**Improvement of High School Students' Physics Problem Solving Skills Through Problem Based Learning Assisted by LKPD**

**Ika Trisni Simangunsong1, Kristina Uskenat1, Dede Parsaoran Damanik2, Ita Pratiwi Simangunsong3, Andre Agachi Purba2**

1Physics Education Department, Universitas Musamus, Merauke

2Physics Education Department, Universitas Darma Agung, Medan

3Master of Mathematics Education, The State University of Medan, Medan

\*Corresponding author: ikatrisni@unmus.ac.id

***Abstract***

*Classroom action research is used in this study. The aim of the research is to improve students' physics problem-solving abilities through Problem Based Learning (PBL) assisted by Lembar Kerja Peserta Didik (LKPD). The research was conducted in high school. The research sample was 10th-grade students on the topic of Measurement. In one cycle, there are 4 stages: planning, action, observation, and reflection. At the end of the cycle, an evaluation is conducted, using tests as the instrument. Consists of 4 essay-type questions that have been validated by a team of experts. The success indicator is that at least 70% of students achieve learning completeness, with a completeness criterion of 65. The pre-cycle was conducted before the class was treated. The initial test showed that no students achieved mastery, with an average problem-solving ability score of 54.67.The research was conducted in 2 cycles through the implementation of PBL assisted by LKPD. The results obtained in cycle I showed that 15 students achieved learning completeness, meaning 41.17% experienced an improvement in problem-solving skills, with an average problem-solving ability of 63.75. The next step was to implement cycle II. The findings in cycle II showed that 29 students achieved learning completeness, which means 80.05% experienced an improvement in problem-solving skills in the moderate category, with an average score of 70.05. Thus, it can be concluded that there is an improvement in high school students' physics problem-solving skills through PBL assisted by LKPD.*

***Key Words****: CAR, LKPD, PBL, Problem Solving*

**How to cite:**

**INTRODUCTION**

Education is an important part of advancing the life of a nation. The curriculum currently in use requires every student to collaborate with others to solve existing problems. The current curriculum demands emphasize several learning model options that support the 4C program. Critical thinking, creativity, communication, and collaboration are the four skills that students in the 21st century are expected to possess (Kementerian Pendidikan, n.d.). These skills can be trained through the learning process. Physics has become one of the subjects in high school that can be directed to enhance those skills. Therefore, it is very important for educators to prepare relevant physics lessons, so that the teaching and learning process becomes more optimal and aligned with the objectives (Faresta et al., 2024). Activities in learning should be able to guide students to interact with peers through collaboration, which encourages communication skills, critical thinking, and creativity.

Observations and interviews conducted at one of the high schools in Merauke show that the learning process that has been carried out still lacks activities that involve students in acquiring knowledge, both individually and in groups. Physics learning is predominantly delivered through a mathematical learning system, making it seem like physics is just a subject of calculations with existing formulas. The social learning theory proposed by Vygotsky emphasizes that the learning process originates from an individual's active role in the learning environment, as well as guidance from those who are more knowledgeable. Thus, it can be concluded that learning will be meaningful if students are active in the process. Teachers must be creative to innovate, in finding real things that connect the subject matter with everyday life (I. T. Simangunsong et al., 2024). This can be achieved, among other ways, through the utilization of lembar kerja peserta didik (LKPD).

LKPD has become one of the learning media that guides students to learn theoretically and implement it practically with their peers, under the guidance of a teacher. LKPD helps students to interact with the material through learning activities and receive guidance to discover concepts (Aulina Rahmatin et al., 2022). The worksheet plays a role in enhancing students' problem-solving skills (Maysaputri & Admoko, 2024). Through problem-solving activities, students gain deeper information, construct it, and determine the final outcome (Putri et al., 2023). Polya stated that problem-solving ability is a high-level activity skill for finding solutions to problems, equipped with the knowledge already possessed. Problem-solving becomes an important skill to be stimulated in students, so that they become accustomed to finding solutions through processes, in accordance with the correct theoretical concepts. One of the factors contributing to the low problem-solving abilities of students is their lack of involvement in learning activities (I. T. Simangunsong et al., 2023).

