How e-Worksheet Based Blended Problem Based Model Improve Problem Solving Skills?

Yanti Sofi Makiyah[a] and Sandi Septiana[b]
Physics Education, Siliwangi University, Siliwangi Street No. 24, Tasikmalaya 46115, Indonesia

Keywords: e-Worksheet, Blended Problem-Based Learning, Problem-Solving Skills.

Abstract: Problem-solving skills are one of the skills that pre-service physics teachers must possess in this century as prospective professional physics teachers. Therefore, one way that can be done to practice problem-solving skills is by providing e-Worksheets based on Blended Problem-Based Learning (e-WB-PBL) model. This study aimed to determine the effectiveness of using e-WB-PBL in improving problem-solving skills. This study was carried out as part of Siliwangi University's physics education study program for pre-service physics teachers taking mechanics courses for the 2022/2023 academic year. This study uses mixed methods with a sequential explanatory design (two groups pretest-posttest). The sample was determined by purposive sampling with a full selection of 85 pre-service physics teachers. The control class consisted of 43 pre-service physics teachers, and the experimental class consisted of 42 pre-service physics teachers. The control class applies Discovery Learning (DL) learning, while the practical course applies Blended Problem-Based Learning (B-PBL). Statistical tests were used to analyze the data that were acquired, including N-Gain, to determine the improvement in problem-solving skills after using e-WB-PBL; the effectiveness of e-WB-PBL was determined by calculating the effect size, and the effect of e-WB-PBL was determined based on the results of the Mann Whitney test. The results of the N-Gain analysis show that the improvement in the problem skills of the experimental class is more significant than that of the control class, which is 0.9 in the "high" category. The results of the effect size calculation stated that e-WB-PBL was "very effective" in improving problem-solving skills, with a value of 1 in the "huge" category. The results of the Mann-Whitney test stated significant differences in the problem-solving abilities of the control class and the experimental style, with the improvement in the practical class's problem-solving skills being better than the control class. Based on the three results of the analysis, using e-WB-PBL is very influential and effective in improving problem-solving skills.

1 INTRODUCTION

Problem-solving skills are one of the 21st-century skills that need to be trained in physics education so pre-service physics teachers to become professional physics teachers. Problem-solving skills are fundamental in learning physics (Rizqa et al., 2020). Amin et al (2021) state that problem-solving skills must be taught and developed in the 21st century to meet graduate competency standards to deal with societal problems and environmental issues. It is also essential to train problem-solving skills to develop pre-service physics teacher's potential, which is directed through scientific investigation and helps solve a problem, find facts, building theories and concepts so that they are used to dealing with problems they encounter in their daily activities, especially physics learning activities at school.

One physics learning model that can be used to practice problem-solving skills is problem-based learning (PBL). The PBL model incorporates real-world challenges they must resolve to develop pre-service physics teachers' problem-solving abilities (Diana & Makiyah, 2021). One way that can be done to solve this problem is by carrying out investigations in the form of practical activities in the laboratory so that pre-service physics teachers will also be competent in problem-solving skills (Darmaji et al.,

[a] https://orcid.org/0000-0003-0957-9365
[b] https://orcid.org/0009-0000-3813-4280

Makiyah, Y. and Septiana, S.
How e-Worksheet Based Blended Problem Based Model Improve Problem Solving Skills?.
DOI: 10.5220/0012196900003738

In *Proceedings of the 4th International Conference on Innovation in Education (ICoIE 4 2022) - Digital Era Education After the Pandemic*, pages 90-95
ISBN: 978-989-758-669-9; ISSN: 2975-9676

2019). The PBL model is also proven to be an alternative to improving problem-solving skills, especially in Physics (Diana et al., 2022).

Observations in the mechanics class revealed that one barrier to using the PBL model to practice problem-solving abilities was that the time needed was still insufficient, depending on offline or online learning. Therefore, one solution that can be done to overcome these obstacles is to combine face-to-face learning with online education combined with independent laboratory practicum activities so that the teaching is called Blended Problem-Based Learning (B-PBL).

