The Effect of Problem Based Learning Student's Worksheets on Their Ability to Undestand Mathematical Concepts

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Abstract

This research aims to determine the significant influence of students' problem-based learning worksheets on their ability to understand mathematical concepts. This research is quantitative research with a quasi-experimental method type Pretest-Posttest Control Group Design design. The population is the entire class VIII and sampling using a cluster sampling method. The data collection instrument in this study is a validated test. From the results of this study, there is a significant influence between problem-based learning student worksheets on the ability to understand mathematical concepts in the relationship and function material of grade VIII students of SMP Negeri 2 Panyabungan.

Keywords: *Student Worksheets; Problem Based Learning; Understand Concepts.*

Abstrak

Tujuan penelitian ini adalah untuk mengetahui pengaruh signifikan lembar kerja pembelajaran berbasis masalah siswa terhadap kemampuan pemahaman konsep matematika. Penelitian ini merupakan penelitian kuantitatif dengan metode eksperimen kuasi tipe Pretest-Posttest Control Group Design. Populasinya adalah seluruh kelas VIII dan pengambilan sampel menggunakan metode cluster sampling. Instrumen pengumpulan data dalam penelitian ini adalah tes validasi. Dari hasil penelitian tersebut terdapat pengaruh yang signifikan antara lembar kerja siswa berbasis masalah terhadap kemampuan pemahaman konsep matematika pada materi hubungan dan fungsi siswa kelas VIII SMP Negeri 2 Panyabungan.

Kata Kunci: Lembar Kerja Siswa; Pembelajaran Berbasis Masalah; Pemahaman Konsep.

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INTRODUCTION

Mathematics is one of the subjects studied at every level of education. The main principle in learning mathematics is to improve and prepare learning activities that are beneficial for students. The aim of learning mathematics is to understand mathematical concepts, explain the relationship between concepts, and apply concepts or algorithms (Hultdin et al., 2023) flexible, accurate, efficient and precise in solving problems. Based on this, it is necessary to provide students with an understanding of concepts related to the real world so that they can be actively involved in learning and can apply the concepts they have learned in everyday life. To obtain an optimal understanding of concepts, in which students are actively involved, it is necessary to provide learning resources for students (Anjos & Vieira, 2021).

One learning resource that helps students apply the concepts they have learned is by using student worksheets. According to Zulfah, student worksheets are a learning resource that helps teachers achieve learning goals, especially to improve students' mathematical problem-solving abilities. Student worksheets can arouse student activity (Mayerhofer et al., 2023) in learning and students can apply them in real life. Student worksheets are a guide for students to learn a concept so that students can solve a problem.

Based on the results of initial observations carried out by researchers at Panyabungan Junior High School, information was obtained in the form of learning resources used by teachers only in the form of teacher and student textbooks, mathematics learning in schools also tends to be oriented towards the material in books rather than at the stage of understanding the concepts of the material being studied. So most students tend to learn by memorizing formulas. Another problem that can be seen is that the teacher teaches the material as stated in the book (directly introduced with formulas) which causes students to find it difficult to understand the material being taught and students become passive during learning. This also raises many problems, namely: students' shallow understanding in solving problems (Patmaniar et al., 2021), and students experience cognitive obstacles in solving mathematical problems (Schukajlow et

al., 2023), so they experience difficulties in learning mathematics (Chin & Fu, 2021), (Aliu, 2023).

From the results of the observations above, it shows the students' lack of understanding of mathematical concepts. Apart from that, in observations, the learning resources used were only teacher and student handbooks. The teaching materials used contain more material. Therefore, learning innovations and appropriate tools are needed according to students' needs related to real-life problems, so that students not only know directly but can discover the concept being studied. Students must master the subject matter effectively (Tirpáková et al., 2023), the basis is from understanding the concept (Stovner & Klette, 2022) which will influence important aspects of learning (Lendínez Muñoz et al., 2023). Learning innovations and appropriate tools to overcome the above problems are through learning resources in the form of student worksheets based on problem-based learning. The problem-based learning (PBL) model is one model that is appropriate to use because the problem is the starting point in this model which will indirectly develop students to be skilled in solving problems.