Polya formulated the stages to stimulate problem-solving abilities, namely: 1) understanding the problem; 2) planning the problem-solving; 3) executing the problem-solving stages; 4) reviewing (I. P. Simangunsong et al., 2022). These stages become activities that can be applied to guide students in problem-solving during the classroom learning process. Those steps align with the syntax also possessed by the Problem Based Learning (PBL) model, namely: 1) orienting students to the problem; 2) organizing students; 3) guiding students; 4) developing and presenting results; and 5) analyzing and evaluating the final results. PBL is designed, among other things, to make students better at problem-solving (Hidayah et al., 2018; I. T. Simangunsong, 2013). The results show an improvement in problem-solving abilities in the moderate category for the class that was given the application of LKPD-PBL (Risamasu & Pieter, 2024). Another finding states that Problem Based Learning assisted by LKPD is effective in improving students' science learning outcomes (Kade Agus Sudiandika, 2021).

Study objectives

LKPD aims to complement Problem Based Learning, so it is expected that the learning process through PBL Assisted by LKPD will enhance the problem-solving skills in physics of high school students.

Novelthy Of the current study

PBL assisted by LKPD becomes a learning activity designed to conduct experiments, collaborate to find or solve problems, and draw conclusions from the learning outcomes. The novelty of this research lies in the PBL model assisted by LKPD on the core material of Measurement for students in the Southern Papua region. In its implementation, the role of the facilitator within the group is very beneficial for improving students' abilities. Although previous research has highlighted the benefits of PBL-LKPD, this study is unique because it explores learning in the easternmost region of Indonesia, specifically on the physics material of Measurement using the facilitation method through LKPD.

**METODHS**

Classroom action research has become the type of research used. The research was conducted at one of the high schools in Merauke. The subjects of the research were 32 students from class X on the topic of Measurement in the odd semester of the 2023/2024 academic year. The research was conducted in two cycles. The cycle based on the development of Kemmis and Taggart consists of four main stages: action plan, implementation, observation, and reflection.(Jarjani Usman, 2019).

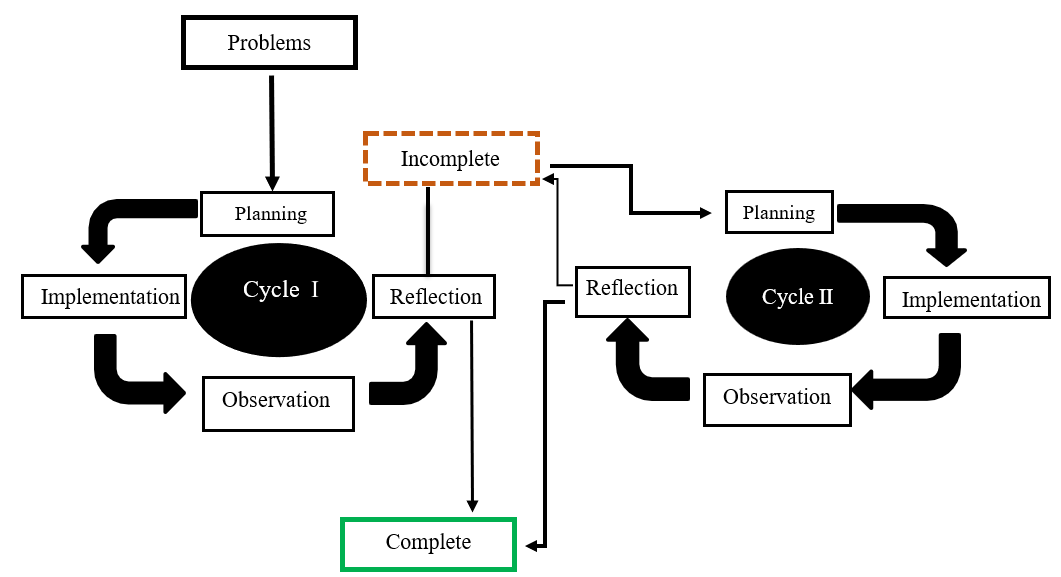


Figure 1. PTK Cycle

The data collection technique uses a problem-solving ability test administered at the end of the cycle. Consisting of 4 questions, in the form of essay tests, which have previously been validated by 1 lecturer and 1 teacher. Next, the obtained data is analyzed descriptively.

