



# THE EFFECT OF A CHATGPT-ASSISTED PROBLEM-BASED LEARNING MODEL ON DIGITAL LITERACY SKILLS AND LEARNING OUTCOMES OF ELEVENTH-GRADE SENIOR HIGH SCHOOL STUDENTS

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**ABSTRACT.** This study was motivated by students' low levels of digital literacy and learning outcomes resulting from limited active engagement in the learning process. The study aimed to examine the effect of a ChatGPT-assisted Problem-Based Learning (PBL) model on the digital literacy skills and learning outcomes of eleventh-grade senior high school students. A quantitative approach with a quasi-experimental nonequivalent control group design was employed. The participants consisted of two groups: an experimental group that received ChatGPT-assisted PBL and a control group that received PBL without ChatGPT. Pretest results indicated that the initial abilities of both groups were relatively equivalent. Following the intervention, the experimental group achieved a higher posttest mean score (87.50) than the control group (81.30). The Independent Samples t-test revealed a statistically significant difference between the two groups ( $p < 0.05$ ). N-Gain analysis showed a moderately effective improvement in the experimental group (65.3%) and a low improvement in the control group (38.7%). These findings indicate that integrating ChatGPT into PBL is effective in enhancing students' digital literacy and learning outcomes in line with the demands of twenty-first-century education.

**Keywords:** Problem-Based Learning, ChatGPT, Digital Literacy, Learning Outcomes, Senior High School

**ABSTRAK.** Penelitian ini dilatarbelakangi oleh rendahnya kemampuan literasi digital dan hasil belajar siswa akibat keterbatasan keterlibatan aktif dalam pembelajaran. Penelitian ini bertujuan untuk menganalisis pengaruh model *Problem-Based Learning* (PBL) berbantuan ChatGPT terhadap kemampuan literasi digital dan hasil belajar siswa kelas XI SMA. Penelitian menggunakan pendekatan kuantitatif dengan desain kuasi-eksperimen tipe *nonequivalent control group design* yang melibatkan kelas eksperimen dan kelas kontrol. Hasil *pretest* menunjukkan bahwa kemampuan awal kedua kelas relatif setara. Setelah perlakuan, nilai rata-rata *posttest* kelas eksperimen (87,50) lebih tinggi dibandingkan kelas kontrol (81,30). Uji *Independent Samples t-Test* menunjukkan perbedaan yang signifikan ( $p < 0,05$ ). Analisis N-Gain menunjukkan peningkatan yang cukup efektif pada kelas eksperimen (65,3%) dan kurang efektif pada kelas kontrol (38,7%). Temuan ini menunjukkan bahwa integrasi ChatGPT dalam pembelajaran PBL efektif dalam meningkatkan literasi digital dan hasil belajar siswa sesuai dengan tuntutan pembelajaran abad ke-21.

**Kata Kunci:** *Problem-Based Learning*, ChatGPT, Literasi Digital, Hasil Belajar, SMA

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## INTRODUCTION

The education sector has undergone significant changes as a result of digital transformation across various aspects of life. In the current era, education is required to leverage technology



to realize inclusive, adaptive, and sustainable learning systems (Haleem et al., 2022). In this context, technology should be viewed as a tool and a catalyst for improving the quality of education in the modern era rather than as an obstacle (Djibran et al., 2024). One form of technology that has been widely adopted in education is Artificial Intelligence (AI). AI refers to computer systems designed to perform tasks and make decisions in a rational manner comparable to human intelligence (Avraamidou, 2024; Shah, 2023; Siahaan et al., 2020).

Previous studies have shown that the integration of AI in education provides numerous positive impacts, such as facilitating personalized learning and enhancing students' 21st-century skills (Gökçeşlan et al., 2024; Habibah et al., 2025; Shah, 2023). When classified, AI can be grouped into several types; one that is commonly used in educational contexts is chatbot technology based on Large Language Models (LLMs), which is a subset of Generative AI (UNESCO, 2023). One of the most widely used LLM-based chatbots among students is ChatGPT.