Learning innovations and appropriate tools to overcome the above problems are through learning resources in the form of student worksheets based on problem-based learning. The problem-based learning (PBL) model is one model that is appropriate to use because the problem is the starting point in this model which will indirectly develop students to be skilled in solving problems (Boye & Agyei, 2023) so it will be easy to understand mathematical concepts and increase students' interest in learning (Ottenbreit-Leftwich et al., 2021). The Problem-Based Learning (PBL) learning model is a learning model that presents real problems in everyday life and makes students active in learning (Michael et al., 2023). For this reason, researchers are interested in carrying out research using student worksheets based on Problem-Based Learning.

Previous research conducted was a problem-based learning model that influenced students in understanding learning material (Chen et al., 2021). Likewise with other research, namely problem-based learning models can increase students' interest in learning mathematics (Ottenbreit-Leftwich et al., 2021)

(Sieervant-Miklos, 2020). Problem-based learning is effective learning (Martin & Jamieson-Proctor, 2022) and can make students active in learning (Michael et al., 2023) thereby increasing their understanding of concepts and students will reach a higher level of thinking (Hidajat, 2023).

Based on the explanation above, the aim is to determine whether or not there is a significant influence between student worksheets based on problem-based learning on the ability to understand mathematical concepts in relation and function material for class VIII students at SMPN 2 Panyabungan. This research can be used in the world of education for researchers and other researchers to increase scientific insight. It is hoped that this research can contribute to teaching staff to improve the teaching and learning process and be a solution to academic procrastination, especially in the field of mathematics learning.

RESEARCH METHODS

This type of research is quantitative research using experimental research methods. Experimental research is research that attempts to find the effect of certain variables on other variables in strictly controlled situations (Daverne-Bailly & Wittorski, 2022). The method used a quasi-experimental design method with type Pretest-Posttest Control Group Design. The population in the research were all students class VIII SMPN 2 Panyabungan The 2022/2023 academic year consists of 8 classes with a total of 173 people. Sample selection in the research was carried out using a random sample group selection method (cluster sampling method). So there are two classes selected, where the selected classes are class VIII-1 and class VIII-4. Where class VIII-1 is an experimental class using student worksheets based on problem-based learning. Where in this study two groups were used, namely the experimental group and the control group. Each group was given an initial test (pretest) to determine the initial condition before being given treatment and a final test (posttest) to measure abilities after being given treatment. The experimental group was given treatment, namely the use of student worksheets based on problem-based learning, while the control group received

conventional learning with the application of the PBL learning model in each group.

Table 1. Pretest-Posttest Control Group Design

Group	Pretest	Treatment	Posttest
Experimen	T_1	X	T_2
Control	T_1	-	T_2

The independent variable in this research is students' worksheets based on problem-based learning, while the dependent variable is students' ability to understand concepts. Students' ability to understand concepts is obtained with test instruments in the form of essay questions in the form of pretest and posttest.

In this research, instrument testing is an important part, this is because in this research the data is a depiction of the variables studied because it functions as a tool to prove the hypothesis. Therefore, whether the data is correct or not depends on whether the data collection instrument is good or not. A good data collection instrument must meet two requirements, namely valid and reliable.

Table 2. Test Scoring Guidelines

Skor	Answer Criteria and Reasons
4	Students answer questions completely and correctly
3	Students answer questions correctly and the solution is lacking.
2	Students answer questions correctly and the solution is lacking.
1	The student answered correctly and the solution was wrong.
0	Students do not answer questions.

Table 3. Research Instrument Grid for Pretest-Posttest Students' Understanding df Mathematical Concepts

Subject	Indicator of Concept Understanding	Question Item Number
Relations and Functions	1. Restate a concept	1
	2. Classify objects based on mathematical concepts	4
	3. Provide examples and non-examples of the concept	2
	4. Present concepts in various forms	3
	5. Apply problem solving concepts or algorithms.	5

The aim of using this instrument is to determine whether there is a significant influence between students' problem-based learning worksheets on students' ability to understand mathematical concepts in relation and function material for class VIII students at SMPN 2 Panyabungan.

