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THE MATHEMATICAL COMMUNICATION SKILLS OF HIGH SCHOOL STUDENTS IN THE IMPLEMENTATION OF THE EXPERIENTIAL LEARNING MODEL

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Abstract

The objective of this research is to determine whether the enhancement in mathematical communication skills of students instructed with the experiential learning model surpasses that of students instructed with the conventional learning model. This research is a quasi-experimental research design, with the research sample comprising one experimental class (utilizing the experiential learning model) and one control class (following the conventional approach), each consisting of 20 students. The research instrument employed is a descriptive test comprising a pretest and posttest. Based on the research data analyzed using the *N*-Gain hypothesis test, it can be concluded that there is an improvement in students' mathematical communication skills in the context of the three-variable linear equation system material. This improvement is more pronounced among students taught using the experiential learning model compared to those instructed using the conventional learning model.

Keywords: Experiential learning model, Mathematical communication skills, Linear equation.

Abstrak

Tujuan penelitian ini untuk mengetahui apakah peningkatan kemampuan komunikasi matematis siswa yang diajarkan dengan model pembelajaran experiential learning lebih tinggi dari pada siswa yang diajarkan dengan model pembelajaran konvensional. Penelitian ini merupakan penelitian quasi eksperimen dengan sampel penelitian ini terdiri dari satu kelas eksperimen (model experiental learning) dan satu kelas kontrol (konvensional) dengan masing-masing kelasnya berumlah 20 siswa. Adapun Instrumen penelitian yang digunakan yaitu berupa tes uraian yang berupa pretest dan postest. Dari data penelitian berdasarkan uji hipotesis N-Gain kemampuan komunikasi matematis siswa pada materi sistem persamaan linear tiga variabel dapat disimpulkan bahwa terdapat peningkatan kemampuan komunikasi matematis siswa yang diajarkan dengan model pembelajaran experiential learning lebih lebih tinggi dari pada siswa yang diajarkan dengan model pembelajaran konvensional.

Kata kunci: *Kemampuan komunikasi matematis, Model experiental learning, Persamaan linear.*

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INTRODUCTION

Education is a fundamental aspect of human life that holds significant importance in daily life, particularly within the social sphere. People require education and a deep understanding of how to effectively engage in social interactions to interact harmoniously with those in their vicinity. This is in line with the view of Rosalina and Pertiwi (2018) that education is the process of influencing students to adjust to their environment as much as possible. Thus, students actively develop their opportunities to gain spiritual strength, self-control, personality, intelligence, noble character and skills needed by students, society, nation and state. Consequently, the government has undertaken numerous initiatives to enhance education across both urban and remote regions of the country. In addition to these measures, the government has also introduced several mandatory subjects that students are required to excel in, with mathematics being one of them.

Mathematics is a fundamental science that should be included in all levels of education. Learning mathematics often requires more time and effort to comprehend the material compared to other subjects (Nursalma & Pujiastuti, 2023). In the realm of mathematics education, a recurring issue is the tendency among numerous students to commit formulae to memory rather than grasping underlying concepts. They often fail to fully comprehend the foundational concepts that serve as stepping stones to more advanced material. This predicament arises from the intricate interconnectedness of mathematical concepts, causing students to overlook the fundamental principles that underpin subsequent concepts. Consequently, these challenges result in misconceptions, as misunderstanding one concept can give rise to an entirely different concept that deviates from the intended understanding.

The objectives of learning mathematics are: (1) to foster students' intelligence, especially intellectual understanding; (2) fostering students' understanding in solving problems systematically; (3) obtaining better learning outcomes; (4) fostering students' understanding in communicating responses, especially understanding in writing scientific papers; (5) fostering student character (Heriyaman, 2022). Based on the learning objectives above, communication in mathematics is very necessary as described by the Ministry of Education and Culture in 2013. Communication is one of the skills of a process related to the ability of students to convey or capture ideas to be more creative, both through verbal and writing (Azizah et al., 2020). Students may experience difficulties even though the questions are different from those given. One of the main subjects of mathematics that students learn is the system of linear equations of three variables.

The system of linear equations involving three variables pertains to a set of equations featuring three distinct variables, specifically *x*, *y*, and *z*. In the representation of these variables within the context of a system of linear equations comprising three variables, it is not mandatory to employ the letters *x*, *y*, and *z* exclusively. Alternatively, one may opt to employ alternative letters, such as *a*, *b*, and *c*, or even select letters based on initial letters associated with the variables in question. The system of linear equations of three variables can be manipulated like ordinary variables, for example by addition, subtraction, multiplication and division. However, many students of MAS Mathla'ul Anwar Pusat Menes in general still experience difficulties in Mathematics subjects. This can be seen from the results of students' answers in solving the given three-variable linear equation system problems. These results are presented in Figure 1 and Figure 2.

