MJP Journal of Education and Teaching Learning
Vol.4, No.2 (2026): 258 - 263
https://jurnalilmiah.co.id/index.php/MJPJETL

Implementation of Project Based Learning on Students' Learning Interests in Logic Gate Materials

[1] Rudi Santoso, [2] Muhammad Jarnawi, [3] Muhammad Zaki, [4] Wahyuni N Laratu

[1] [2] [3] [4] Physics Education Study Program, Tadulako University

***Correspondence Author**: rudisantoso@untad.ac.id

Article Info

Keywords:

Project Based Learning; Interest in Learning; Electronics; Logic Gate;

ABSTRACT

The Physics Education Study Program has a great responsibility in producing prospective educators who not only master physics concepts theoretically, but are also able to integrate these masteries with applicative skills in the field of technology, one of which is electronics. Electronic materials, especially logic gates, have an important role in today's technological advancements, so it is necessary to examine students' interest in these materials with the right learning model. Therefore, this study was made with the aim of seeing the influence of the Project Based Learning learning model on students' learning interests in logic gate materials. The results of this study were obtained by testing a hypothesis of p (<.001) < 0.05, which means that there was a significant difference between the students' learning interest scores before and after the implementation of Project Based Learning (PjBL) on the logic gate material which was then strengthened by effect size testing with a result of d = 0.761 indicating a moderate effect and an N-Gain test of g = 0.44 with an increase in the medium category. Based on this test, it can be concluded that there is an influence of the Project Based Learning model on students' learning interest in logic gate material.

Article Information

Kata Kunci:

Project Based Learning; Minat Belajar; Elektronika; Gerbang Logika;

ABSTRACT

Program Studi Pendidikan Fisika memiliki tanggung jawab besar dalam mencetak calon pendidik yang tidak hanya menguasai konsep-konsep fisika secara teoretis, tetapi juga mampu mengintegrasikan penguasaan tersebut dengan keterampilan aplikatif di bidang teknologi, salah satunya elektronika. Materi elektronika terkhusus gerbang logika memiliki peranan penting dalam kemajuan teknologi saat ini, sehingga perlu mengkaji minat mahasiswa pada materi tersebut dengan model pembelajaran yang tepat. Oleh karena itu penelitian ini di buat dengan tujuan untuk melihat pengaruh model pembelajaran Project Based Learning terhadap minat belajar mahasiswa pada materi gerbang logika. Hasil dari penelitian ini diperoleh pengujian hipotesis sebesar p (<.001) < 0.05, yang berarti terdapat perbedaan signifikan antara skor minat belajar mahasiswa sebelum dan sesudah penerapan Project Based Learning (PjBL) pada materi gerbang logika yang kemudian diperkuat dengan pengujian effect size dengan hasil d = 0.761 mengindikasikan efeknya sedang dan uji N-Gain sebesar g = 0.44 dengan peningkatan pada kategori sedang. Berdasarkan pengujian tersebut dapat disimpulkan bahwa terdapat pengaruh model Project Based Learning terhadap minat belajar mahasiswa pada materi gerbang logika.

Article History

Received : 13/08/2026
Revised : 15/08/2026
Accepted : 15/09/2026

✉ ***Corresponding Author:*** (1) Rudi Santoso, (2) Physics Education Study Program, (3) Tadulako University, (4) Jl. Soekarno Hatta, Palu, 94119, Indonesia, (5) Email: rudisantoso@untad.ac.id

1. Introduction

The Physics Education Study Program has a great responsibility in producing prospective educators who not only master physics concepts theoretically, but are also able to integrate these masteries with applicative skills in the field of technology, one of which is electronics. The Electronics 2 course is a follow-up course to Electronics 1 which focuses on the study of digital electronics systems, with logic gates as one of the fundamental subjects in it. Mastery of the concept of logic gates including the logical gates AND, OR, NOT, NAND, NOR, X-OR, and X-NOR along with their truth tables is an important prerequisite for students to understand advanced topics such as sequential circuits, binary number systems, and applications of digital electronics in daily life, as well as a provision for prospective physics teacher students when teaching electronics materials at the secondary school level.

