Volume 7, Nomor 2, Desember 2023
Numerical: Jurnal Matematika dan Pendidikan Matematika
http://journal.iaimnumetrolampung.ac.id/index.php/numerical
DOI:https://doi.org/10.25217/numerical.v7i2.

Problem-based Learning Models Assisted by Interactive Worksheets on Mathematical Communication Skills in Grade V Elementary School

Tania Irni Dewianti[1], Hella Jusra[1]

[1] Universitas Muhammadiyah Prof. Dr. HAMKA, Indonesia
Correspondence: hella.jusra@uhamka.ac.id

Article Info
Article History
Received : 11-10-2023
Revised : 02-11-2023
Accepted : 20-12-2023

Keywords:
Interactive Worksheets;
Mathematical Communication Skills;
Problem-based Learning;

Abstract

The mathematical communication skills of students in elementary schools are still deficient. This happens because students' mathematical communication skills are not developed in elementary schools. In this study, the problem-based learning model (PBL) is applied with the help of interactive worksheets. The PBL model improves students' communication skills in elementary schools. The research objective was to determine the effect of applying the PBL model assisted by interactive worksheets on students' mathematical communication abilities. This research is quantitative research using quasi-experimental research with a post-test-only design. The population of this study was all elementary school students. The sampling technique used non-probability, namely purposive sampling, in which two class IV samples were divided into two groups. The experimental group had 30 students treated by PBL model assisted by interactive worksheets, and the control group was not treated with 30 students. The instrument in this study was a test of mathematical communication skills on fractions. Before using the research instrument, it was tested through validation and reliability processes, then data analysis techniques were carried out to test the hypothesis by previously carrying out the requirements analysis test, namely the normality and homogeneity tests. The data obtained was calculated using the Levene Test with the SPSS 23.0 application with normal and homogeneous distribution results. The results of this study show the influence of the application of PBL models assisted by interactive worksheets on the students' mathematical communication abilities in elementary schools.

INTRODUCTION

Learning mathematics requires communication skills to improve the ability to think mathematically both orally and in writing and to respond appropriately to other students and educators. Mathematical communication skills need to be developed because it is not only a thinking tool that can support the development of patterns or complete and draw conclusions but also helps communicate clear, concise, and precise thoughts, ideas, ideas using symbols, diagrams, tables, or other media [1]–[3]. However, many students still have not been able to provide mathematical answers using their language, according to the results of previous research [4]. Without good mathematical communication skills, progress in learning mathematics will be delayed.

Mathematical communication skills occur in the classroom by delivering mathematics learning material that students learn through formulas, designs, or problem-solving steps [5]–[7].

Print ISSN: 2580-3573, Online ISSN: 2580-2437

In line with Astuti, students need mathematical communication skills to present problems or ideas in mathematics using natural objects, graphs, pictures, diagrams, or tables and can apply mathematical symbols [8]. Whether or not mathematical communication skills are achieved can be seen from the indicators, namely connecting natural objects, diagrams, and pictures into mathematical ideas and explaining situations, ideas, and mathematic relations in writing or orally using natural objects, diagrams, pictures, graphs, and algebra [9], [10].

The results of previous observations made by Ria Deswita at Public Middle Schools in Jambi Province stated that students could not communicate mathematical ideas properly [11]. Students experience difficulties and cannot mention problems or situations through diagrams, symbols, graphs, or mathematical models. There are still many students' answers that cannot be understood by their peers or educators on the questions that have been given. Students have not been able to provide arguments based entirely on mathematical concepts and principles.

The teacher's mathematical communication skills are necessary to develop a learning model through students' thinking skills and communication skills in a problem-based learning (PBL) model [12]–[16]. This model presents real problems in everyday life so that students can construct their knowledge, develop problem-solving skills, and train their communication skills [17]–[20]. The PBL model is expected to be able to increase students' understanding of mathematics and help solve mathematics problems [13], [21], [22].

