 2019).

In addition to the Discovery Learning model, learning media can also be applied to enhance students' mathematical communication abilities and learning outcomes. The construct-based game learning media is a media that facilitates and increases the effectiveness of the learning process. This educational tool can enhance students' abilities to communicate mathematically as it encourages them to interact with learning media and build their own knowledge (Septiyani et al., 2022).

This research seeks to evaluate if the Discovery Learning approach assisted by Construct-based educational game educational tools have the potential to enhance students' abilities to communicate mathematically and achieve better learning results on Data and Diagram material. This study used an experimental method with a population of students in class VII semester II SMP Negeri 1 Tegal for the academic year 2023/2024. The results from this research are expected to provide information and knowledge that an educational model exists that has the potential to enhance students' learning outcomes mathematical communication skills and learning outcomes and learning media that can visualize or demonstrate Data and Diagram material using the Construct application.

In this study, the Construct application was used to visualize and demonstrate data and diagrams. This research aims to deliver insights and knowledge that a learning model exists that has the potential to enhance students' abilities mathematical communication skills and learning outcomes as well as learning media that can visualize or demonstrate Data and Diagram material using the Construct application.

2 METHODOLOGY

This study used an experimental design with a quantitative methodology. The research design used Posttest-Only Control Design. This study compares the Discovery Learning learning model assisted by Construct-based educational game media with conventional educational frameworks on Skills in mathematical communication and the results of student learning on Data and Diagram material.

The participants in this research consisted of seventh grade students from SMP Negeri 1 Tegal for the academic year 2023/2024. In this study, there were three sample classes: control class, experimental class, and trial class. The sampling method used was probability sampling with cluster random sampling technique. Sampling was carried out through the use of lottery paper that had been named, and from the results of sampling obtained class VII A as the experimental class, class VII B as the control class, and class VII D as the test class.

The test instruments in the study consisted of proficiency in mathematical communication tests and student educational outcomes tests. The test assessing mathematical communication skills consists of 10 questions of description questions and the student learning outcomes assessment consisting of 10 multiple-choice questions that have been proven valid by a team of experts. Manova test and right side t test were used to calculate the research hypothesis.

3 RESULTS

The research obtained data from the methods used, namely tests and documentation. The method was employed to assess the proficiency in mathematical communication and learning outcomes of students

with Discovery Learning learning model assisted by contruct-based educational game media and conventional learning models on the subject matter of Data and Diagram class VII.

3.1 Instrument Test

3.1.1 Validity Test

Calculation of the validity of the test is generated using test Information regarding students' abilities in mathematical communication and their academic performance. Assessment of mathematical communication skills number one got the findings from $r_{xy} = 0,618$ and student learning outcomes test number one got the result of $r_{xy} = 0,571$. Furthermore, it is confirmed in the table for N = 32 at the 5% significance level (0.05) obtained $r_{table} = 0,349$. Because the r_{count} in the test for mathematical communication skills and student learning outcomes is greater than r_{table}, Assessment of mathematical communication skills and student learning outcomes number one are declared valid. To assess The accuracy of the examination employing the product moment correlation method, namely (Lestari dan Yudhanegara, 2017):

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (Y)^2]}}$$

Table 1. *Test validity of mathematical communication ability test*

No	r_{count}	r_{table}	Description
1	0,618	0,349	VALID
2	0,507	0,349	VALID
3	0,615	0,349	VALID
4	0,626	0,349	VALID
5	0,967	0,349	VALID
6	0,885	0,349	VALID
7	0,880	0,349	VALID
8	0,769	0,349	VALID
9	0,815	0,349	VALID
10	0,533	0,349	VALID

Table 2. *Test the validity of the student learning outcomes test*

No	r_{count}	r_{tabel}	Description
1	0,571	0,349	VALID
2	0,537	0,349	VALID
3	0,625	0,349	VALID
4	0,488	0,349	VALID
5	0,767	0,349	VALID
6	0,604	0,349	VALID
7	0,562	0,349	VALID
8	0,461	0,349	VALID
9	0,652	0,349	VALID
10	0,775	0,349	VALID

3.1.2 Reliability Test

Test instruments that have a valid index category in the assessment results of the proficiency in mathematical communication test and the student educational results test can basically be utilized, and a reliability test is carried out to see whether each question item used is convincing enough to be reused.

Table 3. *Test reliability of mathematical communication ability tests and student learning outcomes*

No	Variables	r_{count}	r_{table}	Description
1	Kemampuan Komunikasi Matematis	0,849	0,349	RELIABEL
2	Hasil Belajar	0,808	0,349	RELIABEL

3.1.3   Test the Level of Difficulty

The test difficulty level is shown in the table below. Based on the findings of determining the level of difficulty of each test, use the following formula (Lestari dan Yudhanegara, 2017).

$$IK = \frac{\bar{X}}{SMI}$$

Table 4. Test the level of difficulty of the mathematical communication ability test

No	*Difficulty Index*	Description
1	0,80	EASY
2	0,77	EASY
3	0,77	EASY
4	0,72	EASY
5	0,35	MEDIUM
6	0,44	MEDIUM
7	0,36	MEDIUM
8	0,29	HARD
9	0,24	HARD
10	0,34	MEDIUM

Table 5. Test the level of difficulty of the student learning outcomes test

No	*Difficulty Index*	Description
1	0,63	MEDIUM
2	0,34	MEDIUM
3	0,75	EASY
4	0,78	EASY
5	0,41	MEDIUM
6	0,22	HARD
7	0,53	MEDIUM
8	0,78	EASY
9	0,41	MEDIUM
10	0,28	HARD

3.1.4   Distinguishing Power Test

To find the outcomes of the differentiating power of the communication skills test using the following formula (Lestari dan Yudhanegara, 2017).