The prerequisite tests carried out in this research are the normality test homogeneity test and average similarity test, while hypothesis testing uses the t-test. The hypothesis in this research is that there is a significant influence of student worksheets based on problem-based learning on the ability to understand mathematical concepts in relation and function material for class VIII students at SMPN 2 Panyabungan.

RESULTS AND DISCUSSION

Based on the research results, a description of the research results is obtained, namely as follows:

1. Frequency Distribution of Initial Values (Pretest)

The data is described to obtain an initial picture of students' conceptual understanding abilities. The list of frequency distribution of initial (pretest) values can be seen in the table below.

Table 4. Experimental Class Pretest Frequency Distribution

No	Class Intervals	Frequency	Percentage
1	45 - 52	4	17.39 %
2	53 - 60	4	17.39 %
3	61 - 68	4	17.39 %
4	69 - 76	5	21.74 %
5	77 - 84	2	8.70 %
6	85 - 92	2	8.70 %
	Sum	21	100 %

Then, based on the initial distribution data of the experimental class, the characteristics of the research variables will be created in the form of a histogram of the group data above as follows:

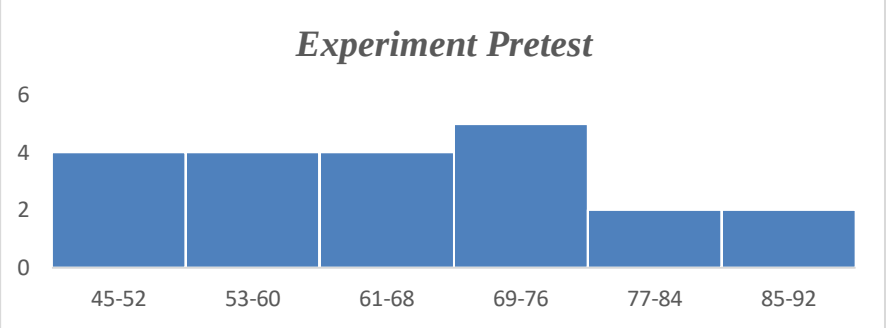

Figure 1. Pretest Histogram of Experiment Class Students

The following is a description of the learning outcomes for the experimental class pretest calculated using the SPSS v.25 application, which is presented in the table below. For complete calculations, see the attachment.

Table 5. Distribution Pretest for Experimental Class

Data Description	Ecperimental Class
Mean	64.76
Std.Error of Mean	2.68
Median	65.00
Mode	65
Std. Deviation	12.29
Variance	151.19
Range	40
Minimum	45
Maximum	85
Sum	1360

Based on the results of the description in the table above, it can be concluded that the pretest scores in the experimental class tend to center on an average score of 64.76, which is in the sufficient category. It can be seen that the standard deviation value between experimental classes is 12.29.

The following is a list of the frequency distribution of control class pretest scores which can be seen in the following frequency distribution table:

Tabel 6. Distribution Pretest for Control Class

No	Class Intervals	Frequency	Percentage
1	40 - 47	2	9.52 %
2	48 - 55	1	4.76 %
3	56 - 63	7	33.33 %
4	64 - 71	6	28.57 %
5	72 - 79	3	14.29 %
6	80 - 87	2	9.52 %
Sum		21	100%

Then, based on the initial distribution data of the control class, the characteristics of the research variables will be created in the form of a histogram of the group data above as follows:

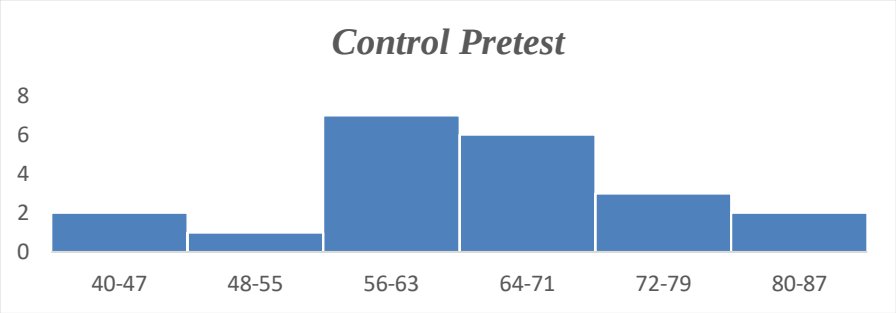

Figure 2. Pretest Histogram of Control Class Students

The following is a description of the learning outcomes for the control class pretest calculated using the SPSS v.25 application, which is presented in the table below.

Table 7. Distribution Pretest for Control Class

Data Description	Control Class
Mean	63.10
Std.Error of Mean	2.42
Median	65.00
Mode	55
Std. Deviation	11.12
Variance	123.69
Range	40
Minimum	40
Maximum	80
Sum	1325

Based on the results of the description in the table above, it can be concluded that the pretest scores in the control class tend to center on an average score of 63.10, which is in the sufficient category. It can be seen that the standard deviation value between control classes is 11.12.

2. Frequency Distribution of Final Scores (Posttest)

Frequency distribution calculation results using the SPSS v application. 25. The frequency distribution list of experimental class posttest scores can be seen in the following table:

Table 8. Distribution Posstest for Experimental Class

No	Class Intervals	Frequency	Percentage
1	60 – 66	4	17.39 %
2	67 – 73	1	4.35 %
3	74 – 80	12	52.17 %
4	81 – 87	3	13.04 %
5	88 – 94	1	4.35 %
6	95 – 101	1	4.35 %
Sum		21	100 %

The following is a description of the data to obtain an overview of the characteristics of the research variables.

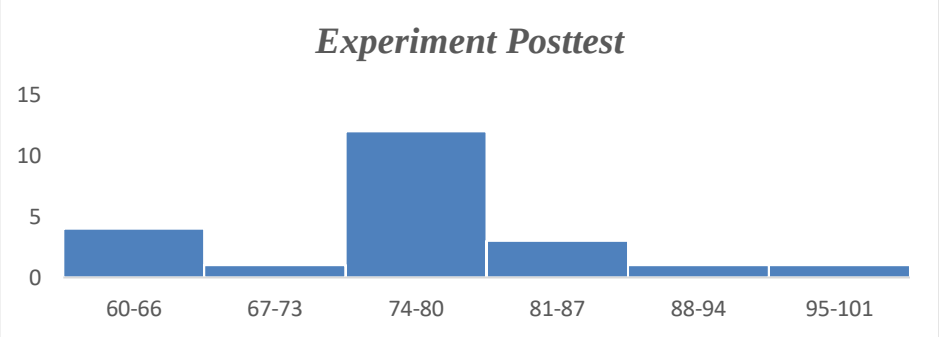

Figure 3. Pretest Histogram of Experiment Class Students

Based on the picture above, it shows that students' ability to understand concepts is developing. This means that students' understanding abilities increased from the initial understanding abilities of students in the

experimental class. The following is a description of the learning outcomes for the experimental class posttest which were calculated using the SPSS v.25 application, which are presented in the table below.

Table 9. Distribution Posttest for Experimental Class

Data Description	Experiment Class
Mean	76.67
Std.Error of Mean	1.90
Median	75.00
Mode	75
Std. Deviation	8.70
Variance	75.83
Range	35
Minimum	60
Maximum	95
Sum	1610

Based on the results of the description in the table above, it can be concluded that the posttest scores in the experimental class tend to center on an average score of 76.67, which is in the good category. It can be seen that the standard deviation value between experimental classes is 8.70.