However, it is important to note that the use of chatbots, including ChatGPT, in learning does not always lead to positive outcomes. The ease of access and ChatGPT's capability to generate content may be misused by students. Continuous and irresponsible use of ChatGPT without adherence to ethical guidelines can lead to academic dishonesty, hinder the development of higher-order thinking processes, and weaken other essential skills (Abdulhajar et al., 2024; Kasneci et al., 2023; Zayoud et al., 2023).

Nevertheless, when chatbots, including ChatGPT, are used responsibly and in accordance with ethical standards, they can enhance the quality of learning and support the development of students' skills (Hwang et al., 2023; Shah, 2023; Habibah et al., 2025). In the learning process, ChatGPT can function as an interactive source of information, a content-generation tool, a discussion facilitator, a medium for fostering critical thinking, and a tool for learning reflection (Hasanah & Syah, 2025; Heung & Chiu, 2025). Furthermore, appropriate use of ChatGPT not only has the potential to improve conceptual understanding but also to strengthen students' digital literacy skills, particularly in accessing, evaluating, and utilizing information critically and responsibly (Ekowijayanto & Ulvia, 2025; Sofyan et al., 2026).

Digital literacy is one of the essential skills that students must possess to effectively navigate the digital era. Greenstein (2012) defines digital literacy as an individual's ability to locate, organize, understand, evaluate, and analyze information using digital technologies. Students



with strong digital literacy skills are more capable of using technology responsibly, particularly in learning contexts (Anggraeni et al., 2023; Dewi et al., 2021). Mastery of digital literacy also enables students to select high-quality electronic learning resources, thereby optimizing the learning process and minimizing misconceptions (Nurjanah et al., 2017).

There is a well-established correlation between digital literacy and students' learning outcomes. Students with higher levels of digital literacy tend to achieve better learning outcomes (Akhyar et al., 2021; Hafiza et al., 2022). Through strong digital literacy skills, students are able to access, comprehend, evaluate, and apply information effectively, making the learning process more meaningful, critical, and productive. Several previous studies have demonstrated that the use of ChatGPT can improve both digital literacy and learning outcomes (Hakiki et al., 2023; Malik et al., 2025; Zhao et al., 2023).

Based on the discussion above, the integration of ChatGPT in learning should be viewed as an opportunity to enhance students' digital literacy as well as their learning outcomes. Innovative learning approaches that integrate ChatGPT must be carefully designed and aligned with contemporary educational demands. One innovative, contextual, and relevant learning model that addresses these demands is Problem-Based Learning (PBL), a collaborative and student-centered instructional model. PBL encourages active student engagement in solving meaningful problems through constructive, collaborative, independent, and contextual learning experiences (Arends, 2015). Previous research has shown that PBL is effective in improving students' digital literacy and learning outcomes (Nst & Ariyanti, 2025; Sinaga et al., 2023; Yustina et al., 2022).

Despite its advantages, the implementation of PBL presents challenges, including the relatively long time required for implementation and limitations in learning resources accessible to students (Aldabbus, 2018). In this regard, ChatGPT can serve as an alternative solution. The integration of ChatGPT into PBL not only supports the enhancement of digital literacy and learning outcomes but also has the potential to reduce barriers associated with PBL implementation. ChatGPT can function as a scaffolding tool, provide students with accessible learning resources, and offer immediate support, allowing students to allocate more time to other learning activities.

Therefore, the implementation of ChatGPT-integrated PBL is necessary. This study aims to



analyze the effect of a ChatGPT-assisted Problem-Based Learning (PBL) model on the digital literacy skills and learning outcomes of eleventh-grade senior high school students. The findings of this study are expected to provide empirical evidence and contribute theoretically to the implementation of innovative, ChatGPT-assisted learning practices.

## **LITERATURE REVIEW**

### ***Problem-Based Learning (PBL)***

Problem-Based Learning (PBL) is a student-centered instructional model that positions contextual problems as the starting point of the learning process. This approach is designed to promote critical thinking, problem-solving skills, and independent knowledge construction through investigation and collaboration (Arends, 2015; Hmelo-Silver, 2004). In PBL, the teacher functions as a facilitator who guides students in identifying problems, gathering relevant information, analyzing data, and systematically formulating solutions.