Despite having a strategic position in the curriculum structure, logic gate material is often perceived by Physics Education students as abstract material and requires logical-mathematical thinking skills that are not always easy to visualize only through theoretical explanations in class [1]. A study conducted on Physics Education students in basic electronics courses found that students' perceptions of motivation and skills towards logic gate material were in a relatively lower category compared to the aspects of material understanding and the use of learning media, which indicates that there is a gap between the understanding of concepts and students' internal motivation to study the material in depth [2]. Similar findings also highlight the importance of additional learning interventions to improve student motivation and learning outcomes in basic electronics courses before taking more complex digital electronics materials [3].

Low interest in learning abstract and technical materials such as logic gates needs serious attention, considering that interest in learning is a psychological condition characterized by an individual's sense of pleasure, interest, attention, and active involvement in a learning activity [4]. Without adequate interest, the process of internalizing the concept of logic gates tends to take place passively, so it has the potential to cause misconceptions and low readiness of students in applying the concept to practicum and digital circuit design tasks. The logic of thinking needed in understanding the logic gate material is also closely related to student learning interests.

This condition indicates the need to reorient the learning strategy in the Electronics 2 course, from a teacher-centered approach to a student-centered and contextual approach. One of the learning models that is widely recommended in the science education literature to overcome this problem is Project Based Learning (PjBL), which is a learning model that actively involves students in designing, building, and testing a real product or project as a concrete representation of the abstract concepts studied. Through direct involvement in assembling and testing a series of logical gates physically and simulatively, students are expected to build a more meaningful conceptual understanding while increasing their interest in learning the material.

International studies have consistently supported the effectiveness of PjBL in increasing students' motivation and interest in learning. Research through meta-analysis of 132 research reports found that project-based learning (PjBL) has a consistent positive effect on students' learning motivation, especially in terms of interest and task value [5]. These findings are further strengthened through a follow-up meta-analysis that found that PjBL has a significant positive impact on the learning effectiveness of students compared to conventional learning models [6]. More specifically in the context of physics learning, it is proven that the application of PjBL produces better learning outcomes than the direct instruction model, especially in students with low levels of academic procrastination [7]. In the context of digital electronic learning, the implementation of PjBL in digital design courses can increase student engagement and understanding compared to conventional learning [8], while project-based learning in electronics students also encourages the development of cognitive and metacognitive skills significantly [9]. PjBL is also effective in increasing student engagement through four main dimensions, namely collaborative learning, disciplinary learning, iterative learning, and authentic learning [10].

Other research has proven that the application of PjBL in physics learning has a significant effect on increasing students' interest in learning and science process skills [11][12]. This is also strengthened by several studies on PjBL that use other aids that have obtained significant results. As well as lesson study-based PjBL which is able to improve the creative thinking skills of high school students in physics learning [13], while reaffirming the effectiveness of PjBL in increasing students' interest and learning outcomes [14]. The profile of the scientific creativity of Physics Education students built through project-based learning also shows the great potential of PjBL to be applied more widely to technical courses within the scope of the Physics Education study program [15].

Based on this description, the researcher is interested in examining the implementation of the Project Based Learning learning model on the learning interest of Physics Education students in the logic gate material in the Electronics 2 course. This title is taken because most of the previous research still focused on the application of PjBL to non-electronic physics topics or at the secondary education level, while research that focuses on the impact of PjBL on the learning interest of prospective physics teacher students in digital electronics materials, especially logic gates, is still rarely explored empirically and measurably. This gap is the basis for the urgency of this research. Through this research, it is hoped that it will make a theoretical contribution through the enrichment of empirical studies on the effectiveness of PjBL in digital electronics learning in the scope of physics education, as well as a practical contribution as a consideration for lecturers teaching the Electronics 2 course in designing learning strategies that are more innovative, contextual, and able to increase students' interest in learning materials that have been considered difficult and abstract.

2. Research Methods

2.1. Research Type and Design

This research is an experimental research with a quantitative approach. The research only involved one class without a comparison class (control class), the design used was classified as a pre-experimental design in the form of One-Group Pretest-Posttest Design. In this design, the group studied was given a pretest to find out the condition of learning interest before treatment, then given treatment in the form of applying the Project Based Learning (PjBL) model to the logic gate material and then given a final measurement (posttest) to determine the condition of learning interest after treatment [16]. The design of this study can be seen in Table 1.