**Figure 1**. Criteria for Scoring Problem-Solving Ability Tests

|  |  |  |
| --- | --- | --- |
| **Aspect** | **Indicator** | **Description** |
| Understanding the problem | Given Asked Data Sufficiency | 3: Given, asked, complete  2: Completely 1: Incomplete  0: Not writing |
| Planning Problem Solving | Process | 4: Complete formula |
|  | 3: Write the formula, but incomplete |
|  | 2: Formula was wrong, but complete |
|  |  | 1: Formula was wrong, but incomplete |
|  |  | 0: Not writing |
| Problem Solving | Resolution Process | 5: The right rules, correct results, and done |
|  |  | 4: The right rules, correct results, but not finished |
|  |  | 3: Almost right, and complete |
|  |  | 2: Formula was wrong, and done |
|  |  | 1: Formula was wrong, but not fiinished |
|  |  | 0: Not writing |
| Checking | Checking | 3: The answer was correct, and complete |
|  |  | 2: The answer was correct, but unit was wrong |
|  |  | 1: The answer was incorrect, but unit was correct |
|  |  | 0: Not writing |

The indicators of success in this research can be seen from the following aspects: a) There is an increase in the average physics problem-solving ability of students from the pretest, cycle I test, and cycle II test. b) At least 70% of students achieve individual problem-solving completeness with a minimum completeness criterion of 65.

**Figure 2**. Problem-Solving Level

|  |  |
| --- | --- |
| Level | Criteria |
| 90%-100% | Very High |
| 80%-89% | High |
| 65%-79% | Medium |
| 55%-64% | Low |
| 0%-54% | Very Low |

**RESULTS AND DISCUSSION**

The first step was to conduct an initial test in the form of a problem-solving ability test. Based on the results of the initial test, it was found that no students passed; the students' ability to solve problems was very low, with an average score of 54.67. There were 4 students in the moderate interval, 6 in the low interval, and 26 in the very low scale. The results of the initial test can be seen in Table 3.

**Table 3**. Pretest Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Percentage | Level Ability | Amount of Students | | Percentage  Number Of Students | | Average Score Ability | |
| 90 − 100 | Very High | 0 | 0% | | 54.67  (Very Low) | |
| 80 − 89 | High | 0 | 0% | |
| 65 − 79 | Medium | 4 | 11.11% | |
| 55 −64 | Low | 6 | 16.67% | |
| 0-54 | Very Low | 26 | 72.22% | |
| Total | | 36 | 100% | |  | |

Based on problem-solving indicators, only 55.25% of students correctly understood the problem (low criteria), 50.30% of students correctly planned the problem-solving, 50.61% of students executed the problem-solving, and 30.45% reviewed their work. This means that, in general, the aspect of the indicator for students' physics problem-solving abilities is still very low. The description of students' problem-solving abilities is obtained in Table 4.

**Table 4**. Results of the Pretest Problem-Solving Test Based on Problem-Solving Indicators

|  |  |  |
| --- | --- | --- |
| Indicator | Percentage of Student Ability | Criteria |
| Understanding Problem | 55.25% | Low |
| Planning Problem Solving | 50.30% | Very Low |
| Implementing Problem Solving | 50.61% | Very Low |
| Checking | 30.45% | Very Low |

Then, treatment was given in the first cycle, through PBL assisted by LKPD. In the planning stage, the researcher discussed with subject teachers, communicated the learning scenario, LKPD, and prepared test instruments that were first validated by an expert team (lecturers and teachers). The implementation stage was carried out by implementing PBL assisted by LKPD. The researcher acted as the instructor, while the teachers and several research team members acted as observers. The observation stage is focused on observing students' activities while carrying out LKPD activities. Some students are confused and not focused on reading the instructions on the LKPD. The facilitator approaches the group, then guides them. Next, a reflection is conducted, followed by a test for the students, which then serves as a basis for the team to observe the changes that occur. The test results in cycle I showed that 15 students met the completion criteria, with an average problem-solving ability score of 63.75, which is at a low level, as detailed in table 5.

**Table 5**. Results of the Test in Cycle I

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Percentage | Level Ability | Amount of Students | Percentage  Number Of Students | Average Score Ability |
| 90 − 100 | Very High | 0 | 0% | 63.75  (Low) |
| 80 − 89 | High | 5 | 13.89% |
| 65 − 79 | Medium | 10 | 27.78% |
| 55 −64 | Low | 15 | 41.67% |
| 0-54 | Very Low | 6 | 16.67% |
| Total | | 36 | 100% |  |

Based on the explanation of the answers, the percentage of students who are already able to understand the problem is 68.56%, able to plan the problem is 67.78%, able to implement problem-solving is 56.47%, and able to review is 55.08%. The results are detailed in Table 6.