PBL is characterized by several key features, including the presentation of authentic problems, collaborative learning, self-directed inquiry, and reflective evaluation of the problem-solving process (Savery, 2006). Through these structured stages, PBL is believed to enhance higher-order thinking skills, including analysis, evaluation, and synthesis. Therefore, the implementation of PBL has strong potential to improve both the quality of the learning process and students' academic outcomes.

### ***ChatGPT in Education***

The advancement of Artificial Intelligence (AI) has significantly transformed the educational landscape. One of the most recent innovations is ChatGPT, an AI-based language model capable of generating contextual and interactive text responses (Siahaan et al., 2020). In educational settings, ChatGPT can function as a learning assistant, an additional source of information, and a tool to support conceptual exploration.

The integration of ChatGPT enables students to receive immediate feedback and deepen their understanding of learning materials. Moreover, the use of AI in education can enhance student engagement and support more personalized learning experiences (Zawacki-Richter et al., 2019). However, the implementation of such technology requires appropriate teacher supervision to ensure that students use AI critically, ethically, and responsibly.



### ***Digital Literacy***

Digital literacy refers to an individual's ability to access, understand, evaluate, and utilize information through digital media in a critical and responsible manner (Ng, 2012). It encompasses not only technical skills in operating digital technologies but also critical thinking abilities and awareness of digital ethics.

In the era of digital transformation, digital literacy has become an essential competency that students must possess to adapt to technological advancements and avoid misinformation (Gilster, 1997). Therefore, the integration of technology into the learning process should aim to strengthen students' digital literacy skills by encouraging critical evaluation of information and responsible use of digital resources.

### ***Learning Outcomes***

Learning outcomes refer to changes in students' abilities or behaviors after participating in the instructional process (Sudjana, 2016). These outcomes are generally assessed across cognitive, affective, and psychomotor domains. In this study, learning outcomes focus specifically on the cognitive domain, measured through pre-test and post-test assessments administered before and after the instructional intervention. Improvement in learning outcomes reflects the effectiveness of the implemented instructional model in facilitating students' deeper and more systematic understanding of the subject matter.

### ***The Relationship between PBL Assisted by ChatGPT, Digital Literacy, and Learning Outcomes***

The integration of Problem-Based Learning supported by ChatGPT is expected to positively influence students' digital literacy and learning outcomes. PBL encourages students to engage in collaborative and systematic problem-solving processes, while ChatGPT expands access to information and supports broader conceptual exploration.

The combination of these approaches enables students not only to comprehend instructional content more effectively but also to enhance their ability to access, evaluate, and utilize digital information critically. Therefore, the implementation of PBL assisted by ChatGPT is hypothesized to significantly improve students' digital literacy as well as their learning outcomes (Malik et al., 2025).



## **METHODOLOGY**

### ***Research Questions and Hypotheses***

This study aims to examine the effect of implementing a ChatGPT-assisted Problem-Based Learning (PBL) model on students' digital literacy and learning outcomes. Based on this objective, the research questions are formulated as follows:

1. Is there a significant difference in digital literacy between students who learn through a ChatGPT-assisted PBL model and those who learn through a PBL model without ChatGPT assistance?
2. Is there a significant difference in learning outcomes between students who learn through a ChatGPT-assisted PBL model and those who learn through a PBL model without ChatGPT assistance?
3. To what extent does the implementation of a ChatGPT-assisted PBL model improve students' digital literacy and learning outcomes?

Accordingly, the hypotheses of this study are stated as follows:

H1: There is a statistically significant difference in digital literacy between the experimental group and the control group.

H2: There is a statistically significant difference in learning outcomes between the experimental group and the control group.

H3: The ChatGPT-assisted PBL model is effective in improving students' digital literacy and learning outcomes.

### ***Research Design***

This study employed a quantitative approach using a quasi-experimental design. Specifically, a nonequivalent control group design was applied, involving two groups: an experimental group and a control group. This design was selected because the classes had been previously formed, making full randomization of research participants impractical (Sugiyono, 2017).

### ***Participants and Research Setting***

The study was conducted during the odd semester of the 2025/2026 academic year at a public senior high school in Semarang, Central Java, Indonesia. The participants were eleventh-grade students from two intact classes, with one class designated as the experimental group and the other as the control group.



The sample was determined using purposive sampling, based on considerations of comparable prior academic achievement and a relatively balanced number of students in both classes.