PBL is the foundation of the B-PBL model, which combines offline and online syntax learning. Applying the PBL model can further support pre-service physics teachers in mastering problem-solving skills. The PBL model engages physics teacher candidates in an interactive, cooperative, learner-centered learning process that fosters problem-solving skills (Aripin et al., 2021). This is by Tong, Kinshuk, & Wei (2020), which state that B-PBL effectively improves problem-solving skills.The B-PBL model is divided into five stages, namely first, orienting pre-service physics teacher's problems that are carried out offline, secondly organizing pre-service physics teachers to study offline and online, thirdly guiding group investigations (practice activities independently in the laboratory), fourthly developing and presenting the results of discussions online, and fifth, the problem-solving process is examined and evaluated offline (Ibrahim et al., 2022; Qalbi & Saparahayuningsih, 2021; Tong et al., 2020). This B-PBL uses an e-worksheet to make it easier to direct pre-service physics teachers in carrying out each stage in B-PBL. It also provides guidance questions in solving problems for learning activities outside the classroom independently or online. The e-worksheet was created based on the five steps in B-PBL and trained four indications of problem-solving abilities, such as comprehending the problem, developing a strategy, putting the plan into action, and reflecting on the final answer (Polya, 1978). B-PBL also leverages the use of technology that is accessible to digital resources, simulations, software, or online learning platforms (Lalima & Lata, 2017). Based on the preceding context, the researchers are interested in knowing how the B-PBL-based e-worksheet enhances problem-solving abilities and how pre-service physics teachers view B-PBL learning.

2 METHOD

This study employs a sequential explanatory design and a mixed method. Analysis in the early stages was carried out by collecting data and analysing it using quantitative methods and then deepening it with qualitative methods (Sugiyono, 2014). They combine data from the two ways connecting with data collection and analysis of the two methods carried out separately but made continuous. In Figure 1, the research design is displayed.

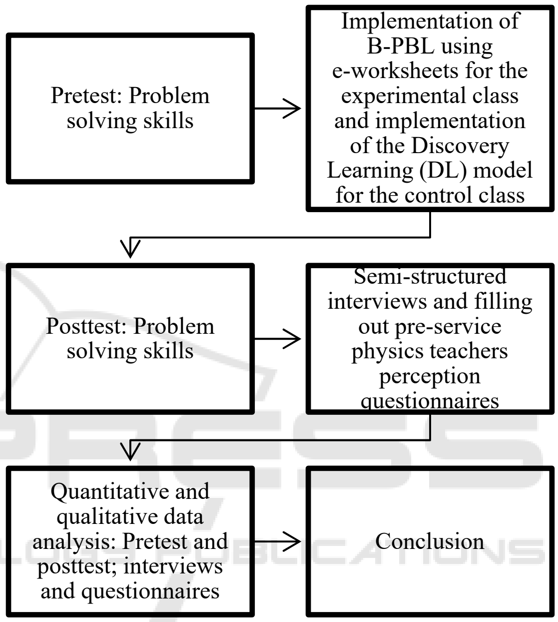

Figure 1: Sequential explanatory research design.

The pre-service physics teachers who took the two-class mechanics course during the 2022/2023 academic year served as the research sample. There were 42 pre-service physics teachers in the experimental class and 43 pre-service physics teachers in the control class.

The research instrument consists of an essay-based three-question test of problem-solving skills, each measuring four indicators of problem-solving skills regarding kinematics, dynamics, and harmonic motion. Other instruments, namely a list of semi-structured interviews and a student perception questionnaire, consist of statements with a Guttman scale on B-PBL consisting of 6 comments.

As for how to calculate the score of problem-solving skills according to Hudha et al (2017) as follows:

$$P = (x/xi) \times 100\% \qquad (1)$$

Where P is the percentage of the final score, x is the score obtained by the pre-service physics teachers on one indicator, and xi is the maximum overall score on the one indicator. The values obtained are then categorized according to each indicator according to Diana & Makiyah (2021) in Table 1.

Table 1: Problem-solving skills category.

Presents (%)	Category
0-39,9	Very less
40-54,99	Less
55,00-69,99	Enough
70,00-84,99	Good
85,00-100,00	Very good

Questionnaire scores use the Guttman scale with the options "Yes" or "No". The following equation then calculates the scores obtained from all pre-service physics teachers:

$$P = (f/N) \text{ X } 100\% \quad (2)$$

Where P is the percentage of the perceived value of the respondent, f is the total score obtained from the respondent, and N is the maximum overall score (Arikunto, 2012; Subana et al., 2015). The calculation results are then analyzed with the following criteria.

Table 2: Questionnaire percentage criteria.

