The Difference in Students' Learning Outcomes Using Problem-Based Learning and Project-Based Learning on The Concept of Vibrations and Waves

Sumarni Sahjat[1], Nursahida Wahnan[2], Fatma Hamid[3], Taslim Buaja[4], Saprudin Saprudin[5], Nurdin Abdul Rahman[6]

[1,2,3,5,6] Program Studi Pendidikan Fisika, FKIP Universitas Khairun, Ternate, Indonesia
Email: sumarni_sahjat@yahoo.com; nursahida_ida@yahoo.com; fatmahamid@unkhair.ac.id;
saprudin@unkhair.ac.id ; udinarahman1964@gmail.com
[4] Universitas Muhammadiyah Maluku Utara, Ternate, Indonesia
[4] taslimsaidbuaja@yahoo.com

ARTICLE INFO

ABSTRACT

This research aims to find out the differences in student learning outcomes using the problem-based learning (PBL) model and project-based learning (PjBL) model on the concept of vibrations and waves. The research type used is a quasi-experiment model while the research design is a two-group experiment with pretests and posttests. The population of the research were class VIII students of SMP National Banau Ternate City, a total of 42 students distributed over 2 classes with a sample of 22 students chosen with the sampling technique then randomized to determine the experimental class and control class. Data in this research used tests. Tests were conducted before and after learning. The results of the study showed that there was a significant difference in the improvement of learning outcomes of students who participated in PBL and PjBL learning.

Corresponding Author:
Sumarni Sahjat
Pendidikan Fisika, FKIP, Universitas Khairun; sumarni_sahjat@yahoo.com

INTRODUCTION

One of the challenges in the current world of education is the weakness of the learning process. In learning, students are often less motivated to develop thinking skills. To increase students' learning interest, teachers should make learning activities more interesting by applying learning models and media that can motivate students to learn. Thus, learning that was previously focused on the teacher can shift to student-centered learning (Mahmud et al., 2018). The development of science and technology challenges teachers to devote significant effort to creating effective media that can produce interactive learning (Mellisa & Yanda, 2019).

Learning still minimally utilizes media that can attract students' attention, as well as models that are less innovative and not yet adapted to their characteristics. As a result, students become less active in the learning process. This low learning motivation affects the achievement of their learning outcomes (Asriningsih et al., 2021). One of the topics that students have difficulty learning is the topic of vibrations and waves (Saprudin et al., 2022; Marinda et al., 2023; Saprudin et al., 2023).

Learning media refers to all tools or means used by teachers to deliver material in a structured manner to help students understand and master the lesson better. This media can be in the form of physical objects, technology, or a combination of both, designed to present information more effectively, thereby increasing students' understanding and retention of learning concepts (Hutasoit et al., 2024).

Learning media has an inseparable role in the teaching and learning process in the world of education. This media includes all forms of tools or methods used to convey messages from educators to students, to evoke their thoughts, emotions, attention, and interest in learning (Sahjat & Buaja, 2017). The lack of use of media that attracts students' attention and learning models that are not innovative and not by their characteristics causes students to be less active in participating in the learning process (Asriningsih et al., 2021).

There is a difference in learning outcomes between students who use audio-visual media and students who use picture media in Science learning. The research results show that the use of audio-visual media has a positive impact on the Science learning outcomes of second-grade Elementary School students (Hastuti & Budianti, 2014).

The learning process that does not use media cannot attract students' attention, and the models are not innovative according to student characteristics, thus making students less active in participating in learning. Low student motivation in learning impacts learning achievement (Izzaty et al., 2017). The utilization of audio-visual animation media in children's story learning can be a means to improve students' listening skills. Thus, learning objectives can be achieved, while also encouraging changes in student behavior towards a more positive direction in the learning process (Ahmad et al., 2018).

Science learning can help students understand various types and conditions of their surrounding natural environment, and human conditions, increase their understanding of how things happen, increase their insight, and help them apply scientific knowledge to the real world (Margareta, 2023). To overcome these problems, there needs to be an effort to improve learning outcomes, especially in Science subjects, by developing a creative and innovative learning approach so that these problems can be overcome and learning objectives can be achieved (Taslim et al., 2024).