**Table 6**. Results of the Cycle I Problem-Solving Test Based on Problem-Solving Indicators

|  |  |  |
| --- | --- | --- |
| Indicator | Percentage of Student Ability | Criteria |
| Understanding Problem | 68.56% | Medium |
| Planning Problem Solving | 67.78% | Medium |
| Implementing Problem Solving | 56.47% | Low |
| Checking | 55.08% | Low |

The results in cycle I, which did not meet the success indicators, necessitated the researchers to conduct cycle II. The team once again created a learning scenario plan, the test instruments were changed in terms of numbers (without altering their alignment with the expected learning outcomes), and similarly for the LKPD, which were differentiated in terms of images and numbers (but still within the same concept as the LKPD in Cycle II). In the Implementation and Observation stage, the class received PBL treatment assisted by LKPD, with the researchers acting as the instructor, subject teacher, and the research team acting as observers. Reflection stage, students were given a test instrument consisting of 4 questions, which were different from the previous test but still aimed at the same objective. The reflection results showed that 29 students achieved learning completeness, with an average test score of 70.15, which falls under the moderate criteria. A more detailed description is listed in Table 7.

**Tabel 7**. The Results of Cycle II test

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Percentage | Level Ability | Amount of Students | | Percentage  Number Of Students | | Average Score Ability | |
| 90 − 100 | Very High | 1 | 2.78% | | 70.15  (medium) | |
| 80 − 89 | High | 8 | 22.22% | |
| 65 − 79 | Medium | 20 | 55.56% | |
| 55 −64 | Low | 5 | 13.89% | |
| 0-54 | Very Low | 2 | 5.56% | |
| Total | | 36 | 100% | |  | |

Based on the answer description in cycle II, it was found that the percentage of students who were able to understand the problem was 75.36%, able to plan the problem-solving was 72.46%, able to execute the problem-solving was 68.89%, and 65.58% were able to recheck. This is explained in table 8.

**Table 8**. Results of the Cycle I Problem-Solving Test Based on Problem-Solving Indicators

|  |  |  |
| --- | --- | --- |
| Indicator | Percentage of Student Ability | Criteria |
| Understanding Problem | 75.36% | Medium |
| Planning Problem Solving | 72.46% | Medium |
| Implementing Problem Solving | 68.89% | Medium |
| Checking | 65.58% | Medium |

The results of the pretest, cycle I, and cycle II, when compared in terms of average results, will be visually represented in a graph, showing that there is an improvement in students' physics problem-solving abilities with the use of PBL assisted by LKPD. This improvement is visually evident in Figure 2

Figure 2. Perbandingan Skor Rata-Rata Pretest, Siklus I, dan Siklus II

The line formed on the graph interprets that there is an increase in students' physics problem-solving abilities in that class. Meanwhile, the comparison of the percentages of the detailed problem-solving indicators can also be seen in Figure 3.

Figure 3. Comparison of Problem-Solving Ability Indicators

The indicator "understanding the problem" has a higher percentage compared to the other 3 indicators in every situation, which is consistent with previous researchers' findings (Fitriadi & Medriati, 2023), which found that the highest sequence of indicators starts with understanding the problem, planning the problem, executing the solution, and finally reviewing. Other research also confirms this relevance, with a recap of the sequence of mastery of problem-solving ability indicators, namely understanding, planning, executing, and ending at the reviewing stage (Agusta, 2020). If students understand the problem, they will then be able to plan and execute the solution, and finally conclude the process by reviewing what has been done. However, the researchers observed that some students were hindered in solving the problems due to inaccuracies in mathematical calculations. This has an impact on the next indicator. It cannot be denied that physics is quite closely related to numbers, and it involves calculations. So students are also expected to have good mathematical skills in order to solve problems in Physics. What makes Physics a complicated subject is that, in addition to understanding Physics concepts, students must also master mathematical concepts (Hasyim, 2018). This also affects the students' learning completeness, which reached the minimum threshold in the second cycle with a percentage of 80.05%. The comparison of completeness in the three research conditions is presented in Table 9.