Table 1 Research Design

Pretest	Treatment	Posttest
O_1	X	O_2

2.2. Population and Research Sample

The population in this study is all students of the Physics Education Study Program who are taking the Electronics 2 course in the current semester which amounts to 3 classes. The sample of this study is class C which amounted to 33 people. Sampling is carried out using a simple random sampling technique, which is selection is carried out randomly without considering certain strata, groups, or characteristics in the population [16].

2.3. Research Instruments

The instrument used in this study is in the form of a questionnaire of learning interests with a Likert scale (4 or 5 points), which is compiled based on a grid of learning interest indicators including students' feelings of pleasure, interest, attention, and involvement while participating in learning logic gate material [4]. This questionnaire was given to students twice, namely before (pretest) and after (posttest) the application of the PjBL model.

2.4. Data Collection Techniques

The data in this study was collected through the provision of a learning interest questionnaire directly to all research samples, both in the pretest and posttest stages of the implementation of the PjBL model. In addition to the questionnaire, observations of the implementation of PjBL-based learning were also carried out as supporting data to see the consistency between the learning process that took place and the results of measuring student learning interest.

2.5. Data Analysis Techniques

The data obtained is then analyzed and obtained through the following stages:

- Descriptive analysis, to describe the average score, minimum score, maximum score, and category of student learning interest during the pretest and posttest.
- Data normality test, using the Shapiro-Wilk test that is appropriate for a small sample count (n = 33).
- Hypothesis test, using a paired sample t-test.
  The hypothesis:
  H_0: There is no significant difference between the pretest and posttest scores of students' learning interests.
  H_1: There is a significant difference between the pretest and posttest scores of students' learning interests.
- Effect size test, to see the magnitude of the influence of PjBL on students' learning interests.
- The N-Gain test, to determine the magnitude of the increase in students' interest in learning before and after the implementation of PjBL, by categorizing the increase into high, medium, or low categories [17].

3. Results and Discussion

3.1. Research Results

1) Descriptive Analysis

The data on student learning interest was obtained from questionnaires given before (pretest) and after (posttest) the application of the Project Based Learning (PjBL) model to the logical gate material for 33 students of the Physics Education Study Program, shown in the following Table 2:

Table 2 Decryption of Research Results

	Learning Interest Pretest	Posttest of Learning Interest
N	33	33
Missing	0	0
Red	3.48	3.71
Median	3.45	3.73
Standard deviation	0.301	0.386
Minimum	2.76	3.00
Maximum	4.15	4.61

2) Data Normality Test

The data nobility test was performed using the Shapiro-Wilk test. This is done because the data used in this study is relatively small, namely 33 people or less than 50 people. The test results can be seen in Table 3:

Table 3 Normality Test

	Learning Interest Pretest	Posttest of Learning Interest
Standard deviation	0.301	0.386
Range	1.39	1.61
Shapiro-Wilk W	0.987	0.968
Shapiro-Wilk p	0.955	0.416

Based on Table 3, the results of the data test on the pretest were obtained of p(0.955) > 0.05 and the posttest of p(0.416) > 0.05. Based on these results, it is concluded that the two data are distributed normally. This is strengthened by the results of the histrogram analysis shown in Figure 1 and Figure 2.

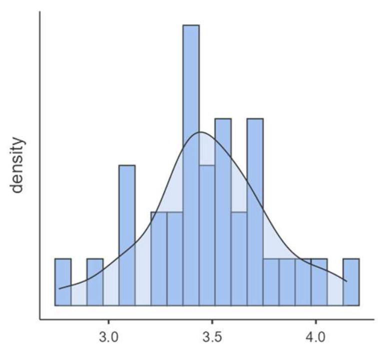

Figure 1. Histogram Pretest of Learning Interest

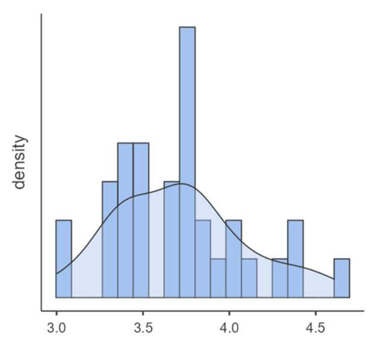

Figure 2 Histogram Posttest Interest in Learning

With this assumption of normality fulfilled, the next hypothesis test uses parametric statistics, namely the paired sample t-test.