The utilization of learning media in the teaching orientation stage can increase the effectiveness of the learning process and the delivery of material. Media plays a role as a tool to facilitate learning activities. Considering that each type of media has different characteristics, careful and appropriate selection is very necessary so that the media can be used optimally (Rahmawati et al., 2020).

RESEARCH METHODOLOGY

The research method used in this study was a quasi-experimental method with a pretest-posttest nonequivalent multiple group design (Wiersma & Jurs, 2009; Saprudin et al., 2020). This design uses two experimental groups, namely experimental group I where the student group was taught using the PBL model, and experimental group II where the student group was taught using the PjBL model. Before being given the treatment, both classes were first given an initial test in the form of a pretest to determine the initial abilities of both groups and after being given the treatment, a final test in the form of a posttest was conducted to determine the extent of students' mastery of the relevant concepts. Student learning outcome data were collected through a test instrument in the form of essay questions. The improvement of student learning outcomes was analyzed by determining the average normalized gain score in both classes (Hake, 1998).

Table 1. Experimental design

Group	Pretest (dependent variable)	Treatment	Posttest (dependent variable)
G1	O1	PBL	O2
G2	O3	PjBL	O4

RESULTS AND DISCUSSIONS

After conducting the tests, the data obtained is as shown in Figure 1. In general, student learning outcomes increased after participating in learning using either the PBL model or the PjBL model. The magnitude of the increase in student learning outcomes in both classes was categorized as high.
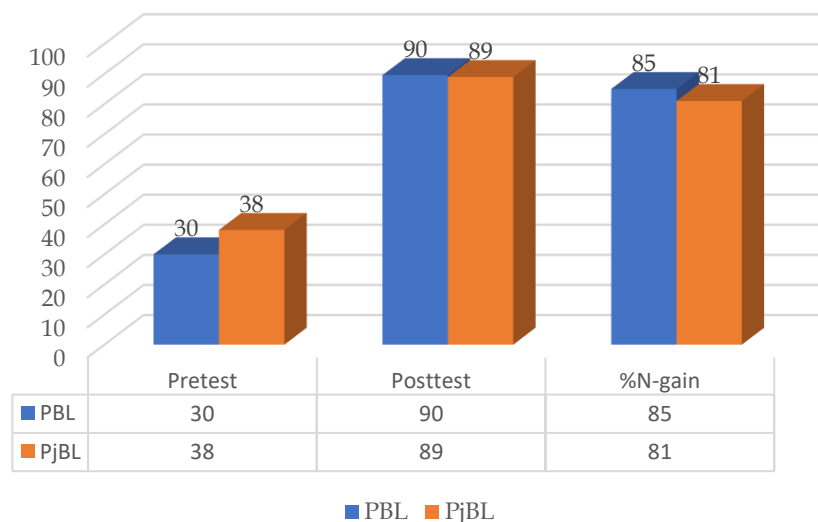

	Pretest	Posttest	%N-gain
PBL	30	90	85
PjBL	38	89	81

Figure 1. Differences of Students' Learning Outcomes between PBL and PjBL Models

This data was then analyzed using the two-mean similarity test statistic (t-test). However, prior to that, an analysis requirement test was conducted, namely the homogeneity test and the normality test. The calculation results of the normality test for X1 data obtained χ^2count = 10.00 with dk = 10 and α = 0.05, χ^2table = 18.307. Meanwhile, for X2 data, the result χ^2count = 6.4 with dk = 11 and α = 0.05, χ^2table = 19.675. From the calculation results for both

X1 and X2 data, it was obtained that $\chi2$count < $\chi2$table (10.00 < 18.307 and 6.4 < 19.675) so it can be said that both X1 and X2 data are normally distributed. The homogeneity test obtained Fcount = 1.60 with numerator dk and denominator dk = 21 at α = 0.05, and Ftable was obtained = 2.00. From these results, it shows that Fcount < Ftable (1.60 < 2.00). Thus, it can be concluded that the data is said to be homogeneous.