The PBL model involves students in the learning process and prioritizes existing problems in the home, school, and community environments to gain knowledge and understanding through mathematical communication skills [23]. Not only problems, students will analyze, collect information, look for alternative solutions, and make choices and conclusions. The learning model's advantage can increase activity and encourage students' abilities to discover new knowledge, improve critical thinking skills, and provide opportunities for students to implement the knowledge they have in everyday life [24], [25].

The PBL model has five stages: students, educators, and teachers play an essential role in the learning process in this stage of the PBL model. The teacher explains the learning objectives, presents practice questions, and asks students to find the source of the problem. Then, students prepare the results to be reported and evaluated. The steps taken in this study used a PBL model assisted by interactive worksheets. With the PBL model assisted by interactive worksheets, it is necessary to improve mathematical communication skills because these models and media combine to create a more interactive learning atmosphere and make students more active.

Thus, the PBL model can be applied more optimally, and the technology-based learning process uses interactive worksheets to improve mathematical communication skills. The worksheet with the PBL model contains guidelines for learning activities that emphasize active experiments or discoveries by students to find ways to solve the problems they face and draw conclusions about their learning. Interactive worksheets contain instructions for completing steps by the planned learning strategy to improve mathematical communication skills [27]. A live worksheet was chosen as an interactive worksheet for this study. Liveworksheet is a free web-based platform that is available on Google. This live worksheet in learning can help educators make student activity sheets that are varied and interesting, not just multiple choice or descriptions, and take advantage of new technology because they can produce sound, display videos, and produce voice messages.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

Educators can create new sheets in the live worksheet or use those provided on the page. There is a student access menu and educator access.

This study hypothesizes that the PBL model is influenced by interactive worksheets on the mathematical communication skills of fourth-grade elementary school students. Previous research has examined mathematical communication skills with PBL models but did not use live worksheets. Therefore, this study has an update by applying a PBL model assisted by a live worksheet to improve students' mathematical communication skills.

METHODS

This study uses a quantitative experimental method to look for the effect of a particular treatment variable with a post-test-only design. The population in this study was elementary school students. The sample was 30 students in class VI A as the experimental group and 30 in class VI B as the control group. The data collection technique uses a non-probability sampling technique, namely purposive sampling. Before the instrument is used in research, it is tested, namely the validity and reliability test. The following are the validity test results:

Table 1. Validity Test

No Question	r-table	r-count	Information
1	0.361	0.44234	Valid
2a	0.361	0.37598	Valid
2b	0.361	0.41367	Valid
3a	0.361	0.76701	Valid
3b	0.361	0.71868	Valid
4	0.361	0.47045	Valid
5a	0.361	0.70179	Valid
5b	0.361	0.53519	Valid

The total validity of the instrument is calculated using the product moment correlation technique. After testing with 30 students, the results are five valid questions with a significance level of 5%. If the question obtains a calculation result that is more significant than the r-table, it can be declared valid.

Table 2. Reliability Test

Variable	Cronbach Alpha	Conclusion
Mathematical Communication Skills	0.613	Reliable

After conducting the validity test, the researcher calculated the reliability test using the Alpha Cronbach formula with a significance level of 0.05. Testing the reliability of obtaining results of 0.613, it can be concluded that the instrument of mathematical communication ability is reliable.

Furthermore, the data analysis technique was carried out to test the hypothesis using previously conducted requirements analysis tests, namely the normality and homogeneity tests. The normality test uses the Shampiro-Wilk formula, the homogeneity test is calculated using the Levene Test formula, and in testing the hypothesis, the t-test is used with the formula, namely the Independent Sample T-test.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

RESULTS AND DISCUSSION

The test was carried out after learning was completed (post-test) in the control and experimental groups to determine if the two groups had differences in output. The following is a summary of the post-test score results :

Table 3. Recapitulation of the post-test scores results

Class	Lowest value	The highest score	Average
Experiment	65	95	82.5
Control	0	70	57.8

PBL models assisted by interactive worksheets obtained an average score of 82.5, with the highest score of 95 and the lowest score of 65. Meanwhile, the results of the final test given to the group the control with the lecture learning model obtained an average score of 57.8 out of a possible 70. The summary of the post-test scores showed that the average score of the experimental group was more significant.