The following is a list of the frequency distribution of control class posttest scores which can be seen in the following frequency distribution table:

Table 10. Distribution Posstest for Control Class

No	Class Intervals	Frequency	Percentage
1	50 – 56	1	4.76 %
2	57 – 63	2	9.52 %
3	64 – 70	10	47.62 %
4	71 – 77	4	19.05 %
5	78 – 84	2	9.52 %
6	85 – 91	2	9.52 %
Sum		21	21

Then, based on the final distribution data of the control class, the characteristics of the research variables will be created in the form of a histogram of the group data above as follows:

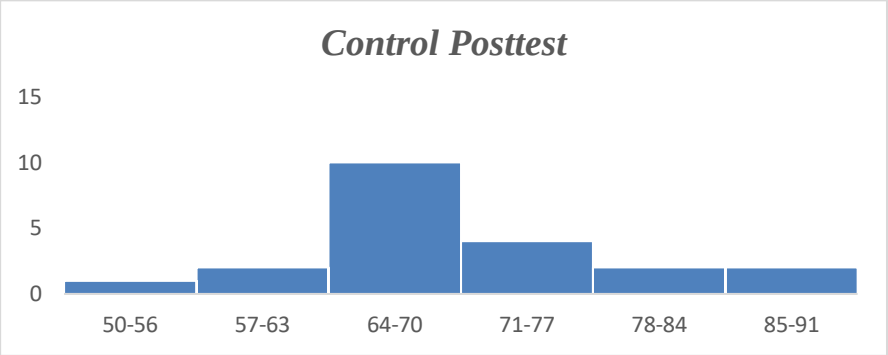

Figure 4. Posttest Histogram of Control Class Students

The following is a description of the learning outcomes for the control class posttest which were calculated using the SPSS v.25 application, which are presented in the table below.

Table 11. Distribution Posttest for Control Class

Data Description	Control Class
Mean	69.76
Std.Error of Mean	1.90
Median	70.00
Mode	65
Std. Deviation	8.72
Variance	76.19
Range	35
Minimum	50
Maximum	85
Sum	1465

Based on the results of the description in the table above, it can be concluded that the posttest scores in the control class tend to center on an average score of 69.76, which is included in the sufficient category. 69.76, which is included in the sufficient category.

Based on the research results, it was found that the two class groups started in the same conditions. It was discovered after testing normality and

homogeneity on the pretest data. The calculation results show that the average pretest score in the experimental class is 64.76 and the control class is 63.10.

From the results of data analysis, the posttest questions given to students to measure student learning outcomes showed that the average score for the experimental class was 76.67 and the control class was 69.76. Based on data processing using the t-test, the two classes have differences where the value (Sig. (2-tailed) < 0.05, namely 0.014 < 0.05, thus accepted. So it can be concluded that "there is a significant influence between student worksheets based on problem-based learning on the ability to understand mathematical concepts in relation and function material for class VIII students at SMPN 2 Panyabungan.

Based on the presentation and analysis of the data that has been carried out, it shows that there are significant differences between t_{test}dan t_{table}. The results of analysis using the t test were obtained t_{test}= 2,566 and known value t_{tabel} with opportunities 5% and dkn = (21 + 21) - 2 = 40 obtained t_{table}= 2,021 (t_{test}> t_{table}; 2,566 > 2,021) so H_0 rejected and H_a It is accepted that there is a significant influence on the use of student worksheets based on problem based learning on the ability to understand mathematical concepts in relation and function material for class VIII students at SMPN 2 Panyabungan.

Learning using student worksheets based on problem-based learning was carried out over 2 meetings. The learning process uses student worksheets based on problem-based learning on relationship and function material. Learning using problem-based learning consists of 5 stages, namely 1) student orientation to the problem; 2) organizing students to study; 3) guiding students' investigations independently and in groups; 4) developing and presenting work results; 5) analyzing and evaluating. Each stage in problem-based learning is used to solve problems on students' worksheets. The relationship between student worksheets and problem-based learning lies in the stage of guiding students' investigations independently or in groups. At this stage, students are guided through student worksheets to collect

information about relationship and function material independently with their group.