Differences in improvements in student learning outcomes were analyzed using the t-test. After analysis, the results obtained were tcount = 2.19 and ttable = 2.02. The results of the data calculation show that tcount > ttable or 2.19 > 2.02 at a significant level of 5%, thus H0 is rejected and Ha is accepted. This shows that there is a significant difference in improving the learning outcomes of students who participate in learning by implementing the PBL and PjBL models.

The difference in the increase in student learning outcomes is influenced by several factors, namely internal and external factors of students. Internal factors are factors that originate from within the student who is learning, namely physiological factors which include physical condition and the condition of the five senses, as well as psychological factors which include intelligence, individual talent, individual interest, learning motivation, emotions, and cognitive abilities. While external factors are factors that influence the learning process and outcomes of students, these factors include the natural environment which includes air conditions, weather, time, place or school building, tools used in lessons, and the social environment which includes the social environment of students at home, the social environment of students at school, and the social environment in the community. The increase in learning outcomes above is in line with the PjBL model, which is a learning approach with long-term activities that involve students in designing, creating, and presenting products to solve real-world problems. Students are trained to analyze, then explore, gather information, interpret, and evaluate in working on projects related to the problems being studied (Sani, 2014).

PBL is a learning approach where the delivery is done by presenting a problem, asking questions, facilitating investigation, and opening dialogue. The problems studied should be contextual problems found by students in their daily lives. Problems must be solved by applying several concepts and principles that are simultaneously learned and covered in the subject curriculum (Candra, 2018; Lestari & Juanda, 2019). PBL is not designed to help teachers convey too many concepts or information to students, but rather to help students develop their thinking skills, problem-solving abilities, and intellectual abilities; learn to act like adults through simulated situations; train independence and self-directed learning. Thus, the use of learning models is very important because even if a teacher in the learning process has mastered the material well, but if they do not use a method, especially for junior high school students, the learning objectives will not be achieved well.

The implementation of PBL and PjBL models has proven effective in improving student learning outcomes because this approach places students as active subjects in the learning process (Hotimah, 2020; Nurhadiyati et al., 2020). Through PBL, students are encouraged to identify problems, seek relevant information, and formulate solutions independently or in groups (Wardani, 2023). This activity not only improves conceptual understanding but also trains critical thinking, problem-solving, and collaboration skills (Saharsa et al., 2018; Wartono et al., 2018, Elizabet & Sigahatong, 2018; Najib et al., 2017; Pratiwi et al., 2020; Oktaviana &

Haryadi, 2020; Kartikasari et al., 2021; Afelia et al., 2024). Meanwhile, through PjBL, students are encouraged to explore, design, and complete real projects that are relevant to the learning material (Ansya, 2023; Nugraha et al., 2023; Saputra et al., 2023). This activity requires high cognitive involvement, so that students not only memorize concepts but also understand their application in everyday life. This process can significantly improve students' conceptual understanding, critical thinking skills, and communication skills, which ultimately have an impact on improving learning outcomes (Wahyuni & Fitriana, 2021; Puspitasari et al., 2020; Hidayat & Puspitasari, 2022; Sholeh et al., 2024).

In this approach, students are faced with real problems that are relevant to everyday life, so they are encouraged to analyze situations, identify root causes, and design logical and effective solutions. This process accustoms students to think reflectively and systematically, and develops critical reasoning skills. Thus, PBL not only improves mastery of subject matter, but also equips students with high-order thinking skills that are very much needed in facing real-world challenges (Farhan & Arisona, 2022; Selirowangi et al., 2024). The PBL and PjBL models have significant long-term benefits for students' future success. Both approaches not only focus on mastering academic material but also emphasize the development of 21st-century skills needed in the real world, so that they can equip students to be able to successfully face the complexities of the world of work and real life more adaptively and independently.

