Journal of Informatics and Vocational Education (JOIVE)
Vol.8, No.3, Nov 2025, pp. 1~7
ISSN: 2746-7813

The Effect of Interactive Multimedia Use in Problem-Based Learning on Learning Outcomes

Muhammad Aldy Faturrohman[1], Basori[2], Febri Liantoni[3]
[1,2,3] Department of Informatics Education, Universitas Sebelas Maret, Indonesia

Article Info

Article history:

Received July 2, 2025
Revised Oct 10, 2025
Accepted Nov 1, 2025

Corresponding Author:

Muhammad Aldy Faturrohman,
Basori, Febri Liantoni,
Universitas Sebelas Maret
Jl. A. Yani No.200, Dusun II,
Pabelan, Kec. Kartasura,
Kabupaten Sukoharjo, Jawa
Tengah 57161
Email:
maldyfaturrohman03@gmail.co
c
febri.liantoni@staff.uns.ac.id
basori@staff.uns.ac.id

ABSTRACT

The low learning outcomes and problem-solving abilities of vocational high school students in Banyudono in the subject of Informatics indicate the need for the application of more effective learning strategies based on interactive multimedia. This study aims to analyze the effect of problem-based learning (PBL) assisted by interactive multimedia on the Informatics learning outcomes of vocational high school students in Banyudono, given the limited empirical research that examines the integration of these two approaches in the context of regional vocational high schools. This study uses a quantitative approach with a quasi-experimental non-equivalent control group design. The sample was determined through proportional stratified random sampling involving experimental and control classes. Data were collected through pretest and posttest, then analyzed using normality test, homogeneity test, balance test, hypothesis test, and N-Gain test. The results showed that PBL learning assisted by interactive multimedia provided a significant improvement in learning outcomes compared to conventional learning. The average posttest score of the experimental class reached 85.45 and was higher than that of the control class, even though the pretest score of the control class was relatively higher. The N-Gain score of the experimental class was in the moderate to high category. These findings indicate that PBL assisted by interactive multimedia is effective in improving the learning outcomes of vocational high school students in Banyudono.

Keywords: Multimedia Interaction, Problem-Based Learning, Learning Outcome

1. INTRODUCTION

In the era of globalization, improving student learning outcomes has become a critical priority in education systems worldwide (Wibisono, 2020).. Recent international assessments, including the Programme for International Student Assessment (PISA) 2022, indicate that Indonesian students continue to perform below the OECD average in reading, mathematics, and science, highlighting persistent challenges in learning effectiveness (OECD, 2023). These challenges are more pronounced in semi-rural areas such as Banyudono, where preliminary observations in vocational high schools (SMK) reveal that Informatics instruction is still largely teacher-centered, with limited use of interactive multimedia to support problem-solving activities. As a result, students often experience difficulties in understanding abstract concepts and applying knowledge in real-world contexts.

Although access to education in Indonesia has improved, disparities in learning outcomes between urban and non-urban regions remain significant. Factors such as limited instructional resources, varying teacher competencies, and suboptimal implementation of student-centered learning models contribute to these gaps (Yudiana et al., 2023). Previous studies have demonstrated that problem-based learning (PBL) and interactive multimedia independently enhance student engagement and conceptual understanding. However, empirical studies that integrate PBL with interactive multimedia in vocational education, particularly in SMK settings in Banyudono, are still scarce. Existing research has predominantly focused on general secondary education or

urban contexts, leaving a clear research gap regarding the effectiveness of this integrated approach in resource-limited vocational schools.