The calculation of the normality test in Table 4:

Table 4. Normality Test

	Shapiro-Wilk		
Class	Statistics	Df	Sig.
Control	.942	30	.103
Experiment	.938	30	.082

The normality test shows a sig score greater than 0.05. The significance of the control group was 0.103, and that of the experimental group was 0.082, more significant than 0.05. It can be stated that the data is normally distributed. A homogeneity test is carried out to determine whether the population has the same variance. Homogeneity test calculation using SPSS 23.0. looks as follows:

Table 5. Homogeneity Test

Levene Statistics	df1	df2	Sig.
1,680	1	58	.200

The homogeneity test shows that the value of Sig. > 0.05. The significance value of 0.200 is more significant than 0.05. The data from the study are homogeneous and have the same variance. A t-test was carried out to see the final hypothesis. The following is the calculation result:

Table 6. Independent Sample T-test

		F	Sig	T	Df	Sig. (2-tailed)	Mean Differences	std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Mathematical communication skills	Equal variances assumed	1,680	.200	-7.076	58	.000	-21.500	3038	-27.581	-15.418
	Equal variances are not assumed.			-7.076	51.962	.000	-21.500	3038	-27.581	-15.418

Print ISSN: 2580-3573, Online ISSN: 2580-2437

As shown in Table 6 above, the calculation used the post-test score between the two groups. It can be seen that the significance value (two-tailed) is 0.000, which indicates less than 0.05. The ability to communicate using the lecture method significantly differs from mathematical communication using PBL learning models assisted by interactive worksheets.

The experimental group generally succeeded in the PBL model, assisted by interactive worksheets on mathematical communication skills. Using live worksheets in the learning process is the proper aspect to make students more active and innovative. The strategy of applying the live worksheet-assisted PBL model is carried out by displaying relevant visuals before starting the teaching and learning process. An explanation of fractional material is done before the research begins.

Figure 1. Explanation of Material Using Interactive Worksheets

After explaining the material, students are given a problem to solve, and then the researcher directs students to solve the problem using a live worksheet. After completing the research problem, students are given a final test that implements a PBL model, assisted by a live worksheet, to determine mathematical communication skills.

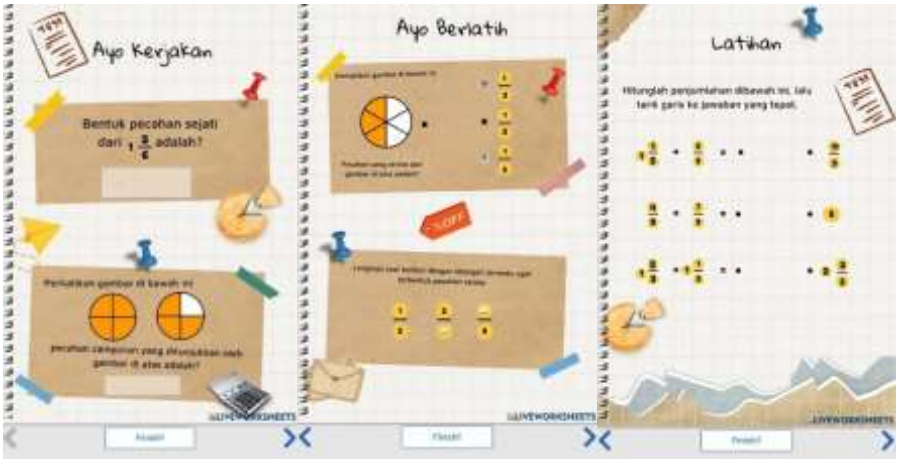

Figure 2. Exercise Using Interactive Worksheets

Print ISSN: 2580-3573, Online ISSN: 2580-2437

The control group learned using the lecture method, in which the researcher explained fractional material, and then students completed tests on mathematical communication abilities. As a result, many students do not listen to the explanation given. Researchers conducted a final test to determine students' mathematical communication skills in the control group.

Based on the results of the data analysis, there is a significant difference between the mathematical communication abilities of students using the lecture method and the mathematical communication abilities of students using PBL models assisted by interactive worksheets. The calculation results show that the control group averages 57.8 while the experimental group averages 82.5. In the t-test (two-tailed), a significance result of $0.000 < 0.05$ was obtained. Analysis of the final test data showed that students in the experimental group had higher mathematical communication skills than the control group.