$$D = \frac{\overline{X_A} + \overline{X_B}}{S_{max}}$$

Table 6. Test the distinguishing power of the mathematical communication ability test

No	*Distinguishing Power*	Description
1	1,61	EXCELLENT
2	1,55	EXCELLENT
3	1,55	EXCELLENT
4	1,44	EXCELLENT
5	0,70	GOOD
6	0,88	EXCELLENT
7	0,71	EXCELLENT
8	0,59	GOOD
9	0,48	GOOD
10	0,69	GOOD

Meanwhile, to test the differentiating power of the student learning outcomes test using the following formula (Yadnyawanti, 2019).

$$D = \frac{R_u}{T_u} - \frac{R_i}{T_i}$$

Table 7. *Test the distinguishing power of the student learning outcomes test*

No	*Distinguishing Power*	Description
1	0,50	GOOD
2	0,44	GOOD
3	0,50	GOOD
4	0,44	GOOD
5	0,56	GOOD
6	0,44	GOOD
7	0,44	GOOD
8	0,44	GOOD
9	0,44	GOOD
10	0,56	GOOD

3.2 Prerequisite Test

The calculation of the prerequisite examination consists of tests for normality and homogeneity, which are carried out using the mathematical communication ability test and the student learning outcomes test. The purpose of the normality test is to confirm that the data used has a normal distribution, while the purpose of the homogeneity test is to ensure that the variance between information groups is the same.

3.2.1 Normality Test

The calculation of the normality test using the Liliefors test can be seen in the following table.

Table 8. *Normality test of mathematical communication ability data*

No	Variables	L_{count}	L_{table}	Description
1	Experiment Class	0,151	0,157	NORMAL
2	Control Class	0,142	0,157	NORMAL

Table 9. *Normality test of student learning outcomes data*

No	Variables	L_{count}	L_{table}	Description
1	Experiment Class	0,148	0,157	NORMAL
2	Control Class	0,119	0,157	NORMAL

Based on table 8 and table 9, it shows that the data on mathematical communication skills and student learning outcomes $L_{count} < L_{table}$. So it can be concluded that the data on mathematical communication skills and student learning outcomes are normally distributed.

3.2.2 Homogeneity Test

Based on the calculation, it can be concluded that $F_{count} < F_{table}$ or in other words both classes are homogeneous. The following table summarizes the results of the homogeneity test on both samples:

Table 10. *Data homogeneity test of mathematical communication ability and learning outcomes*

No	Variables	F_{count}	F_{table}	Description
1	Mathematical Communication	1,267	1,804	HOMOGEN
2	Learning Outcomes	1,459	1,804	HOMOGEN

Based on table 10 shows that the data of mathematical communication ability and learning outcomes of students $F_{count} < F_{table}$. So it can be concluded that the data of mathematical communication ability and learning outcomes of students have homogeneous variance.

3.3 Hypothesis Test

3.3.1 First Hypothesis Test

The calculation of the first hypothesis test results, obtained that $F_{count} = 6{,}128 > F_{table} = 3{,}069$ so that H_0 is rejected, which means that there are differences in mathematical communication skills and learning

outcomes of students taught with the Discovery Learning learning model assisted by construct-based game media and conventional learning models.

3.3.2 Second Hypothesis Test

Calculation of the results of the second hypothesis test, obtained that $t_{count} = 3,578 > t_{table} = 1,670$ so that H_0 is rejected which means that the Discovery Learning learning model assisted by Construct-based game media is better than the conventional learning model on students' mathematical communication skills.

3.3.3 Third Hypothesis Test

Calculation of the results of the third hypothesis test, obtained that $t_{count} = 1,815 > t_{table} = 1,670$ so that H_0 is rejected, which means that the Discovery Learning learning model assisted by Construct-based game media is better than the conventional learning model on student learning outcomes.

4   CONCLUSIONS

From the research conducted at SMP Negeri 1 Tegal, it was concluded that there were variations in the abilities related to mathematical communication and student achievements resulting from instruction using the Discovery Learning model assisted by construct-based game media and traditional educational approaches and skills in mathematical communication and student achievement results from instruction using the Discovery Learning model assisted by construct-based game media better than conventional learning models.

REFERENCES

Fahmi, A. N. … Coesamin, M. (2019). Pengaruh Model Pembelajaran Discovery Terhadap Peningkatan Kemampuan Komunikasi Matematis Siswa. *Jurnal Pendidikan Matematika*.

Indriany, P. E. … Purwanto. (2023). Penerapan Model Discovery Learning dalam Meningkatkan Kemampuan Komunikasi Matematis dan Hasil Belajar pada Peserta Didik SMP. *Prosiding Seminar Nasional …*, 2639–2647.

Lestari, K. E., dan Yudhanegara, M. R. (2017). Penelitian Pendidikan Matematika. In *Bandung: PT Refika Aditama*.

Lubis, R. N. … Rahayu, W. (2023). Kemampuan Komunikasi Matematis Siswa pada Pembelajaran Matematika. *Jurnal Riset Pembelajaran Matematika Sekolah*, *7*(2), 23–34.

Nurhasanah, S. … Syafrimen. (2019). *Strategi Pembelajaran*. EDU PUSTAKA.

Nurhuda. (2022). *Landasan Pendidikan* (N. Gazali (ed.)). Ahlimedia Press.

Septiyani, D. Y. … Susanta, A. (2022). Pengaruh Media Pembelajaran Berbasis Macromedia Flash Terhadap Kemampuan Komunikasi Matematis Siswa. *Didactical Mathematics*, *4*(2), 413–423.

Yadnyawanti, I. A. G. (2019). *Evaluasi Pembelajaran* (I. K. Suda (ed.)). UNHI PRESS.