Presents (%)	Category
0	There aren't any
0–25	Fraction
26–49	Almost half
50	Half
51–75	Most of the
76–99	Almost entirely
100	Entirely

Calculation of the score (N-Gain) can be expressed in the following equation:

$$\text{N} - \text{Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}} \quad (3)$$

The N-Gain value obtained is interpreted using Hake's criteria (1999) as follows:

Table 3: N-Gain criteria.

N-Gain	Criteria
N-Gain < 0.3	Low
0.7 ≥ (N-gain) ≥ 0.3	Medium
(N-Gain) > 0.7	High

The equation used to determine the effect size is as follows:

$$\text{effect size} = \frac{\overline{\text{X}}_{\text{posttest}} - \overline{\text{X}}_{\text{pretest}}}{\sqrt{\frac{\text{S}_{\text{posttest}}{}^2 + \text{S}_{\text{pretest}}{}^2}{2}}} \quad (4)$$

Where $\bar{X}$ The average of the pretest and posttest scores, and S is the standard deviation. The effect size value obtained is interpreted using the criteria of Diana & Makiyah (2021) as follows:

Table 4: Effect size criteria.

Effect Size	Criteria
ES<0,2	Very small
0,2≤ES<0,5	Small
0,5≤ES<0,8	Moderate
0,8≤ES<1,0	Large
ES≥1,0	Huge

The statistical analysis included normality and hypothesis tests using the SPSS software. If the significance value (Sig.) obtained from the normality test is more significant than 0.05, it indicates that the data is typically distributed. In these circumstances, a t-test is performed. However, the Mann-Whitney U test in SPSS is utilized if the data is not normally distributed. The alternative hypothesis (Ha) is accepted when the significance value or asymptotic significance (Asymp. Sig.) (2-tailed) is less than or equal to 0.05. Conversely, Ha is rejected when the significance value or asymptotic importance (Asymp. Sig.) (2-tailed) is more significant than 0.05.

The problem-solving skills instrument that has been made has been validated by three experts and then tested on 35 pre-service physics teachers to determine the value of validity and reliability. Based on the results of the validity test with SPSS, it can be seen that the problem-solving skills essay questions are all valid and the reliability test results for problem-solving skills questions are 0.710 in the high category.

3 RESULT AND DISCUSSION

Based on data analysis in Figure 2, it was found that the posttest average in the experimental class was more significant than the control class, with the "very good" category for the experimental class and the "good" category for the control class. The practical course and the control class improve problem-solving abilities, although to a different extent. Discovery Learning and B-PBL treatments can improve problem-solving skills but have different improvement categories. In the experimental class, problem-solving skills have improved by 0.9 in the "high category," compared to 0.6 in the "medium category" for the control class. Discovery Learning (DL) and B-PBL are effective for improving problem-solving skills but have different effectiveness criteria. B-PBL using e-worksheet has a "huge" sort while DL has a "moderate" criteria. The hypothesis test results show that B-PBL has a more significant effect on improving skills than DL with Asymp. Sig. (2-tailed) 0.000 less than 0.05 then Ha is accepted. When it comes to improving problem-solving skills, B-PBL outperforms DL because the model syntax in B-PBL trains problem-solving skills very well by training understanding the problem, devising a plan, carrying out a plan, and looking back at the completed solution. The best way to teach problem-solving is still to confirm the syntax model of the DL with stimulation, problem statements, data collecting, data processing, verification, and generalization. E-worksheets, according to other studies, considerably enhance problem-solving abilities (Hasna et al, 2021; Islam et al., 2021). According to other investigations, e-worksheets enhance problem-solving abilities through B-PBL applicable to everyday phenomena (Destianingsih, Pasaribu, & Ismet, 2016; Sari & Sinurya, 2019).

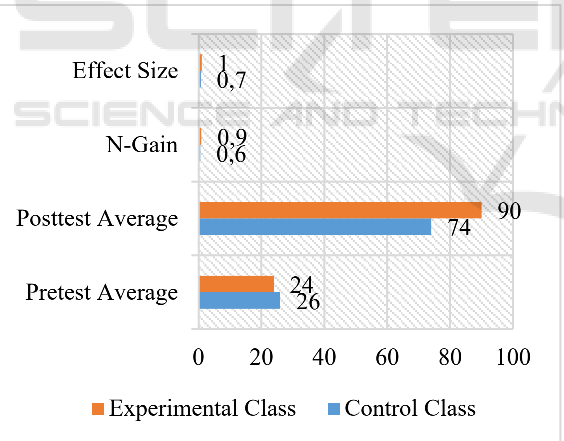

Figure 2: Results of pretest and posttest data analysis.