This research is in line with Zulma Nur Sofia. The study focuses on activities to compare the mathematical communication abilities of students who use the lecture method with the PBL model. The PBL model is more significant to the lecture method and influences students' mathematical communication skills [28]. PBL-assisted interactive worksheets make student-centred learning using unstructured and actual problems as contexts for students to build knowledge/concepts and train students' problem-solving abilities. Closely related to problem-solving, one of the skills that are important and much needed in this process is mathematical thinking ability [14], [29], [30].

Communication is vital in mathematics and helps students develop patterns to solve problems, thoughts, and ideas precisely and briefly [3], [30]. Students try to communicate the results of their thinking to other students based on their abilities; what is conveyed will be more apparent to them. In addition, other students who only listen and listen will gain knowledge from the results of listening to the explanation. Several studies have shown that PBL can improve students' mathematical communication skills. Kurniati & Sutiarso [31], PBL presents open-ended problems through the use of interactive learning media, which has a significant effect on improving students' mathematical abilities. PBL is cooperative learning, where students find it easier to find and understand complex concepts if they can discuss these problems with their friends [16], [32]. The teacher provides opportunities for students to express their own opinions, hear the opinions of their friends, and jointly discuss the problems the teacher gave [12], [14]. PBL contributes to communication skills and creativity in solving mathematical problems.

The PBL was assisted by interactive worksheets on students' mathematical communication skills, proving the mentioned learning process activities. Interactive worksheets assist this application of the PBL model. There is an influence on the student's mathematical communication abilities in elementary schools. Combining the PBL model with interactive worksheets makes students more active and innovative and can improve their mathematical communication skills according to the expected results.

CONCLUSIONS

Based on the study findings, the PBL model assisted by interactive worksheets positively affects students' mathematical communication skills. The PBL model, assisted by interactive worksheets, influences elementary school students' mathematical communication skills. Students

Print ISSN: 2580-3573, Online ISSN: 2580-2437

can communicate the results of the answers to math questions using the mathematics language so that educators can easily understand. It is expected that teachers in mathematics studies can use PBL models assisted by interactive worksheets to increase students' mathematical communication skills. The limitations of this research are the mathematical communication abilities of elementary school students. It is hoped that further research will be conducted with a broader scope.

REFERENCES

[1] N. M. Hutapea and S. Saragih, "Improving Mathematical Communication Skills of SMP Students Through Contextual Learning," *Journal of Physics: Conference Series*, 2019, doi: doi:10.1088/1742-6596/1351/1/012067.

[2] D. H. Tong, B. P. Uyen, and N. Van Anh Quoc, "The improvement of 10th students' mathematical communication skills through learning ellipse topics," *Heliyon*, vol. 7, no. 11, p. e08282, Nov. 2021, doi: 10.1016/j.heliyon.2021.e08282.

[3] N. Rohid, S. Suryaman, and R. D. Rusmawati, "Students' Mathematical Communication Skills (MCS) in Solving Mathematics Problems: A Case in Indonesian Context," *INT J INSTRUCTION*, vol. 4, no. 2, pp. 19–30, Sep. 2019, doi: 10.29333/aje.2019.423a.

[4] W. Umar, "Membangun Kemampuan Komunikasi Matematis Dalam Pembelajaran Matematika," *Infinity Journal*, vol. 1, no. 1, p. 1, 2012, doi: 10.22460/infinity.v1i1.2.

[5] A. Susanto, *Teori Belajar dan Pembelajaran di Sekolah Dasar*. Jakarta: $ Kencana, 2013.

[6] S. Aisyah, D. I. Sari, and R. Faulina, "The Effectiveness of Probing-Prompting Learning Model using Google Meet Platform on Student's Mathematical Communication Ability," *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*, vol. 6, no. 1, pp. 211–220, Feb. 2022, doi: 10.31331/medivesveteran.v6i1.1940.