The use of interactive multimedia in learning offers several significant advantages, particularly in enhancing student engagement and conceptual understanding (Mališů & Šaloun, 2020). Interactive multimedia enables the presentation of learning materials through visual, audio, and interactive elements, which can help students grasp abstract concepts more effectively and maintain learning motivation (Kafle, 2024). In addition, it supports self-paced learning and accommodates diverse learning styles, aligning with the principles of differentiated instruction. However, interactive multimedia also presents certain limitations, including dependence on technological availability, infrastructure readiness, and teachers' competence in designing and managing digital learning media (Andini & Hadi, 2020). In educational settings with limited resources, challenges such as restricted access to devices, unstable internet connectivity, and increased preparation time may hinder optimal implementation.

Problem-based learning (PBL) has the primary strength of fostering students' critical thinking, problem-solving, and collaborative skills through the use of authentic, real-world problems (Abidin & Sulaiman, 2024). This approach encourages active learning by engaging students in inquiry, analysis, and knowledge construction, thereby making learning more meaningful (Rianto et al., 2025). Nevertheless, PBL also has weaknesses, such as requiring careful instructional planning, longer instructional time, and a high level of student readiness for independent and collaborative learning (Das et al., 2023). Without adequate guidance, students may experience confusion or difficulty in achieving learning objectives. Therefore, the integration of PBL with interactive multimedia must be carefully designed to maximize the strengths of both approaches while minimizing their limitations in classroom practice.

Therefore, this study seeks to address this gap by examining the impact of problem-based learning supported by interactive multimedia on students' learning outcomes in Informatics at the SMK level in Banyudono. The findings are expected to provide evidence-based insights for improving instructional practices and supporting more equitable and effective learning strategies in vocational education.

2. RESEARCH METHOD

This study uses a quantitative approach with an experimental design, namely a quasi-experiment with a non-equivalent control group design at a state vocational school in Banyudono. This approach was chosen to obtain the effect of a treatment in a more effective and practical way. Sampling was carried out using cluster sampling. This means that each group from the existing population has the same probability of becoming a research sample. In this study, the author selected two classes as samples: Class X TJKT 1 and Class X MPLB 1. The sample sizes for the control and experimental groups were 34 and 33 students, respectively. Data collection techniques included pre-tests and post-tests. Data analysis utilized normality tests, homogeneity tests, balance tests, hypothesis tests, and N-Gain tests.

This research falls under the category of quantitative research, as the approach used is descriptive quantitative, meaning that in quantitative research, data can be explained using precise figures (Darwin et al., 2021:13).

Table 1. Quantitative research design

Group	Pretest	Treatment	Posttest
Control	✓	Conventional method	✓
Experiment	✓	Multimedia interactive with PBL	✓

2.1. RESEARCH PROCEDURES

Data collection was conducted during class hours at SMK Negeri 1 in Banyudono. Data collection details were carried out using pretest and posttest methods. The pretest was conducted at the beginning of the lesson using questions that were in line with the learning indicators. After the intervention using interactive multimedia and problem-based learning for the experimental class in grade X MPLB 1 and conventional learning models for the control class in grade X TJKT 1, a posttest was conducted.

The analysis was conducted after data collection from samples using normality tests, homogeneity tests, balance tests, hypothesis tests, and N-Gain tests.

Therefore, the objective of this quantitative study is to describe the significance and influence of interactive multimedia use in the context of problem-based learning. Thus, this study employs a quantitative approach with a quasi-experimental design using a non-equivalent control group research pattern.

Before the test instrument was administered, its validity and reliability were examined to ensure the accuracy and consistency of the measurement. Item validity was analyzed using the Pearson product–moment correlation by correlating each item score with the total test score. An item was considered valid if the obtained correlation coefficient exceeded the critical value at a significance level of 0.05, indicating that the item was able to measure the intended construct. Furthermore, instrument reliability was assessed using Cronbach's alpha to evaluate the internal consistency of the test items. A Cronbach's alpha coefficient greater than 0.70 indicated that the instrument had acceptable reliability and that the items consistently measured students' learning outcomes. The results of these analyses confirmed that the test instrument met the required validity and reliability criteria and was therefore appropriate for use in data collection.