CONCLUSION

Student learning outcomes increased after participating in learning, both in students who participated in learning by implementing the PBL and PjBL models. The increase in student learning outcomes in both groups can be categorized as high. There is a significant difference in the increase in student learning outcomes who participated in PBL and PjBL learning.

REFERENCES

Ahmad, A., Hajar, S., & Almu, F. F. (2018). Peningkatan keterampilan menyimak cerita anak melalui media animasi audio visual siswa kelas VI SD. Jurnal Ilmiah Profesi Pendidikan, 3(1). https://doi.org/10.29303/jipp.v3i1.44

Asriningsih, N. W. N., Sujana, I. W., & Sri Darmawati, I. G. A. P. (2021). Penerapan model discovery learning berbantuan media powerpoint meningkatkan hasil belajar ips siswa SD. Mimbar Ilmu, 26(2), 251. https://doi.org/10.23887/mi.v26i2.36202

Afelia, Y. D., Utomo, A. P., & Sulistyaningsih, H. (2024). Implementasi model problem based learning (Pbl) berbasis pembelajaran berdiferensiasi untuk meningkatkan keterampilan kolaborasi pada mata pelajaran biologi di kelas x sma. Jurnal Biologi, 1(2), 1-11. DOI: https://doi.org/10.5281/zenodo.11193365

Ansya, Y. A. U. (2023). Upaya Meningkatkan Minat dan Prestasi Belajar Siswa Kelas IV Sekolah Dasar pada Pembelajaran IPA Menggunakan Strategi PjBL (Project-Based Learning). Jurnal Ilmu Manajemen Dan Pendidikan, 3(1), 43-52. https://doi.org/10.30872/jimpian.v3i1.2225

Candra L. N. P. (2018). Penerapan model pembelajaran kooperatif tipe NHT berbantuan media audio visual untuk meningkatkan hasil belajar IPA. Journal of Education Action Research, 2(4), 355. https://doi.org/10.23887/jear.v2i4.16331

Elizabeth, A., & Sigahitong, M. M. (2018). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kreatif Peserta Didik SMA. Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran MIPA, 6(2), 66–76.

Farhan, M., & Arisona, R. D. (2022). Problem Based Learning (PBL) Berorientasi Higher Order Thinking Skills (HOTS) Untuk Meningkatkan Hasil Belajar IPS. Publikasi Berkala Pendidikan Ilmu Sosial, 2(2).

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. American journal of Physics, 66(1), 64-74.

Hastuti, A., & Budianti, Y. (2014). Pengaruh penggunaan media audio visual terhadap hasil belajar siswa pada mata pelajaran ipa kelas ii sdn bantargebang ii kota bekasi. Jurnal Pedagogik, 2(2), 33–38.

Hidayat, S., & Puspitasari, D. R. (2022). Penerapan Model Pembelajran Project Based Learning (PjBL) untuk Meningkatkan Keterampilan Komunikasi Siswa Sekolah Dasar. Journal of Innovation in Primary Education, 1(2), 192-199.

Hotimah, H. (2020). Penerapan metode pembelajaran problem based learning dalam meningkatkan kemampuan bercerita pada siswa sekolah dasar. Jurnal edukasi, 7(2), 5-11. DOI:https://doi.org/10.19184/jukasi.v7i3.21599

Hutasoit, D. K., Hasanah, L. W., Lubis, M., & Puspita, R. (2024). Media dan Teknologi Pembelajaran PPKn dalam Memenuhi Tujuan dan Fungsi Pendidikan Kewarganegaraan. 3.