[7] A. S. Situmorang and E. Pandiangan, "Analysis of Mathematical Communication Skills on The Material of Two-Variable Linear Equation System in Smp Negeri 7 Medan," *International Journal Of Humanities Education and Social Sciences (IJHESS)*, vol. 2, no. 1, Aug. 2022, doi: 10.55227/ijhess.v2i1.243.

[8] L. Anggraini Astuti, "Peran Kemampuan Komunikasi Matematika Terhadap Prestasi Belajar Matematika Siswa," *Superlattices and Microstructures*, vol. 9, no. 1, pp. 31–33, 2010, doi: 10.1016/0749-6036(91)90087-8.

[9] V. Melinda and M. Zainil, "Penerapan Model Project Based Learning untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa Sekolah Dasar (Studi Literatur)," *Jurnal pendidikan tambusai*, vol. 4, pp. 1526–1539, 2020.

[10] A. P. Kusuma, N. K. Rahmawati, and R. Ramadoni, "The Application of the Accelerated Learning Cycle, Brain-based Learning Model, and Direct Instruction Model toward Mathematical Reasoning in Terms of Mathematical Communication," *Al-Jabar : Jurnal Pendidikan Matematika*, vol. 11, no. 1, Art. no. 1, Jun. 2020, doi: 10.24042/ajpm.v11i1.6185.

[11] R. Deswita and Y. S. Kusumah, "Peningkatan Kemampuan Komunikasi Matematis Siswa Melalui Model Pembelajaran CORE dengan Pendekatan Scientific," *Edumatika : Jurnal Riset Pendidikan Matematika*, vol. 1, no. 1, p. 35, 2018, doi: 10.32939/ejrpm.v1i1.220.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

[12] M. A. Almulla, "The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning," *SAGE Open*, vol. 10, no. 3, p. 2158244020938702, Jul. 2020, doi: 10.1177/2158244020938702.

[13] R. Lusiana, E. Suprapto, and I. Sukristini, "Effectiveness of Problem Based Learning (PBL) on Mathematics Learning Achievement in terms of Student Adversity Quotient (AQ)," *Edumatica : Jurnal Pendidikan Matematika*, vol. 11, pp. 55–63, Aug. 2021, doi: 10.22437/edumatica.v11i02.7670.

[14] W. Zhao, L. He, W. Deng, J. Zhu, A. Su, and Y. Zhang, "The effectiveness of the combined problem-based learning (PBL) and case-based learning (CBL) teaching method in the clinical practical teaching of thyroid disease," *BMC Med Educ*, vol. 20, no. 1, p. 381, Dec. 2020, doi: 10.1186/s12909-020-02306-y.

[15] R. Safitri, H. Haryanto, and H. Harizon, "Development of PBL-STEM-based E-LKPD to improve students' science literacy skills on reaction rate materials," *JPKim*, vol. 13, no. 2, pp. 113–129, Aug. 2021, doi: 10.24114/jpkim.v13i2.26980.

[16] B. R. Maxwell, "Problem-Based Learning (PBL) in a Grade 11 World History Class: Trials, Tribulations, and Triumphs," *J Probl Based Learn*, vol. 7, no. 1, pp. 11–20, Apr. 2020, doi: 10.24313/jpbl.2020.00248.

[17] A. Novianti, A. Bentri, and A. Zikri, "Pengaruh Penerapan Model Problem Based Learning (Pbl) Terhadap Aktivitas Dan Hasil Belajar Siswa Pada Pembelajaran Tematik Terpadu Di Sekolah Dasar," *Jurnal Basicedu*, vol. 4, no. 1, pp. 194–202, 2020, doi: 10.31004/basicedu.v4i1.323.

[18] L. R. Hima, "Penerapan Model Pembelajaran Problem Based Learning Ditinjau Dari Kemampuan Komunikasi Matematik," *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, vol. 4, no. 2, p. 111, 2016, doi: 10.25273/jipm.v4i2.845.

[19] T. Chamîdy, İ. N. S. Degeng, and S. Ulfa, "The Effect of Problem Based Learning and Tacit Knowledge on Problem-Solving Skills of Students in Computer Network Practice Course," *Journal for the Education of Gifted Young Scientists*, vol. 8, no. 2, pp. 691–700, Jun. 2020, doi: 10.17478/jegys.650400.