Problem: If Betty's age, 10 years in the future has an age of 6 years the age of the youngest sibling is less. Change the sentence into mathematical equations.

Student Answer:

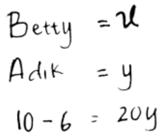

Figure 1. Example of students' answers in answering questions

Figure 1 shows that the students are not able to explain mathematical ideas, situations and relationships in written form with real objects. Students' inability to solve everyday problems using mathematical language and symbols is shown in Figure 2.

Problem: Mrs Dewi bought 1 kg of sugar, 2 kg of cooking oil, and 1 kg of flour for IDR 49,500. Mrs Ihah bought 3 kg of sugar, 1 kg of cooking oil and 2 kg of flour for Rp 73,500. Mrs Ani bought 1 kg of sugar, 3 kg of cooking oil and 4 kg of flour for Rp 92,500. Determine the price of 1 kg of sugar, 1 kg of

Student Answer:

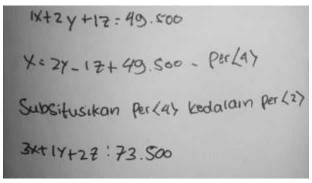

Figure 2. Examples of students' answers in answering questions

It can be seen that students' mathematical communication skills are still relatively low based on Figures 1 and 2. This can be seen on the basis of Soemarmo's indicators of students' mathematical communication skills (Kleden et al., 2017). From the results of the students' answers in Figures 1 and 2 that the students are still unable to explain mathematical relationships in writing and to relate everyday events to mathematical symbols and from the interviews with the mathematics teachers. It can be concluded that the obstacles experienced by students are that they are unable to relate real objects to mathematical ideas and to solve everyday events in mathematical language.

In a general sense, mathematics within the realm of communication encompasses the skills and capabilities required for writing, reading, discussing, listening, and presenting mathematical concepts. Proficiency in mathematical communication is a fundamental skill that students need to cultivate gradually. This is because effective communication skills enable students to articulate their problem-solving thoughts and ideas both orally and in written form. Students in the academically proficient group can excel in conveying mathematical concepts or scenarios in writing, but they still struggle somewhat when it comes to expressing these situations in their own words, through visual representations, or via mathematical models (Fauzi, 2021).

Hence, in order to enhance the intended development of mathematical communication skills, teachers should meticulously plan and formulate their approach to delivering mathematical content to their students. Furthermore, teachers should offer direction to students regarding the content they need to comprehend, enabling the incremental completion of activities that align with each stage of students' abilities for the most effective mathematics education. Mathematical communication can be divided into two categories: oral and written. Mathematical communication skills allow students to use language to communicate ideas, extend their thinking process and understand mathematical concepts. They can also use writing to explain, discuss and express mathematical ideas. Students' mathematical communication skills can be developed through the learning process at school, one of which is the learning process of mathematics. To overcome these problems, a creative, innovative and cheerful teacher is needed, as well as an understanding of learning patterns so that learning is meaningful to students so that students understand the application of mathematics in everyday life.

Addressing these challenges necessitates a teacher who possesses creativity, innovation, a cheerful demeanor, and a deep understanding of learning patterns. This understanding allows for the creation of meaningful learning experiences, enabling students to grasp the practical applications of mathematics in their daily lives. Cognitive strategies-based learning models involve the conversion of experiences into knowledge throughout the learning process. According to Kolb (2014) that knowledge consists of understanding and transformation of experience. The learning model based on experience is the experiental learning model proposed by Dewey (Dobos, 2014).

Experiental Learning is an interaction between students and students, students and teachers, and special problems related to everyday life. The Experintal Learning model encourages students to think more, explore, ask questions, make decisions and apply what they have learnt in their activities. The learning process in the experiential learning model consists of five phases, namely (1) experience phase, (2) share phase, (3) process phase, (4) generalise phase, (5) apply phase (Sari, 2018). For best results through experiential learning, students should be involved in all activities in experiential learning (Mutmainah et al., 2019; Ali, 2023). Judging from research data, it says that experiential learning can improve student learning outcomes. This can be seen from the research. In this research, the author will apply the Experiental Learning model to the learning of mathematics of grade X high school students. From the description above, the author will conduct a research entitled "mathematical communication ability of high school students in the implementation of experiental learning model". The purpose of this research is to determine whether there is a difference in the improvement of mathematical communication skills between students who get learning with the Experiental Learning model and students who get conventional learning.