Based on the data in Figure 3, it was found that B-PBL is very effective and very significant in improving each indicator of aptitude for solving issues. The experimental class's posttest average for problem-solving abilities fell into the "very good" category. The e-worksheet utilized in B-PBL gives "guidance questions and instructions" in addressing problems, enabling pre-service physics teachers to be independent and active in solving problems. B-PBL is very effective and significant for enhancing each indicator of problem-solving skills. Pre-service physics teachers get experiences that are challenging, interesting, and fun so that they are prepared to have problem-solving skills.

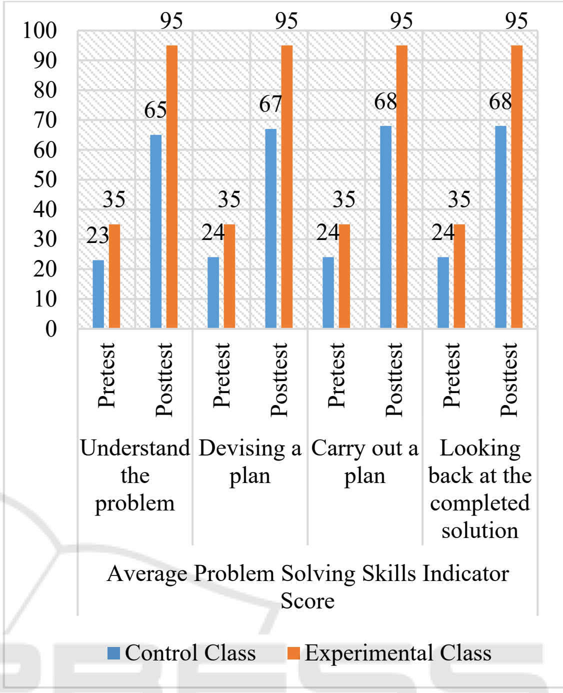

Figure 3: The result PSS indicator score.

Physics pre-service education According to the findings of a Google Form survey, physics instructors provided thoughtful comments. Almost all pre-service physics teachers stated that through B-PBL, using e-worksheets on kinematics, dynamics, and harmonic motion could improve problem-solving skills. Researchers also observed that pre-service physics teachers were more independent and active in finding solutions to problems during the learning process. Almost all pre-service physics teachers stated that Blended-Problem Based Learning (B-PBL) made it easier for them to understand kinematics, dynamics, and harmonic motion materials. Nearly all physics teachers in training claimed that Blended, Problem-Based Learning (B-PBL) improves their problem-solving abilities. Almost all physics teachers in training said they like and appreciate Blended-Problem Based Learning (B-PBL) on kinematics, dynamics, and harmonic motion. Almost all pre-service physics teachers noted that the problems given in Blended-Problem Based Learning (B-PBL) on kinematics, dynamics, and harmonic motion are interesting, so they are motivated to solve these problems independently.

This learning provides a meaningful and memorable experience. Almost all pre-service physics teachers wanted Blended-Problem Based Learning (B-PBL) replicated to other mechanics concepts. The findings of this investigation are investigated by Ukhtikhumayroh & Rahmatsyah (2021), stating that respondents responded positively to the application of B-PBL. Learning that is student-centered and involves active interaction in solving practical problems contributes to an increased understanding of more significant problems (Lukitasari et al., 2019). The characteristics of B-PBL learning encourage pre-service physics teachers to actively plan strategies for solving physics problems and involve intense interactions in the learning process (Triyanto & Prabowo, 2020). The B-PBL model also provides opportunities for pre-service physics teachers to get feedback and reflection on solutions to solve problems to encourage the development of better evaluation abilities (Suwono & Dewi, 2019).

Indicators of problem-solving abilities in the experimental class employing B-PBL are more significant in enhancing student problem-solving abilities, according to the results of the pretest-posttest indicators of problem-solving abilities in the experimental and control classes because learning is carried out much more effectively, namely face-to-face and online, so that time student learning can be more to strengthen the concept of each material studied. In addition, in B-PBL, students go through a process of investigation and laboratory work that is not verification in nature because, in B-PBL, students are asked to learn to make various assumptions and actively think about finding solutions to solving problems (Dewi, 2013).