The use of student worksheets based on problem-based learning can shape and build students' ability to understand mathematical concepts. The relationship between the problem-based learning model and the ability to understand mathematical concepts lies in the stages of analyzing and evaluating the problem-solving process. This stage involves students evaluating the results of the discussion by applying concepts as skills in solving problems, where applying concepts is an indicator of the ability to understand mathematical concepts. This is to the theory which states that problem-based learning is learning that involves students trying to solve problems using several stages of the scientific method so that students are expected to be able to learn knowledge related to the problem and are expected to be able to have problem-solving skills (Hidajat, 2023). Meanwhile, the relationship between students' worksheets and their ability to understand mathematical concepts lies in the indicator of providing examples and non-examples of the concept. Meanwhile, on the students' worksheets, there are examples of working on relationships and functions that are by the concept.

Student worksheets based on problem-based learning can influence the ability to understand concepts by increasing the grades obtained by students. Students who were taught using student worksheets based on problem-based learning had better results in achieving indicators of ability to understand concepts compared to students who were taught using lecture/conventional learning. This is because learning with student worksheets based on problem-based learning involves students trying to solve problems using several stages of the scientific method so that students are expected to be able to learn knowledge related to the problem and at the same time students are expected to be able to have skills in solving problems.

Therefore, learning with student worksheets based on problem-based learning creates activities to stimulate students' curiosity, namely by providing

problems related to students' real lives, group work, or reports and presenting them. These activities make problem-based learning popular with students so they are more motivated to participate in the learning process(Martin & Jamieson-Proctor, 2022), and Education experts have recommended this model as an effective learner-centered learning in mathematics learning (Boye & Agyei, 2023). Meanwhile, conventional learning is direct learning which is dominated by the teacher, which causes students to hear, listen, and memorize more than to discover a concept themselves, so students have difficulty understanding the material being taught and are only active in listening to the teacher's explanation and then recording in the book what the teacher conveys.

CONCLUSION

Based on the problem formulation and hypothesis provided as well as research results based on research results and data analysis, the researcher concluded that there is a significant influence between students' problem-based learning worksheets on their ability to understand concepts in relation and functional material. This can be shown by the results of the hypothesis test which explains that $t_{test} > t_{table}$ that is 2,566 > 2,021. From the results of these calculations it is proven that H_0 rejected and $H_a$is accepted. Thus, there is an influence of student worksheets based on problem-based learning on the ability to understand mathematical concepts in relation and function material for class VIII students at SMPN 2 Panyabungan.

REFERENCES

Aliu, A. (2023). Efficiency of understanding some mathematical problems by means of Pascal ' s triangle. 18(4).

Anjos, M. F., & Vieira, M. V. C. (2021). Motivation. EURO Advanced Tutorials on Operational Research, 12(3), 1–2. https://doi.org/10.1007/978-3-030-70990-7_1

Boye, E. S., & Agyei, D. D. (2023). Effectiveness of problem-based learning strategy in improving teaching and learning of mathematics for pre-service teachers in Ghana. Social Sciences and Humanities Open, 7(1), 100453. https://doi.org/10.1016/j.ssaho.2023.100453

Chen, Y., Hmelo-Silver, C. E., Lajoie, S. P., Zheng, J., Huang, L., & Bodnar, S. (2021). Using Teacher Dashboards to Access Group Collaboration in Problem-based Learning. Interdisciplinary Journal of Problem-Based Learning, 15(2). https://doi.org/10.14434/ijpbl.v15i2.28792

Chin, K. E., & Fu, S. H. (2021). EXPLORING the IMPLEMENTATION of AN INTERVENTION for A PUPIL with MATHEMATICAL LEARNING DIFFICULTIES: A CASE STUDY. Journal on Mathematics Education, 12(3), 531–546. https://doi.org/10.22342/jme.12.3.14473.531-546

Daverne-Bailly, C., & Wittorski, R. (2022). Research Methodology in Education and Training : Postures, Practices and Forms, Volume 12 (Issue volume 12). Wiley-ISTE. http://e-resources.perpusnas.go.id:2048/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsebk&AN=3360223&site=eds-live