RESEARCH METHODS

The methodology employed in this research adopts a Quasi-Experimental approach, employing a quantitative research method. The method used in this research is Quasi Experimental. This research involved two classes, namely the experimental class using the Experiental Learning method and the control class using the direct learning method of learning. The data collection technique is by using the test technique. The test technique used by researchers is the initial test (pretest) in both classes and researchers use questions that have been validated. Furthermore, researchers give treatment to the class that will be used as the object of research. The final step is that the researcher gives the final test (posttest) to both research classes using the same questions when doing the initial test (pretest). The test in this research consisted of 6 questions, where each question number covered all indicators of mathematical communication skills in this research.

An effective instrument must satisfy two crucial criteria: validity and reliability. Given that the research instrument takes the form of a test, in addition to conducting validity and reliability assessments, it is also imperative to evaluate the level of difficulty and differentiation to identify high-quality questions. The following presents the tabulated summary of the test questions' outcomes in Table 1.

Table 1. Recapitulation of question test results

Question Number	Validity	Reliability	*DIF*	*DI*	Description
1	Valid	Reliable	Medium	Medium	Used
2	Valid		Medium	Very good	Used
3	Valid		Difficult	Good	Used
4	Valid		Medium	Medium	Used
5	Valid		Difficult	Medium	Used
6	Valid		Medium	Good	Used

Based on the results of the analysis of the validity test, reliability test, difficulty index (*DIF*), and discrimination index (*DI*) test, the six items that have been tested all valid questions have difficulty levels of difficult, easy and moderate and have moderate, good and excellent discrimination index. Six questions that are feasible can then be used as pretest and posttest tests in experimental and control classes. The data collection techniques used are, 1) observation; 2) communication ability test; 3) documentation. The data analysis techniques used are, 1) *N*-Gain normality test; 2) *N*-Gain homogeneity test; 3) *N*-Gain *t*-test.

RESULTS AND DISCUSSION

Data analysis from the research results, namely on pretest, posttest and *N*-Gain data, is presented as follows.

Description of pretest result data

Researchers previously asked pretest questions, which is a form of question given to students before starting learning. The depiction of the pretest data result of students' mathematical communication skills on the material of the three-variable linear equation system, see Table 2.

Table 2. Data description of pretest score

Class	Mean	N	Std. Deviation	Maximum	minimum
Experiment	28,40	20	5.725	40	20
Control	21,05	20	5.063	33	18

From Table 2, it can be seen that the learning outcomes of experimental class students obtained a maximum pretest score of 40 and a minimum of 20. Meanwhile, control class students obtained a maximum pretest score of 33 and a minimum of 18. With each class size of 20 students. While the class average (mean) for the experimental class was 28.40 and the control class was 21.05. The standard deviation of the experimental class was 5.725 and the control class was 5.725.

Description of posttest result data

Data observation was carried out before the learning process took place on the material of the system of linear equations of three variables. After the data is sufficient, then the data is processed to test normality and homogeneity. Postest was conducted to determine the underlying ability between classes that would be used as experimental and control classes. Description of data from the posttest results of students' mathematical communication skills on the material of the system of linear equations of three variables in Table 3.

Table 3. Data description of posttest score

Class	Mean	N	Std. Deviation	Maximum	Minimum
Experiment	38.25	20	4.598	44	28
Control	28.75	20	5.399	40	20

Normality Test

To find out whether the two samples are normally distributed or not, a data normality test can be carried out on the experimental class. The normality test in this research used the Kolmogorov-smirnov and Sapiro-Wilk tests. A summary of the normality test results can be seen in Table 4.

Table 4. Pretest normality test results

	Class	Statistic	*df*	*p*-value
Pretest	Experiment	0.957	20	0.494
	Control	0.956	20	0.470
Posttest	Experiment	0.920	20	0.100
	control	0.967	20	0.694

Based on Table 4, it can be seen that the data from the pretest of mathematical communication skills of the experimental class has a significance level value of 0.497 and the dick class has a significance level value of 0.470. It can be concluded that the pretest data is normally distributed.