3) Hypothesis Test

The test of the hypothesis results in this study can be seen in Table 4 below.

Table 4 Hypothesis Test

			Statistic.	df	p
Learning Interest Pretest	Posttest of Learning Interest	Student's t	-4.37	32.0	<.001

Based on the tests obtained in Table 4, it can be seen that the significance value obtained is p(<.001) < 0.05 which means that H0 is rejected and H1 is accepted, so it can be concluded that there is a significant difference between the pretest and posttest scores of students' learning interest.

4) Test Effect Size

After the hypothesis test was carried out, then an effect size test was carried out to see how much influence of PjBL on the learning interest of physics students. These results can be seen in Table 5.

Table 5 Effect Size Test

				Effect Size
Learning Interest Pretest	Posttest of Learning Interest	Student's t	Cohen's d	-0.761

Based on Table 5, the influence value of PjBl on student learning interest of d = 0.761 indicates a moderate effect. So from these results, it can be concluded that there is an influence of Project Based Learning on students' learning interest in logic gate material.

4) N-Gain Test

The N-Gain test was carried out to determine the magnitude of the increase in student learning interest before and after the implementation of PjBL. Based on the calculation results, the result was g = 0.44 with a medium category. These results show that there is an increase in students' interest in learning after being given learning using Project Based Learning, although the increase is only in the medium category.

3.2. Discussion

Based on the results of the tests that have been carried out in this study, several things are obtained that answer the hypothesis in this study. The test in this study consisted of a normality test which showed a pretest result of p (0.955) > 0.05 and a posttest of p (0.416) > 0.05 where this result showed that the data was distributed normally. After normal data, hypothesis testing was then carried out which obtained a significance result of p (<.001) < 0.05, which means that there was a significant difference between students' learning interest scores before and after the implementation of Project Based Learning (PjBL) on the logic gate material which was then strengthened by effect size testing with a result d = 0.761 indicating a moderate effect. Based on this test, it can be concluded that there is an influence of the Project Based Learning model on students' learning interest in logic gate material. The N-Gain test also had a fairly good result with a value of g = 0.44 in the medium category. These results show that there is an increase in students' interest in learning after being given learning using Project Based Learning, although the increase is only in the medium category. These findings are consistent with the results that apply a research design of a type of one-group pretest-posttest with Shapiro-Wilk normality test and paired t-test on the application of PjBL for celestial eclipse material in class VII MTs which obtained pretest and posttest data results were declared to be normally distributed (Sig. > 0.05), and the results of the paired sample t-test showed t (26) = 10.26 with $p < 0.001$, so that H_0 is rejected [18]. The similarity of these statistical patterns reinforces the belief that the change in scores in this study is not just a random fluctuation, but a real effect of the PjBL treatment.

Similar evidence was also found in a quasi-experimental study of 50 grade IX students at Nazarbayev Intellectual School, Kazakhstan by applying PjBL to mechanical materials (Newton's Law I, II, III, superposition principles, and types of forces). Using Force Concept Inventory as a measurement instrument, t-test and ANCOVA analysis of pre-post data showed that PjBL had a significant positive effect on students' concept understanding [19]. The relevance of these findings to current research lies in the similarity of the field of physics/electronics material studies that are abstract and require logical reasoning, thus strengthening the argument that the characteristics of PjBL based on direct experience are effective in bridging the gap between abstract concepts and students' concrete understanding.

In terms of active involvement and broader science learning outcomes, a quasi-experimental study of high school students on fluid materials found that the group that studied with PjBL showed very significant differences compared to the group taught by direct methods, both in science process skills and learning outcomes [20]. This is relevant to explain why the increase in interest in learning in this study was also followed by changes in student learning patterns. PjBL not only adds factual knowledge, but also trains process skills that psychologically increase students' sense of involvement and interest in the material being taught.