**Table 9**. Learning Completeness

|  |  |  |  |
| --- | --- | --- | --- |
| Aspect | Pretest | Cycle I | Cycle II |
| Completion | - | 15 students | 29 students |
| Percentage of Completion | - | 41.17% | 80.05 % |

Reflection on cycle I is not only to see the test results but also to serve as a means to improve the implementation in cycle II. The improvements include: 1) Adding more facilitators, so that each group has 1 facilitator who will accompany the guidance process in the LKPD, 2) Increasing the number of example questions and exercises. The results show that in cycle II, 29 students achieved learning completeness. LKPD helps students guide them to follow scientific steps, write down the descriptions of the problems, determine the solution planning, conduct solution analysis, and perform verification. This process aligns with the values contained in PBL. This learning process becomes meaningful because it is derived from personal experience. According Vygotsky's constructivist theory, where students analyze and answer a question, meaning they are in the phase of developing responsibility towards the learning process and also becoming problem solvers. Collaboration skills with peers and teachers positively impact initial understanding and problem-solving abilities. Another finding also states that collaboration skills have an impact on students' problem-solving abilities (Maria Anggelita & Mariono, 2020). Students who actively engage in discussions understand things more quickly because they have the opportunity to express and listen to ideas in a scientific context. The learning environment in the form of grouping will influence a person in acquiring knowledge as well as problem-solving skills.

The results show that in cycle II, 29 students achieved learning completeness. In line with these results, out of 20 students, 17 students improved their problem-solving skills through PBL based on LKPD, or experienced an 85% improvement (Wulan Sari et al., 2024). LKPD that aligns with the curriculum needs is highly needed by students (Isrokijah, 2015) .It has been proven that problem-solving skills using PBL assisted by LKPD will have a better impact (Triatni Putri et al., 2024). PBL and LKPD have similar characteristics, stimulating students to explore their knowledge through real-world learning. When both are combined in a series of learning scenarios, they impact the improvement of students' problem-solving abilities.

**CONCLUSION**

Problem Based Learning has become a learning model that is currently one of the options used to improve students' abilities in physics. Problem-solving skills play an important role for students in the era of society 5.0 so that they become a solution-oriented generation in the future. LKPD as a medium helps teachers deliver lessons directly to students through systematic activities, peer collaboration, and also with the guidance of tutors. Rock-based PBL LKPD can enhance students' physics problem-solving skills.

**RECOMMENDATION**

Some suggestions for future researchers, it is very important to divide students evenly based on their abilities, so that study groups can be interactive and productive. Time management in learning management is also something that needs to be considered, given that LKPD provides activities that sufficiently guide students to explore their thinking abilities.

**ACKNOWLEDGEMENT**

The author expresses gratitude for the support from all parties involved in this research. Special thanks to the research team for their contributions of effort and ideas during the implementation and writing process.

**REFERENCES**

Agusta, E. S. (2020). Peningkatan Kemampuan Pemecahan Masalah Matematika melalui Model Pembelajaran Berbasis HOTS. *Jurnal Riset Pembelajaran Matematika Sekolah*, *4*.

Aulina Rahmatin, J., Juliana, D., & Rokhmat, J. (2022). *GeoScienceEd 3(2) (2022) Lembar Kerja Peserta Didik (LKPD) dengan Konteks Kearifan Lokal Pada Pembelajaran Fisika Article Info*. https://doi.org/10.29303/goescienceedu.v3i2.191

Faresta, R. A., Zhao Ser, T., Nicholas, B., Chi, Y., Astri, I., Sinambela, N., & Mopoliu, A. Z. (2024). Utilization of Technology in Physics Education: A Literature Review and Implications for the. *Future Physics Learning. Lensa: Jurnal Kependidikan Fisika*, *12*(1), 1–27. https://doi.org/10.33394/j

Fitriadi, P., & Medriati, R. (2023). Upaya Meningkatkan Kemampuan Pemecahan Masalah Fisika Peserta Didik dengan Menerapkan Problem Based Learning Model Berbantuan Simulasi PhET. *Triadik*, *22*, 166. https://doi.org/10.33369/triadik.v22i2.33581

Hasyim, F. Hasyim. , R. A. (2018). KECUKUPAN KEMAMPUAN MATEMATIKA BAGI CALON GURU FISIKA. *Jurnal Inovasi Pendidikan Fisika Dan Integrasinya*. https://www.researchgate.net/publication/328329745

Hidayah, S. N., Pujani, N. M., & Sujanem, R. (2018). IMPLEMENTASI MODEL PROBLEM BASED LEARNING UNTUK MENINGKATKAN AKTIVITAS BELAJAR DAN KEMAMPUAN PEMECAHAN MASALAH FISIKA SISWA KELAS X MIPA 2 MAN BULELENG TAHUN PELAJARAN 2017/2018. *JPPF*, *8*(1), 2599–2554.

Isrokijah. (2015). Developing Problem-Based Learning (PBL) Worksheets for the Eight Grade Students at Junior High School. *LLT Journal A Journal on Language and Language Teaching*, *18*(2).