[20] M. Samani, S. Sunwinarti, B. A. W. Putra, R. Rahmadian, and J. N. Rohman, "Learning Strategy to Develop Critical Thinking, Creativity, and Problem-Solving Skills for Vocational School Students," *Jurnal Pendidikan Teknologi dan Kejuruan*, vol. 25, no. 1, Art. no. 1, Apr. 2019, doi: 10.21831/jptk.v25i1.22574.

[21] N. Alfares, "The Effect of Problem-Based Learning on Students' Problem-Solving Self-Efficacy through Blackboard System in Higher Education," *International Journal of Education and Practice*, vol. 9, no. 1, pp. 185–200, 2021.

[22] S. F. Andesa and S. Fitriani, "Improving Problem Solving Ability of 8th Grade Student through The Problem based Learning Model," *Journal of Curriculum and Pedagogic Studies (JCPS)*, vol. 1, no. 2, Art. no. 2, Dec. 2022.

[23] D. Handayani and W. Sopandi, "Penggunaan Model Problem Based Learning untukMeningkatkan Kemampuan Memecahkan Masalah dan Sikap Peduli Lingkungan Peserta Didik," *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru*, vol. 7, no. 2, p. 105, 2016, doi: 10.17509/eh.v7i2.2702.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

[24] S. Jaisook, S. and Chidmongkol, S. and Thongthew, *The Development of Instructional Model by Integrating Problem-Based Learning and Collaborative Learning Approach to Enhance Mathematical Problem Solving, Communication and Connection Abilities*. Valencia, Spain: IATED, 2013.

[25] B. Arisoy and B. Aybek, "The Effects of Subject-Based Critical Thinking Education in Mathematics on Students' Critical Thinking Skills and Virtues," *Eurasian Journal of Educational Research*, 2021, Accessed: Jan. 30, 2023. [Online]. Available: https://eric.ed.gov/?id=EJ1294083

[26] H. E. Pansa, "Pengembangan LKPD dengan Model Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa," *Seminar Nasional Matematika dan Pendidikan Matematika*, pp. 229–238, 2017.

[27] Z. N. Sofia, "Penerapan Model Problem Based Learning untuk Meningkatkan Kemampuan Komunikasi Matematis Siswa dalam Pembelajaran Matematika di kelas IV SDN 028 Kubang Jaya," p. 126, 2021.

[28] R. Darmayanti, R. Sugianto, B. Baiduri, C. Choirudin, and W. Wawan, "Digital comic learning media based on character values on students' critical thinking in solving mathematical problems in terms of learning styles," *Al-Jabar : Jurnal Pendidikan Matematika*, vol. 13, no. 1, pp. 49–66, Jun. 2022, doi: 10.24042/ajpm.v13i1.11680.

[29] M. Arifin, "Penerapan Model Problem Based Learning (PBL) Terhadap Kemampuan Berpikir Kreatif Siswa," vol. 8, no. 2, p. 6, 2020.

[30] N. Hasanah, S. Inganah, and B. P. A. Maryanto, "Learning in the 21st Century Education Era: Problems of Mathematics Teachers in the Use of Information and Communication Technology-Based Media," *JEMS: Jurnal Edukasi Matematika dan Sains*, vol. 11, no. 1, pp. 275–285, Mar. 2023, doi: 10.25273/jems.v11i1.14734.

[31] N. Kurniati and S. Sutiarso, "The Effect of Problem Based Learning and Open-Ended Learning on Mathematics Creative Thinking Ability: A Meta Analysis Study," *Jurnal Pendidikan MIPA*, vol. 22, no. 1, Art. no. 1, Jun. 2021.

[32] M. N. Malik *et al.*, "Team-based Learning and the Analytical Skills of Medical Students as a Consequence of Increased Problem Difficulty," *Cureus*, vol. 11, no. 5, p. e4639, doi: 10.7759/cureus.4639.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

Blank page

Print ISSN: 2580-3573, Online ISSN: 2580-2437