The application of PjBL based on the Higher Order Thinking Skills (HOTS) approach to students of Gunung Rinjani University also obtained results that this approach is able to improve students' abilities according to the demands of 21st century learning, in line with the characteristics of this research subject who are also at the student level [21]. These results strengthen the argument that the effectiveness of PjBL is not limited to the secondary school level, but is also relevant to learning in college, including in courses that demand practical skills such as in logic gate material.

A broader review was also conducted on the effectiveness of PjBL in science and STEAM education which confirmed that the characteristics of PjBL place learners as active designers of projects consistently and contribute to increased motivation and engagement of learning across levels and fields of study [22]. The conclusion of this review provides a broader theoretical basis for the findings of this study, that the increase in interest in learning in logic gate material is not a coincidental phenomenon in one class, but is consistent with a pattern that has been widely reported in the PjBL literature.

More specifically on the student involvement indicator, which in this study showed a moderate N-Gain (0.44), this finding is in line with the statement that PjBL actively trains science process skills through the project monitoring and evaluation stage, a stage that requires students to be directly involved in testing a series of logic gates that have been designed [20].

Overall, the results of this study provide empirical evidence that the application of Project Based Learning to logic gate materials is effective in increasing the learning interest of Physics Education students, both statistically (hypothesis p (<.001) < 0.05) and practically (N-Gain in the medium category). These findings are reinforced and in line with a series of empirical evidence that consistently reports the positive effects of PjBL on students' interest, engagement, and conceptual understanding of abstract science materials.

4. Closing

Based on the results of the tests that have been carried out in this study, it is concluded that there is an influence of the Project Based Learning learning model on students' learning interest in logic gate materials. These results are important to be referenced by subsequent studies that we recommend using the control class as a comparison.

Acknowledgments

This research would not have run without the support of several parties who helped us. Therefore, we would like to express our gratitude to the coordinator of the Physics Education Study Program, Faculty of Teacher Training and Education, Tadulako University, the research team, and physics students who have helped in the smooth running of this research.

Bibliography

[1] Syahbani, A. K. (2018). Rancang bangun alat praktikum gerbang logika dasar berbasis Op-Amp. Journal of Teaching and Learning Physics, 3(2), 7–13. https://doi.org/10.15575/jotalp.v3i2.6552

[2] Anjiana, R., Rosa, I. M., Meilinda, S., & Mahmudah, I. R. (2022). Persepsi mahasiswa pendidikan fisika terhadap penggunaan media pembelajaran berbasis Circuit Wizard di masa pandemi pada materi gerbang logika. DIFFRACTION: Journal for Physics Education and Applied Physics, 4(1), 1–8. https://doi.org/10.37058/diffraction.v4i1.5830

[3] Makiyah, Y. S., Nurdiansah, I., Mahmudah, I. R., & Maulidah, R. (2022). Implementasi software Circuit Wizard pada mata kuliah elektronika dasar untuk meningkatkan motivasi dan hasil belajar siswa. Radiasi: Jurnal Berkala Pendidikan Fisika, 15(1), 22–27. https://doi.org/10.37729/radiasi.v15i1.1844

[4] Friantini, R. N., & Winata, R. (2019). Analisis minat belajar pada pembelajaran matematika. JPMI (Jurnal Pendidikan Matematika Indonesia), 4(1), 6–11. https://doi.org/10.26737/jpmi.v4i1.870

[5] Wijnia, L., Noordzij, G., Arends, L. R., Rikers, R. M. J. P., & Loyens, S. M. M. (2024). The effects of problem-based, project-based, and case-based learning on students' motivation: A meta-analysis. Educational Psychology Review, 36(1), Article 29. https://doi.org/10.1007/s10648-024-09864-3

[6] Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: A meta-analysis study. Frontiers in Psychology, 14, 1-14. https://doi.org/10.3389/fpsyg.2023.1202728

[7] Santyasa, I. W., Rapi, N. K., & Sara, I. W. W. (2020). Project based learning and academic procrastination of students in learning physics. International Journal of Instruction, 13(1), 489–508. https://doi.org/10.29333/iji.2020.13132a