Hidajat, F. A. (2023). A comparison between problem-based conventional learning and creative problem-based learning on self-regulation skills: Experimental study. Heliyon, 9(9), e19512. https://doi.org/10.1016/j.heliyon.2023.e19512

Hultdin, U. W., Bergqvist, E., Bergqvist, T., Vingsle, L., & Österholm, M. (2023). Applying a new framework of connections between mathematical symbols and natural language. Journal of Mathematical Behavior, 72(December 2022). https://doi.org/10.1016/j.jmathb.2023.101097

Lendínez Muñoz, E. M., García García, F. J., Lerma Fernández, A. M., & Abril Gallego, A. M. (2023). Increase in self-efficacy in prospective teachers through theory-based lesson study. Journal of Mathematics Teacher Education, 0123456789. https://doi.org/10.1007/s10857-023-09597-0

Martin, D. A., & Jamieson-Proctor, R. (2022). Pre-service Teachers' Perceptions of Problem-based Learning for Developing their Mathematics Teaching Pedagogy. Interdisciplinary Journal of Problem-Based Learning, 16(1). https://doi.org/10.14434/ijpbl.v16i1.28739

Mayerhofer, M., Lüftenegger, M., & Eichmair, M. (2023). Impact of a Mathematics Bridging Course on the Motivation and Learning Skills of University Students. In International Journal of Research in Undergraduate Mathematics Education (Issue 0123456789). Springer International Publishing. https://doi.org/10.1007/s40753-023-00224-0

Michael, K., Alemu, M., Desie, Y., Atnafu, M., Assefa, S., Regassa, C., Wodaj, H., & Abate, A. (2023). Understanding and practice of active learning among upper primary school science and mathematics teachers. Heliyon, 9(6), e16854. https://doi.org/10.1016/j.heliyon.2023.e16854

Ottenbreit-Leftwich, A. T., Kwon, K., Brush, T. A., Karlin, M., Jeon, M., Jantaraweragul, K., Guo, M., Nadir, H., Gok, F., & Bhattacharya, P. (2021). The impact of an issue-centered problem-based learning

curriculum on 6th grade girls' understanding of and interest in computer science. Computers and Education Open, 2(November 2021), 100057. https://doi.org/10.1016/j.caeo.2021.100057

Patmaniar, Amin, S. M., & Sulaiman, R. (2021). STUDENTS' GROWING UNDERSTANDING in SOLVING MATHEMATICS PROBLEMS BASED on GENDER: ELABORATING FOLDING BACK. Journal on Mathematics Education, 12(3), 507–530. https://doi.org/10.22342/JME.12.3.14267.507-530

Phaiah, J. (2023). Analyzing Prospective Elementary Teachers' Evidence of Conceptual Understanding and Procedural Fluency. Investigations in Mathematics Learning, 15(2). https://doi.org/https://doi.org/10.1080/19477503.2022.2139112

Schukajlow, S., Krawitz, J., Kanefke, J., Blum, W., & Rakoczy, K. (2023). Open modelling problems: cognitive barriers and instructional prompts. Educational Studies in Mathematics, 0123456789. https://doi.org/10.1007/s10649-023-10265-6

Sieervant-Miklos, V. (2020). Problem-oriented project work and problem-based learning: "Mind the gap!" Interdisciplinary Journal of Problem-Based Learning, 14(1), 1–17. https://doi.org/10.14434/ijpbl.v14i1.28596

Stovner, R. B., & Klette, K. (2022). Teacher feedback on procedural skills, conceptual understanding, and mathematical practices: A video study in lower secondary mathematics classrooms. Teaching and Teacher Education, 110, 103593. https://doi.org/10.1016/j.tate.2021.103593

Tirpáková, A., Gonda, D., Wiegerová, A., & Navrátilová, H. (2023). Developing the concept of task substitution and transformation by defining own equivalences. Educational Studies in Mathematics, 2004. https://doi.org/10.1007/s10649-023-10264-7