3. RESULT AND ANALYSIS

One of the responsibilities that teachers must carry out at school is to provide support to students so that they can become students who are in line with the school's vision. Through education, teachers contribute to many aspects of life, including school, social, cultural, and economic aspects. Throughout the entire educational process, teachers play a major role as educators. Teachers have various roles to carry out, where they must perform their duties and be responsible for the learning outcomes of children through interaction in the teaching and learning process.

3.1. RESULT

3.1.2. PRE-TEST

Table 2. Data description pretest

Data statistic	Control	Experiment
Average	45.28	42.12
Lowest value	20	20
Highest value	80	60
Standard deviation	16.91	11.92
Variance	286.27	142.23

A pre-test was administered prior to the treatment to identify students' initial abilities in Informatics learning (Blanco et al., 2022). The descriptive statistics of the pretest scores are presented in Table 2. The results indicate that the control class had a slightly higher mean score than the experimental class, suggesting that students in the control group possessed marginally better initial knowledge. However, the relatively large standard deviation in the control class reflects a wider dispersion of scores, indicating greater variability in students' initial abilities compared to the experimental class.

3.1.3. POST-TEST

Table 3. Data description posttest

Data statistic	Control	Experiment
Average	64.11	85.45
Lowest value	40	50
Highest value	90	100
Standard deviation	15.2	10.63
Variance	231	113

The post-test was conducted to measure students' learning outcomes after the implementation of the instructional treatments (Siregar et al., 2023). As shown in Table 3, the experimental class achieved a substantially higher mean posttest score than the control class. This finding indicates that students who learned through problem-based learning supported by interactive multimedia demonstrated superior learning outcomes compared to those who received conventional instruction. In addition, the lower standard deviation in the experimental class suggests more consistent learning achievement among students.

3.2. PREREQUISITE TEST

Prerequisite tests in research are a series of tests conducted before performing the main analysis to ensure that the data used meets the assumptions required by the statistical method to be applied. The purpose

of prerequisite tests is to verify that the data meets the criteria required to use a particular analysis technique, so that the results obtained are valid and can be interpreted correctly.

3.2.1. NORMALITY TEST

Table 4. Normality test result

Data	Category	Sig (0.05)	Conclusion
Pretest	Control	0.016	Abnormal
	Experiment	0.016	Abnormal
Posttest	Control	0.053	Normal
	Experiment	0.001	Abnormal

Prior to hypothesis testing, prerequisite tests were conducted to ensure the appropriateness of the statistical analysis. The results of the normality test using the Shapiro–Wilk method are summarized in Table 4 (Manik et al., 2023).

3.2.2 HOMOGENEITY OF VARIANCE

Table 5. Homogeneity of variance test result

Category	Result	Balance test	Conclusion
Pre-test (Control vs. Experiment)	0.007	0.007 < 0.05	not homogeneous
Post-test (Control vs. Experiment)	0.03	0.03 < 0.05	not homogeneous

The findings reveal that most of the pretest and posttest data were not normally distributed. Furthermore, the homogeneity of variance test using Levene's test, as presented in Table 5, indicates that the variances between the control and experimental groups were not homogeneous. These results justify the use of non-parametric statistical tests in subsequent analyses (Zimmerman, 2014).

3.2.3 BALANCE TEST

To examine the equivalence of the groups before treatment, a balance test was conducted using the Mann–Whitney U test. As shown in Table 6, the pretest scores of both groups did not differ significantly, indicating that the control and experimental classes were statistically balanced at the outset of the study (Akbar et al., 2024).

Table 6. Balance test result

Result	Balance test (data pre-test)	Conclusion
0.569	0.569 > 0.05	Balance

3.3 HYPOTHESIS TEST

Table 7. Hypothesis test result

Result	Mann-Whitney U test (data post-test)	Conclusion
0.000	0.000 < 0.05	The alternative hypothesis is accepted

Hypothesis testing was performed using the Mann–Whitney U test on the posttest scores due to the non-normal data distribution. The results presented in Table 7 demonstrate a significant difference between the two groups, leading to the acceptance of the alternative hypothesis. This finding confirms that the application of problem-based learning integrated with interactive multimedia had a significant effect on students' learning outcomes.