Derived from the analysis result in Table 4, it is evident that the posttest data assessing the mathematical communication skills of students in the experimental class yields a significance level of 0.100, while the control class registers a significance level of 0.694. When scrutinised in the context of a significance level ≥ 0.05, this indicates that the sample originates from a population with a normal distribution.

Homogeneity test

The homogeneity test is used to determine whether the two classes have relatively the same criteria or not, a summary of the pretest and posttest homogeneity test results can be seen in Table 5.

Table 5. Pretest homogeneity test results

	Levene Statistic	*df1*	*df2*	*p*-value
Pretest	0.614	1	38	0.438
Posttest	0.544	1	38	0.465

Based on Table 5, in the pretest data, it is found that p-value > 0.05 from the calculation of the experimental class and control class obtained significance = 0.438 so that the experimental class and control class come from the same variant, it can be concluded that the sample comes from a homogeneous population.

Furthermore, in the posttest data, it is found that p-value > 0.05 from the calculation of the experimental class and control class obtained significance = 0.465 so that the experimental class and control class come from the same variance, it can be concluded that the sample comes from a homogeneous population.

Hypothesis testing

After the data is collected, data analysis can be done to test the hypothesis. Hypothesis testing using the independent sample test test. The reason why the independent sample test was used on the pretest and posttets to find out whether there was an increase in students' mathematical communication skills.

Table 6. Pretest and posttest hypothesis test results

Data	*F*	*df*	*p*-value
Pretest	0,614	38	0,000
Posttest	0,544	38	0,000

Based on Table 6, the pretest hypothesis test of students' mathematical communication skills on the material of the system of linear equations of three variables, it can be seen that *p*-value= 0.000, this means that at a significance level $\alpha \geq 0.05$, there is no significant difference in the mathematical communication skills between students in the experimental class with the experiential learning model and those in the control class with the conventional model.

On the other hand, the posttest hypothesis test of students' mathematical communication skills on the material of the system of linear equations of three variables, it can be seen that *p*-value= 0.000 This implies that, at a significance level $\alpha < 0.05$, there is no significant difference in the mathematical communication skills between students in the experimental class with the experiential learning model and those in the control class with the conventional model.

_N_-gain test

Description of gain score of improving mathematical communication skills of experimental and control class students in class X (Phase E) MAS Mathla'ul Anwar Pusat Menes. For more details can be seen in Table 7.

Table 7. Description of gain score results of control and experiment classes

Class	N	Min	Max	Average *N*-gain	Std. Deviation *N*-gain
Experiment	20	0.00	1.00	62.64	0.29056
Control	20	0.00	0.82	21.51	0.22329

The data analysis of the research outcomes reveals that students subjected to the experiential learning model exhibit superior mathematical communication skills compared to those exposed to conventional learning methods. This is evident in the research results, which indicate that the experimental class achieved an average *N*-Gain value of 62.64, while the control class recorded an average *N*-Gain value of 21.55. This is in line with research by Sapta (2017) entitled "The Effect of Experiential Learning Model on Student Mathematical Communication" This is because the application of the experiential learning model in the experimental class shows learning based on experience. Both the experiences they have gone through and the experiences they are going through. In the implementation of learning, students are given worksheet to be studied by the group. Thus, students can easily understand what will be learned with the researcher. Where in the implementation of the experimental class, namely by researching and analysing and presenting results based on real experiences. For the experimental class students work independently and in groups to construct mathematical communication skills orally and in writing.

The following is an account of learning utilizing the experiential learning model within the experimental class, as follows: Stage 1 (Experience) At this stage each student is formed in a group, each group is given worksheet by the researcher and given the opportunity to read first, Stage 2 (Share) At this stage the researcher invites students to be able to present the outcomes they get during the discussion to complete the worksheet that the researcher has given, Stage 3 (Process) At this stage students analyse the experiments they have done on worksheet. At this stage students are also able to compare the experimental results obtained with their friends, Stage 4 (Generalize) At this stage the researcher helps students to relate the experimental results to related concepts. Since the material discussion is about the system of linear equations of three variables, so the researcher helps students to relate the results of the experiment to the system of linear equations of three variables, Stage 5 (Apply) At this stage the researcher gave several problems related to the system of linear equations of three variables. Giving this question to see the students' ability to the problems that have been discussed previously, this apply stage includes the final stage of learning using the Experiental Learning model. Meanwhile, the control class that used conventional methods saw learning that was still teacher-centred, because students were less accustomed to planning problem solving independently which made students confused if given problems that were different from the example. However, this difference also makes a difference in the acquisition of students' mathematical communication skills in both the experimental and control classes.