Izzaty, R. E., Ayriza, Y., Setiawati, F. A., & Amalia, R. N. (2017). Prediktor prestasi belajar siswa kelas 1 sekolah dasar. Jurnal Psikologi, 44(2), 153. https://doi.org/10.22146/jpsi.27454

Kartikasari, I., Nugroho, A., & Muslim, A. H. (2021). Penerapan model pbl untuk meningkatkan kemampuan berpikir kritis siswa pada kelas iv sekolah dasar. Jurnal gentala pendidikan dasar, 6(1), 44-56. DOI: https://doi.org/10.22437/gentala.v6i1.10124

Lestari, I., & Juanda, R. (2019). Komparasi model pembelajaran problem based learning dan project based learning terhadap hasil belajar siswa pada materi perangkat keras jaringan internet kelas IX SMP negeri 5 sungai kakap kabupaten kubu raya. Efektor, 6(2), 127–135. http://ojs.unpkediri.ac.id/index.php/efektor-ehttps://doi.org/10.29407/e.v6i2.13159://creativecommons.org/licenses/by-sa/4.0/

Mahmud, A. F., Buaja, T., & Noh, S. A. (2018). Problem-based learning model applied: Enhancing the first grade students' english achievement at muhammadiyah islamic school kota ternate. International Journal of Scientific and Technology Research, 7(12), 270–272.

Margareta, J. (2023). Pengembangan Media Pembelajaran Ipa Berbasis Games Untuk Siswa Kelas 5 Sd. 6, 954–958.

Marinda, F., Muhammad, N., & Saprudin, S. (2023). Pengembangan konten e-modul interaktif materi getaran dan gelombang berbasis problem based learning. JPF (Jurnal Pendidikan Fisika) FKIP UM Metro, 11(1), 94-107.

Mellisa, M., & Yanda, Y. D. (2019). Developing audio-visual learning media based on video documentary on tissue culture explant of Dendrobium bigibbum. JPBI (Jurnal Pendidikan Biologi Indonesia), 5(3), 379–386. https://doi.org/10.22219/jpbi.v5i3.9993

Najib, I. A., Suyatna, A., & Wahyudi, I. (2017). Pengaruh Model Pembelajaran Problem Based Learning terhadap Keterampilan Berpikir Kreatif Siswa SMP. Jurnal Pembelajaran Fisika Universitas Lampung, 5(1), 116912.

Nugraha, I. R. R., Supriadi, U., & Firmansyah, M. I. (2023). Efektivitas strategi pembelajaran project based learning dalam meningkatkan kreativitas siswa. Jurnal Penelitian Dan Pendidikan IPS, 17(1), 39-47. DOI: https://doi.org/10.21067/jppi.v17i1.8608

Nurhadiyati, A., Rusdinal, R., & Fitria, Y. (2020). Pengaruh model project based learning (pjbl) terhadap hasil belajar siswa di sekolah dasar. Jurnal Basicedu, 5(1), 327-333. DOI: 10.31004/basicedu.v5i1.684

Oktaviana, D., & Haryadi, R. (2020). Pengaruh model pembelajaran problem based learning (PBL) terhadap kemampuan pemecahan masalah mahasiswa. AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 9(4), 1076. DOI: http://dx.doi.org/10.24127/ajpm.v9i4.3069

Pratiwi, D. A., Djumhana, N., & Hendriani, A. (2020). Penerapan model PBL untuk meningkatkan pemahaman konsep IPA siswa kelas V SD. Jurnal Pendidikan Guru Sekolah Dasar, 5(1), 11-18.

Puspitasari, L., Astuti, B., & Masturi, M. (2020). Penerapan Project Based Learning (PjBL) Terbimbing untuk Meningkatkan Keaktifan dan Pemahaman Siswa pada Konsep Momentum, Impuls, dan Tumbukan. Physics Education Research Journal, 2(2), 69-82. DOI:https://doi.org/10.21580/perj.2020.2.2.4959

Rahmawati, B. F., Badarudin, B., & Hadi, M. S. (2020). Penggunaan media interaktif power point dalam pembelajaran daring. Fajar Historia: Jurnal Ilmu Sejarah Dan Pendidikan, 4(2), 60–67. https://doi.org/10.29408/fhs.v4i2.3135

Sahjat, S., & Buaja, T. (2017). Penerapan metode quantum learning untuk meningkatkan hasil belajar mata pelajaran IPA pada siswa kelas IV SD negeri 1 daruba morotai selatan. Jurnal Pendidikan Mipa, 1(12), 81–87. http://lib.unnes.ac.id/1261/

Sani, R. A. (2014). Pembelajaran Saintifik untuk Implementasi Kurikulum 2013. Jakarta: PT Bumi Aksara.