3.4 N-GAIN TEST

Table 8. N-Gain test result

Category	N-Gain	N-Gain	Conclusion
Control	0.3445	34%	Increasing moderately

Experiment	0.7469	74%	Increasing higly

Finally, the magnitude of learning improvement was analyzed using the N-Gain test. As shown in **Table 8**, the experimental class achieved a high N-Gain category, while the control class showed only a moderate improvement. This result indicates that problem-based learning supported by interactive multimedia was more effective in enhancing students' learning progress than conventional learning methods.

3.5. ANALYSIS

Based on the results obtained from the pretest and posttest in the experimental and control classes, the use of interactive multimedia and problem-based learning showed a significant effect on improving student learning outcomes. In the experimental class that implemented the problem-based learning (PBL) model with interactive multimedia, students experienced more consistent and significant improvements compared to the control class that used conventional learning. This is reflected in the significant difference between the average pretest and posttest scores in both classes.

The improvement in learning outcomes in the experimental class was also evident in the posttest score distribution, which was more concentrated in the high score range (83-100), indicating the effectiveness of the learning model used. In contrast, the more even distribution of posttest scores in the control class indicated greater variation in student achievement. These findings align with the results of several studies on the impact of interactive multimedia in learning, which show that multimedia can enhance student engagement and facilitate a deeper understanding of the material (Setyowati et al., 2020; Turku, 2024).

The use of interactive multimedia not only makes the material more interesting, but also provides opportunities for students to actively interact with the lesson material, thereby deepening their understanding. This is in line with constructivist theory, which states that students learn better when they are actively involved in the learning process (Cheuk et al., 2020; Kazmagambet et al., 2020).

The findings of this study have important practical implications for vocational high school (SMK) teachers, particularly in supporting the implementation of the Merdeka Curriculum, which emphasizes student-centered learning, competency development, and contextual problem solving. Problem-based learning supported by interactive multimedia can be flexibly adapted to classroom settings with limited resources through the use of simple multimedia tools, such as instructional videos, interactive PowerPoint presentations, or free and open-source applications accessible via school devices or students' personal smartphones. Teachers can design authentic, work-related problems aligned with vocational competencies, enabling Informatics learning to focus not only on conceptual understanding but also on the development of critical thinking and problem-solving skills. Moreover, this approach aligns with the principle of differentiated instruction promoted in the Merdeka Curriculum, as interactive multimedia allows students to learn at their own pace and according to their individual learning styles. With careful instructional planning, the integration of problem-based learning and interactive multimedia can be implemented incrementally without requiring costly technological infrastructure, while simultaneously enhancing instructional effectiveness and improving students' workplace readiness.

4. CONCLUSION

This study reveals a significant difference in student learning outcomes in Informatics between the experimental and control classes. Although the average pretest score of the control class was slightly higher than that of the experimental class, the posttest results indicate a much greater improvement in the experimental class. The experimental class achieved an average posttest score of 85.45, compared to 64.11 in the control class. This significant improvement suggests that problem-based learning, when supported by interactive multimedia, is more effective in enhancing student learning outcomes.

However, the difference in pretest scores between the two groups should not be interpreted as a limitation of the study, but rather as an inherent characteristic of the quasi-experimental design employed. Although the initial abilities of the groups were not fully equivalent, the substantial improvement observed in the experimental group's posttest scores provides strong empirical evidence of the positive impact of the applied instructional approach. Furthermore, the high N-gain value of 74% achieved by the experimental class indicates a significant learning improvement, thereby reinforcing the effectiveness of problem-based learning integrated with interactive multimedia in enhancing student performance.