4 CONCLUSIONS

In this study, the e-worksheets-based blended problem-based model is very effective with a vast category in improving problem-solving skills. Furthermore, the worksheet instructions are designed to be easily understandable, and an element of humor is incorporated to add enjoyment to the experience of pre-service physics teachers as they independently and actively answer questions and find solutions to problems. Based on the data analysis findings, e-worksheets-based blended problem-based models are essential for significantly improving the problem-solving skills of pre-service physics teachers, particularly in the high category. These models provide the necessary training for enhancing problem-solving skills by answering questions in the worksheet and actively seeking solutions to problems. As a result, pre-service physics teachers gain valuable and meaningful experiences that are both exciting and engaging. E-worksheets-based blended problem-based models are highly recommended for learning to improve problem-solving skills.

ACKNOWLEDGEMENTS

Researchers would like to thank Lembaga Penelitian, Pengabdian Kepada Masyarakat, and Penjaminan Mutu Pendidikan (LP2M-PMP) for financing this research. This activity can be carried out correctly and smoothly with the support and assistance of various related parties. Therefore, the research team would like to thank the chair of the Siliwangi University LP2M-PMP, the dean of the Siliwangi University FKIP, and the lecturers in the Department of physics Education and pre-service physics teachers class of 2021 in Siliwangi University.

REFERENCES

Amin, A. K., Degeng, N. S., Setyosari, P., & Djatmika, E. T. (2021). The Effectiveness of Mobile Blended Problem Based Learning on Mathematical Problem Solving. *International Journal of Interactive Mobile Technologies*, *15*(1), 119–141. https://doi.org/10.3991/IJIM.V15I01.17437

Arikunto. (2012). *Prosedur Penelitian suatu Pendekatan Praktik*. Jakarta: Rineka Cipta.

Aripin, W. A., Sahidu, H., & Makhrus, M. (2021). Efektivitas Perangkat Pembelajaran Fisika Berbasis Model Problem Based Learning untuk Meningkatkan Kemampuan Pemecahan Masalah dan Kemampuan Berpikir Kritis Peserta Didik. *Jurnal Penelitian Dan Pembelajaran Fisika Indonesia*, *3*(1). https://doi.org/10.29303/jppfi.v3i1.120

Darmaji, Astalini, Kurniawan, D. A., Parasdila, H., & Iridianti. (2019). E-Module based problem solving in basic physics practicum for science process skills. *International Journal of Online and Biomedical Engineering*, *15*(15), 4–17. https://doi.org/10.3991/ijoe.v15i15.10942

Destianingsih, E., Pasaribu, A., & Ismet. (2016). Pengaruh Model Problem Based Learning terhadap Kemampuan Pemecahan Masalah Siswa pada Pembelajaran Fisika Kelas XI di SMA Negeri 1 Tanjung Lubuk. *Jurnal Inovasi Dan Pembelajaran Fisika*, 1–6. https://doi.org/10.36706/jipf.v3i1.3423

Dewi, C. A. (2013). Pengaruh Blended Learning dalam Pembelajaran Berbasis Masalah (PBL) terhadap Hasil

Belajar Mahasiswa IKIP Mataram pada Materi Pencemaran Lingkungan. *Jurnal Prisma Sains*, *1(1)*, 1–11.

Diana, R., & Makiyah, Y. S. (2021). The Effectiveness of Student Worksheets (LKPD) Based on The Problem Based Learning (PBL) Model to Improve Problem-Solving Skills in Multiple Gap Interference Material. *Jurnal Pendidikan Fisika*, *10*(1), 48–54. https://doi.org/10.22611/jpf.v10i1.24763

Diana, R., Surahman, E., & Makiyah, Y. S. (2022). The Effect of Problem Based Learning with Laboratory Activities on Students' Problem-Solving. *Jurnal Pendidikan MIPA*, *23*(3), 1017–1028.