[8] Skliarova, I. (2021). Project-based learning and evaluation in an online digital design course. Electronics, 10(6), Article 646. https://doi.org/10.3390/electronics10060646

[9] Shekh-Abed, A. (2024). Metacognitive self-knowledge and cognitive skills in project-based learning of high school electronics students. European Journal of Engineering Education, 50(1), 214–229. https://doi.org/10.1080/03043797.2024.2374479

[10] Almulla, M. A. (2020). The effectiveness of the project-based learning (PBL) approach as a way to engage students in learning. SAGE Open, 10(3). https://doi.org/10.1177/2158244020938702

[11] Aini, Q., Lesmono, A. D., & Wahyuni, S. (2018). Hasil belajar, minat dan kreativitas siswa SMA pada pembelajaran fisika menggunakan model project based learning dengan memanfaatkan bahan bekas. Jurnal Pembelajaran Fisika, 7(1), 1–7. https://doi.org/10.19184/jpf.v7i1.7218

[12] Roziqin, M. K., Lesmono, A. D., & Bachtiar, R. W. (2018). Pengaruh model pembelajaran berbasis proyek (project based learning) terhadap minat belajar dan keterampilan proses sains siswa pada pembelajaran fisika di SMAN Balung. Jurnal Pembelajaran Fisika, 7(1), 108–115. https://doi.org/10.19184/jpf.v7i1.7232

[13] Fauziah, C., Nuvitalia, D., & Saptaningrum, E. (2018). Model Project Based Learning (PjBL) berbasis lesson study terhadap kemampuan berpikir kreatif siswa SMA. Jurnal Penelitian Pembelajaran Fisika, 9(2), 125–132. https://doi.org/10.26877/jp2f.v9i2.3170

[14] Hamidah, I., & Citra, S. Y. (2021). Efektivitas model pembelajaran Project Based Learning (PjBL) terhadap minat dan hasil belajar siswa. BIOEDUSAINS: Jurnal Pendidikan Biologi dan Sains, 4(2), 307–314. https://doi.org/10.31539/bioedusains.v4i2.2870

[15] Sumo, M., Jatmiko, B., & Supardi, Z.A.I. (2024). Profile of scientific creativity based on project based learning of physics education undergraduate students: Preliminary research. JIPF (Jurnal Ilmu Pendidikan Fisika), 9(3), 377–386. https://doi.org/10.26737/jipf.v9i3.5802

[16] Sugiyono. (2019). Metode penelitian kuantitatif, kualitatif dan R&D. Alfabeta.

[17] Coletta, V. P., & Steinert, J. J. (2020). Why normalized gain should continue to be used in analyzing preinstruction and postinstruction scores on concept inventories. Physical Review Physics Education Research, 16(1), Article 010101 1-7. https://doi.org/10.1103/PhysRevPhysEducRes.16.010108

[18] Mahfudz, H. U. T., Inayah, N., & Yanti, A. W. (2025). Model Project-Based Learning untuk peningkatan pemahaman konsep gerhana langit siswa kelas VII MTs. Jurnal Basicedu, 9(6), 1926–1937. https://doi.org/10.31004/basicedu.v9i6.10939

[19] Naushabekov, Z., Maxutov, S., Mansurova, A., & Japashov, N. (2025). Effect of project-based learning on middle school students' conceptual understanding of mechanics: A quasi-experimental study. European Journal of Science and Mathematics Education, 13(3), 225–237. https://doi.org/10.30935/scimath/16826

[20] Sutaryani, L. G., Pujani, N. M., & Tika, I. N. (2024). Project-based learning on science process skills and learning outcomes in high school physics: A quasi-experimental study on the topic of fluids. Journal of Education Research and Evaluation, 8(4), 806–815. https://doi.org/10.23887/jere.v8i4.83769

[21] Junaidi, A. M., Hamidy, R. R., & Karomi, K. (2022). Project based learning menggunakan pendekatan higher order thinking skills (HOTS) untuk meningkatkan kemampuan mahasiswa abad 21 di Universitas Gunung Rinjani. Palapa, 10(2), 361–375. https://doi.org/10.36088/palapa.v10i2.2181