Jarjani Usman, M. H. M. Z. R. (2019). *BUKU PRAKTIS  PTK Ber-ISBN*.

Kade Agus Sudiandika, I. (2021). *Efektivitas Model Problem Based Learning Berbantuan LKPD Terhadap Hasil Belajar Muatan Pelajaran IPA I Made Gede Swiyadnya 1 \*, I Made Citra Wibawa A R T I C L E I N F O*. *9*(2), 203–210. https://ejournal.undiksha.ac.id/index.php/JJPGSD

Kementerian Pendidikan, K. R. dan T. (n.d.). *PEMBELAJARAN ABAD 21*. Retrieved August 19, 2024, from https://cerdasberkarakter.kemdikbud.go.id/sahabatkarakter/kegiatan/93212a18-7b1e-4f4e-9919-51129308a785.pdf

Maria Anggelita, D., & Mariono, A. (2020). *Pengaruh Keterampilan Kolaborasi Terhadap Kemampuan Pemecahan Masalah Peserta didik SMK*. *5*(2). https://doi.org/10.32832/educate.v5i2.3323

Maysaputri, Y., & Admoko, S. (2024). Pengembangan LKPD Berbasis Argumentasi dengan Bantuan Web Energy4Me untuk Meningkatkan Kemampuan Pemecahan Masalah pada Peserta Didik SMA. In *Setyo Admoko* (Vol. 13, Issue 3).

Putri, M. W., Prayogi, S., Gummah, S., & Azmi, I. (2023). Pengaruh Model Problem-Based Learning (PBL) Terhadap Kemampuan Pemecahan Masalah Fisika Siswa. *Lensa: Jurnal Kependidikan Fisika*, *11*(1), 22. https://doi.org/10.33394/j-lkf.v11i1.10071

Risamasu, P. V. M., & Pieter, J. (2024). JURNAL PENDIDIKAN FISIKA UNDIKSHA PENGEMBANGAN E-LKPD BERBASIS PROBLEM BASED LEARNING UNTUK MENINGKATKAN KEMAMPUAN PEMECAHAN MASALAH PESERTA DIDIK. *JURNAL PENDIDIKAN FISIKA UNDIKSHA*, *14*(1).

Simangunsong, I. P., Simangunsong, I. T., Studi, P., Profesi Guru, P., & Fisika, P. (2022). *Penerapan Model Pembelajaran Problem Based Learning untuk  Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa*. *4*(2), 840–851.

Simangunsong, I. T. (2013). ANALISIS PEMAHAMAN KONSEP DAN KEMAMPUAN PEMECAHAN MASALAH FISIKA DENGAN MENGGUNAKAN MODEL PROBLEM BASED INSTRUCTION (PBI) DAN DIRECT INSTRUCTION (DI). *Digital Respository Unimed*, http://digilib.unimed.ac.id/3874/.

Simangunsong, I. T., Panjaitan, J., & Panggabean, D. D. (2023). PROBLEM BASED LEARNING ON STUDENTS’ CONCEPT MASTERY AND PROBLEM SOLVING SKILLS PROBLEM BASED LEARNING TERHADAP PENGUASAAN KONSEP DAN KEMAMPUAN PEMECAHAN MASALAH MAHASISWA. *Natural Science: Jurnal Penelitian Bidang IPA Dan Pendidikan IPA*, *9*(2), 156–166.

Simangunsong, I. T., Uskenat, K., & Gebze, D. A. (2024). PROBLEM BASED LEARNING BERBASIS ARTIFICIAL INTELLIGENCE TERHADAP KEMAMPUAN BERPIKIR SISWA. *Jurnal Pendidikan Fisika*, *13*(1), 41. https://doi.org/10.24114/jpf.v13i1.56702

Triatni Putri, Q., Studi Pendidikan Matematika, P., & Sembilanbelas November Kolaka, U. (2024). Effectiveness of the Problem-Based Learning Model Using LKPD in Mathematical Problem Solving. In *Jurnal Ilmu-ilmu Pendidikan dan Sains* (Vol. 12).

Wulan Sari, Y., Widiantie, R., Widiarsih, W., & Menengah Kejuruan An-Nuur Pasaleman, S. (2024). *PENGARUH MODEL PROBLEM BASED LEARNING DENGAN LKPD BERBASIS MASALAH TERHADAP KEMAMPUAN PEMECAHAN MASALAH SISWA PADA MATERI LIMBAH DAN POLUSI*. https://journal.fkip.uniku.ac.id/JGuruku/index