To further illustrate this improvement, a closer look at the distribution of posttest scores reveals that the majority of scores in the experimental class concentrated in the higher score range (83–100), with the frequency table (Table 2 and Table 3) clearly showing a higher percentage of students achieving scores above

80 compared to the control class. This concentration in the higher score range reinforces the argument that the use of interactive multimedia in problem-based learning helps students to better understand the material and achieve higher learning outcomes.

In summary, while the groups were not balanced at the pretest stage, the posttest results, particularly in the experimental class, demonstrate the effectiveness of the teaching method. The improvements observed highlight the value of combining interactive multimedia with problem-based learning to enhance student performance.

Future research is recommended to extend the scope of this study by involving larger and more diverse samples across different schools and regions to enhance the generalizability of the findings. Subsequent studies may also employ a true experimental design with randomized group assignment to further control initial ability differences and strengthen causal inference. In addition, future investigations could explore the long-term effects of problem-based learning supported by interactive multimedia on students' problem-solving skills, learning retention, and higher-order thinking abilities. Examining the integration of this approach with different types of interactive multimedia and instructional technologies, as well as its application in other subject areas, would also provide a more comprehensive understanding of its effectiveness in varied educational contexts.

ACKNOWLEDGEMENTS

The researcher would like to express sincere gratitude to Sebelas Maret University for its support and the opportunity to conduct this research. Special thanks are also extended to SMK Negeri 1 Banyudono for providing the necessary resources and access for data collection. The researcher is grateful to the participants of this study, including the students of class X TJKT 1 and X MPLB 1, for their valuable contributions.

The researcher realizes that this research is far from perfect due to the limitations of the researcher. Nevertheless, the researcher hopes that this thesis will be useful for readers and the development of science.

.

REFERENCES

Abidin, Z., & Sulaiman, F. (2024). The Effectiveness of Problem Based Learning on Students' Ability to Think Critically. *Zabags International Journal of Education*, *2*(1), 1–6. https://doi.org/10.61233/zijed.v2i1.13

Akbar, R., Sukmawati, U. S., & Katsirin, K. (2024). Analisis Data Penelitian Kuantitatif. *Jurnal Pelita Nusantara*, *1*(3), 430–448. https://doi.org/10.59996/jurnalpelitanusantara.v1i3.350

Alvarez Blanco, M., Van Vlierberghe, P., Rossetti, M., Janssens, K., Peeters, B., & Desmet, W. (2022). Pre-test analysis to reproduce random pressure fields with multi-channel acoustic control. *Mechanical Systems and Signal Processing*, *163*, 108103. https://doi.org/10.1016/j.ymssp.2021.108103

Andini, S., & Hadi, A. (2020). Effect Student and Teacher Response to the use of Interactive Multimedia in the Learning Process. *Jurnal KomtekInfo*, *7*(4), 302–306. https://doi.org/10.35134/komtekinfo.v7i4.92

Cheuk, S., Nichol, E., Marsidi, A., Ali, S. S. S., Sahari, S., Jakpar, S., Tinggi, M., Yusof, S. M., Mohamed, A. S., Lee, D., & Janang, J. (2020). Service Learning in a Malaysian Undergraduate Tax Class. *International Journal of Academic Research in Progressive Education and Development*, *9*(2). https://doi.org/10.6007/IJARPED/v9-i2/7963

Darwin, M., Mamondol, M. R., Sormin, S. A., Nurhayati, Y., Tambunan, H., Sylvia, D., Adnyana, I. M. D. M., Prasetiyo, B., Vianitati, P., & Gebang, A. A. (2021). *METODE PENELITIAN PENDEKATAN KUANTITATIF* (T. S. Tambunan, Ed.; pp. 13–14). Media Sains Indonesia.