Hasna, H. R., Fajriyah, K., & Saputra, H. J. (2021). The Effect of Blended Learning Based on The Problem-Based Learning Model Assisted by Puzzle Media on The Critical Thinking Skills of Fifth Grade Students on Ecosystem Themes. *Journal of Education Technology*, *5*(1), 14. https://doi.org/10.23887/jet.v5i1.29770

Hudha, M. N., Aji, S., & Rismawati, A. (2017). Pengembangan Modul Pembelajaran Fisika Berbasis Problem Based Learning untuk Meningkatkan Kemampuan Pemecahan Masalah Fisika. *SEJ (Science Education Journal)*, *1*(1), 36–51. https://doi.org/10.21070/sej.v1i1.830

Ibrahim, M. M., Jamaludin, K. A., Rosli, M. S., Muhamad, M. I. D., Taha, H., & Borhan, M. T. (2022). Enhancing Self-Directed Learning Skills via Blended Problem-based Learning in Chemistry Learning. *Central Asia and The Caucasus*, *22*(1), 1818–1835. Retrieved from https://doi.org/10.37178/ca-c.22.1.182

Islam, M. N., Sumarmi, S., Putra, A. K., Sugiyati, P., & Salsabilah, S. (2021). The Effect of Interactive Blended-Problem Based Learning Assisted Virtual Classroom on Critical Thinking Skills of Students of The Society Era 5.0. *Jurnal Geografi Gea*, *21*(2), 135–146. https://doi.org/10.17509/gea.v21i2.38862

Lalima, D., & Lata Dangwal, K. (2017). Blended Learning: An Innovative Approach. *Universal Journal of Educational Research*, *5*(1), 129–136. https://doi.org/10.13189/ujer.2017.050116

Lukitasari, M., Purnamasari, I., Utami, S., & Sukri, A. (2019). Blended-Problem-Based Learning: How its impact on students' critical thinking skills? *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *5*(3), 425–434. https://doi.org/10.22219/jpbi.v5i3.10048

Polya, G. (1978). How to solve it: a new aspect of mathematical method second edition. *The Mathematical Gazette*. Retrieved from http://www.jstor.org/stable/3609122?origin=crossref

Qalbi, Z., & Saparahayuningsih, S. (2021). Penggunaan Blended-Problem Based Learning di Masa Covid-19 untuk Meningkatkan Kemampuan Berpikir Kritis pada Mata Kuliah Kreativitas dan Keberbakatan. *Jurnal Ilmiah Kependidikan*, *8*(1), 1–11. http://dx.doi.org/10.30998/fjik.v8i1.8600

R.R, H. (1999). Analyzing change/gain scores. Retrieved from http://physics.indiana.edu

Rizqa, A., Harjono, A., & Wahyudi. (2020). Model Pembelajaran Inkuiri Terbimbing Berbantuan Post Organizer. *ORBITA. Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, *6*(1), 243–247.

Sari, D., & Sinurya, J. B. (2019). Pengaruh Model Problem Based Learning berbantuan Laboratorium Virtual terhadap Peningkatan Kemampuan Pemecahan Masalah Fisika Siswa SMAN 5 Medan. *Journal of Chemical Information and Modeling*, *53*(2), 35–39. https://doi.org/https://doi.org/10.24114/jiaf.v5i2.12554

Subana, Rahadi, M., & Sudrajat. (2015). *Statistik Pendidikan*. Bandung: Pustaka Setia.

Sugiyono. (2014). *Metode Penelitian Kombinasi (Mix Methods)*. Bandung: CV. Alfabeta.

Suwono, H., & Dewi, E. K. (2019). Problem-Based Learning Blended with Online Interaction to. In *International Conference for Science Educator and Teachers (ISET)* (pp. 030003-1–7). https://doi.org/10.1063/1.5094001

Tong, Ya., Kinshuk, & Wei, X. (2020). Teaching Design and Practice of a Project-Based Blended Learning Model. *International Journal of Mobile and Blended Learning*, *12*(1), 33–55. Retrieved from http://doi.org/10.4018/IJMBL.2020010103

Triyanto, S. A., & Prabowo, C. A. (2020). Efektivitas Blended-Problem Based Learning dengan Lesson Study Terhadap Hasil Belajar Effectiveness of Blended-Problem Based Learning with Lesson Study toward Learning Outcomes. *Bioedukasi: Jurnal Pendidikan Biologi*, *13*(1), 42–48. https://doi.org/10.20961/bioedukasi-uns.v13i1.37960

Ukhtikhumayroh & Rahmatsyah. (2021). Efek Model Problem Based Learning (PBL) Berbantuan Alat Praktikum terhadap Kemampuan Pemecahan Masalah pada Materi Pokok Elastisitas dan Hukum Hooke. *INPAFI (Inovasi Pembelajaran Fisika)*, 2017–2020. https://doi.org/10.24114/inpafi.v8i4.21144