Saprudin, S., Liliasari, L., Setiawan, A., & Prihatmanto, A. (2020). Optical gamification (OG); Serial versus random model to improve pre-service physics teachers' concept mastery. International Journal of Emerging Technologies in Learning (IJET), 15(9), 39-59.

Saprudin, S., Januarsih, M. S., Rahman, N. A., & Rizal, R. (2023). Digital game to support the effectiveness of using interactive e-module on vibration and waves concept (IeMVWC). Techno: Jurnal Penelitian, 12(1), 46-55.

Saprudin, S., Ahlak, I., Salim, A., Haerullah, A. H., Hamid, F., & Rahman, N. A. (2022). Pengembangan e-modul interaktif getaran dan gelombang (EMIGG) untuk pembelajaran ipa di smp. Jurnal Pendidikan MIPA, 12(1), 97-106.

Saharsa, U., Qaddafi, M., & Baharuddin, B. (2018). Efektivitas Penerapan Model Pembelajaran Problem Based Learning Berbantuan Video Based Laboratory Terhadap Peningkatan Pemahaman Konsep Fisika. Jurnal Pendidikan Fisika, 6(2), 57–64. DOI: https://doi.org/10.24252/jpf.v6i2.5725

Saputra, A., Saprudin, S., Hamid, F., & Rahman, N. A. (2023). Optimalisasi model project based learning terhadap motivasi belajar mahasiswa calon guru fisika di era new normal. U-Teach: Journal Education of Young Physics Teacher, 4(1), 19-29. DOI: https://doi.org/10.30599/uteach.v4i1.456

Selirowangi, N. B., Aisyah, N., & Rohmah, L. (2024). Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Higher Order Thinking Skills (HOTS). EDUKASIA: Jurnal Pendidikan dan Pembelajaran, 5(1), 31-40. DOI: https://doi.org/10.62775/edukasia.v5i1.714

Sholeh, M. I., Tasya, D. A., Syafi'i, A., Rosyidi, H., Arifin, Z., & binti Ab Rahman, S. F. (2024). PENERAPAN PEMBELAJARAN BERBASIS PROYEK (PJBL) DALAM MENINGKATKAN KEMAMPUAN BERPIKIR KRITIS SISWA. Jurnal Tinta: Jurnal Ilmu Keguruan Dan Pendidikan, 6(2), 158-176. DOI:

Taslim B, et al. (2022). Penggunaan media animasi audio visual untuk meningkatkan hasil belajar IPA di SD negeri 2 kota ternate. Attractive : Innovative Education Journal Vol. 6, No. 3, November 2024 ISSN : 2685-6085.

Wahyuni, E., & Fitriana, F. (2021). Implementasi model pembelajaran project based learning (pjbl) dalam meningkatkan hasil belajar peserta didik pada mata pelajaran pendidikan agama islam SMP Negeri 7 Kota Tangerang. Tadarus Tarbawy: Jurnal Kajian Islam dan Pendidikan, 3(1). DOI: http://dx.doi.org/10.31000/jkip.v3i1.4262

Wardani, D. A. W. (2023). Problem based learning: membuka peluang kolaborasi dan pengembangan skill siswa. Jawa Dwipa, 4(1), 1-17. DOI: https://doi.org/10.54714/jd.v4i1.61

Wartono, W., Diantoro, M., & Bartlolona, J. R. (2018). Influence of problem based learning model on student creative thinking on elasticity topics a material. Jurnal Pendidikan Fisika Indonesia, 14(1), 32–39. DOI:10.15294/jpfi.v14i1.10654

Wiersma, W & Jurs, S. G. (2009). Research Methods in Education an introduction Ninth Edition. United States of America: Pearson Education, Inc.