Das, S., Nandgaonkar, V., Eklarker, R., Balkhande, B. W., & Pande, S. D. (2023). *Exploring the Dynamics of PBL-Based Learning* (pp. 146–158). https://doi.org/10.4018/978-1-6684-9472-1.ch009

Gep Rianto, Reza Hanafi, & Gusmaneli Gusmaneli. (2025). Strategi Pembelajaran Inkuiri untuk Meningkatkan Keterampilan Berpikir Kritis Siswa. *Edukasi Elita : Jurnal Inovasi Pendidikan*, *2*(2), 300–309. https://doi.org/10.62383/edukasi.v2i2.1512

Kafle, R. (2024). Interactive Multimedia in Teaching Physics Concepts Effectively. *Journal of Nepal Physical Society*, *10*(1), 29–36. https://doi.org/10.3126/jnphyssoc.v10i1.72833

Kazmagambet, B., Ibraimova, Z., & Kaymak, S. (2020). THE EFFECT OF ACTIVE LEARNING METHOD ON STUDENTS' ATTITUDE TOWARDS MATHEMATICS. *Proceedings of International Young Scholars Workshop*, *9*. https://doi.org/10.47344/iysw.v9i0.219

Malasasari Siregar, T., M.G. Siahaan, B., Nova Enjelika, T., Endayanti Simbolon, M., & Maruli Siringo-ringo, R. (2023). Pengaruh Pemberian Pre-Test dan Post-test pada Mata Pelajaran Matematika dalam Keberhasilan Evaluasi Pembelajaran di SMA Swasta Cahaya Medan. *ULIL ALBAB : Jurnal Ilmiah Multidisiplin*, *3*(1), 396–401. https://doi.org/10.56799/jim.v3i1.2622

Mališů, P., & Šaloun, P. (2020). Multimedia and interactivity in educational materials. *Technium Social Sciences Journal*, *13*, 47–50. https://doi.org/10.47577/tssj.v13i1.1818

Manik, E., Affandi, A., Priadana, S., Hadian, D., & Puspitaningrum, D. A. (2023). *Comparison of normality testing with chi quadrat calculations and tables for the statistical value departement of elementary school education student at the University of Jember*. 020018. https://doi.org/10.1063/5.0111307

OECD. (2023). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*. OECD Publishing. https://doi.org/10.1787/53f23881-en

Setyowati, E., Hidayati, I. S., & Hermawan, T. (2020). PENGARUH PENGGUNAAN MULTIMEDIA INTERAKTIF TERHADAP PEMAHAMAN KONSEP DALAM PEMBELAJARAN MATEMATIKA DI MTs DARUL ULUM MUHAMMADIYAH GALUR. *Intersections*, *5*(2), 26–37. https://doi.org/10.47200/intersections.v5i2.553

Turku, M. (2024). Teaching and Learning English Literature Through Multimedia. *Academic Journal of Interdisciplinary Studies*, *13*(3), 279. https://doi.org/10.36941/ajis-2024-0080

Wibisono, Y. (2020). PENGEMBANGAN DAN IMPLEMENTASI KURIKULUM ISMUBA DI SMP MUHMAMMADIYAH PAKEM SLEMAN YOGYAKARATA. *At-Tajdid : Jurnal Pendidikan Dan Pemikiran Islam*, *3*(2), 167. https://doi.org/10.24127/att.v3i2.1124

Yudiana, K., Putri, N. N. C. A., & Antara, I. G. W. S. (2023). Kesenjangan Kemampuan Literasi Siswa Sekolah Dasar di Daerah Perkotaan, Pinggiran Kota, dan Pedesaan. *Jurnal Penelitian Dan Pengembangan Pendidikan*, *7*(3), 540–547. https://doi.org/10.23887/jppp.v7i3.69790

Zimmerman, D. W. (2014). Consequences of choosing samples in hypothesis testing to ensure homogeneity of variance. *British Journal of Mathematical and Statistical Psychology*, *67*(1), 1–29. https://doi.org/10.1111/bmsp.12001