Furthermore, based on the pretest and posttest data obtained in the experimental and control classes, it is then continued with the calculation of *N*-gain to determine the increase in student learning outcomes before and after being treated using Experiental Learning Model learning. Based on the results of the *N*-gain test in (Table 7), it shows that there is a difference between the pretest and posttest scores of both the experimental and control classes, with an average *N*-gain value of the experimental class (62.64) with fairly effective criteria, while the average *N*-gain of the control class (21.51) with less effective criteria. It can be concluded that the average *N*-gain value of the experimental class is better than the average *N*-gain value of the control class in improving students' mathematical communication skills.

CONCLUSION

In light of the outcomes from the research on the experiential learning model's impact on the mathematical communication skills of high school students, it can be deduced that there is an enhancement in students' mathematical communication abilities regarding the topic of systems of linear equations with three variables, when comparing students subjected to the experiential learning model to those taught using conventional learning methods. The improvement in mathematical communication skills observed among students in the experimental class, following the implementation of the experiential learning model, surpasses that of the control class. This implies that the experiential learning model effectively enhances students' proficiency in mathematical communication.

REFERENCES

Ali, C. A. (2023). Exploration of the Ability of Preservice Mathematics Teachers Using Kolb's Experiential Learning Theory & Learning Styles. *Indonesian Journal of Science and Mathematics Education*, *6*(1), 11-25.

Azizah, N., Usodo, B., & Saputro, D. R. S. (2020). The written mathematical communication ability of junior high school students in solving set problems. *Journal of Physics: Conference Series*, *1538*(1), 012103. https://doi.org/10.1088/1742-6596/1538/1/012103

Dobos, Á. (2014). Experiential learning for professional development in the civil service. *Procedia-Social and Behavioral Sciences*, *116*, 5085-5090. https://doi.org/10.1016/j.sbspro.2014.01.1078

Fauzi, A. (2021). Analisis kemampuan Komunikasi Matematis Siswa Pada Pembelajaran Daring. *Undiksha Journal of Mathematics Education*, *12*(1), 32-41.

https://doi.org/10.23887/jjpm.v12i1.33245

Heriyaman, H. (2022). Peningkatan Kemampuan Pemahaman Konsep Matematis dengan Pembelajaran Model Snowball Throwing Berbantuan Alat Peraga Pada Masa Pandemi Covid-19. *Jurnal Edukasi Sebelas April*, *6*(1), 67-75.

Kleden, M. A., Geradus, U., & Sugi, Y. (2017). Meningkatkan kemampuan komunikasi matematis siswa smp melalui pembelajaran kontekstual berbasis budaya pesisir. *Seminar Nasional Matematika dan Aplikasinya* (pp. 151–159). Universitas Airlangga

Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development*. Pearson Education.

Mutmainah, M., Rukayah, R., & Indriayu, M. (2019). Effectiveness of Experiential Learning-Based Teaching Material in Mathematics. *International Journal of Evaluation and Research in Education (IJERE)*, *8*(1), 57-63. https://doi.org/10.11591/ijere.v8i1.15903

Nursalma, A., & Pujiastuti, H. (2023). Pengaruh Waktu Belajar dan Motivasi Belajar terhadap Hasil Belajar Matematika. *OMEGA: Jurnal Keilmuan Pendidikan Matematika*, *2*(3), 135-141. https://doi.org/10.47662/jkpm.v2i3.479

Rosalina, E., & Pertiwi, H. C. (2018). Pengaruh Model Pembelajaran SAVI (Somatis, Auditori, Visual, dan Intelektual) terhadap Kemampuan Komuniasi Matematika Siswa. *Jurnal Pendidikan Matematika: Judika Education*, *1*(2), 71-82. https://doi.org/10.31539/judika.v1i2.313

Sapta, A. (2017). Pengaruh Model Pembelajaran Experiential Learningterhadap Komunikasi Matematis Siswa. *Pythagoras: Jurnal Program Studi Pendidikan Matematika*, *6*(2), 94-99. https://doi.org/10.33373/pythagoras.v6i2.630

Sari, L. N. I. (2018). Peningkatan Kemampuan Komunikasi Matematis dan Motivasi Belajar Siswa dengan Menerapkan Model Pembelajaran Experiential Learning. *Logaritma: Jurnal Ilmu-ilmu Pendidikan dan Sains*, *6*(01), 75-85. https://doi.org/10.24952/logaritma.v6i01.1246