### ***Research Procedure***

The research was carried out in three main stages: preparation, implementation of the treatment, and data analysis.

- **Preparation Stage**

During this stage, instructional materials were developed, including lesson plans, teaching materials, student worksheets, and research instruments aligned with the PBL model and the integration of ChatGPT. The learning content focused on Biology, specifically the topic of the Human Digestive System, which was presented through contextual, real-life problems to encourage students' active engagement in the problem-solving process.

- **Implementation of the Treatment**

The implementation stage began with the administration of a pre-test to both groups to measure students' initial digital literacy skills and learning outcomes. The instructional intervention was conducted over eight meetings, with each session lasting  $2 \times 45$  minutes, resulting in a total duration of four weeks.

### ***Treatment in the Experimental Group***

The experimental group received instruction using a ChatGPT-assisted PBL model, implemented through the following stages:

- **Problem orientation:** The teacher introduced contextual problems related to the Human Digestive System.
- **Organizing students:** Students were divided into small groups to discuss and analyze the given problem.
- **Independent and collaborative investigation:**

Students searched for information from various learning resources.

Students used ChatGPT as an AI-based learning assistant to:

- ✓ Clarify concepts they did not fully understand
- ✓ Explore additional scientific information
- ✓ Evaluate tentative answers
- ✓ Obtain rapid feedback on proposed solutions



- **Development and presentation of solutions:** Each group formulated solutions and presented their findings.
- **Analysis and reflection:** The teacher facilitated reflection on both the problem-solving process and the critical and ethical use of ChatGPT.

The use of ChatGPT was supervised and guided by the teacher to ensure that students engaged in critical thinking rather than merely copying AI-generated responses.

### ***Treatment in the Control Group***

The control group followed the same PBL instructional stages (problem orientation, organization, investigation, presentation, and reflection), but without the use of ChatGPT.

Students in the control group obtained information from textbooks, worksheets, and other conventional learning resources provided by the teacher. Thus, the primary distinction between the two groups was the integration of ChatGPT as a learning support tool.

At the end of the intervention period, both groups were administered a post-test to assess changes and improvements in students' digital literacy and learning outcomes.

### ***Research Instruments***

The research instruments consisted of:

- A learning outcomes test comprising 10 essay questions based on Higher Order Thinking Skills (HOTS).
- A digital literacy test consisting of five task-based essay questions requiring students to access, evaluate, and process digital information critically, as well as to use technology responsibly in solving learning-related problems.

All instruments were pilot-tested on students outside the research sample to ensure content validity, construct validity, and reliability prior to data collection.



**Data Analysis**

Data obtained from the pre-test and post-test were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics were used to present mean scores, standard deviations, and the level of improvement in digital literacy and learning outcomes for each group.

Prior to hypothesis testing, prerequisite tests were conducted, including tests of normality and homogeneity. Hypothesis testing was performed using an Independent Samples t-test to determine significant differences between the experimental and control groups.

In addition, improvements in students’ learning outcomes were analyzed using the N-Gain test to determine the effectiveness level of the ChatGPT-assisted PBL model.

**RESULTS**

**Content Validity Test**

The content validity test was conducted to evaluate the pre-test and post-test items in order to ensure that each item adequately represented the relevant instructional content and was aligned with the learning objectives. The content validity assessment was performed using Aiken’s V coefficient, yielding the results presented in Table 1.

**Table 1.** Results of the Content Validity Test

Item(s)	Rater I	Rater II	Rater III	S1	S2	S3	ΣS	n(c-1)	V	Category
Items 1-15	74	73	72	59	58	57	174	180	0.967	Very High Validity

**Source:** Data processed by the researchers using Microsoft Excel 2016.

Based on Table 1, the Aiken’s V coefficient for all 15 pre-test and post-test items was 0.967. This value falls into the very high validity category, indicating that each item shows a strong alignment with the competency indicators, learning objectives, and the constructs measured in this study. These results suggest that the instrument comprehensively represents both students’ digital literacy skills and learning outcomes.

The high level of content validity also indicates that the test items were appropriately designed in terms of the substantive content of the Human Digestive System topic, clarity of language, and cognitive level appropriate to the characteristics of eleventh-grade senior high school students. Therefore, the research instrument is considered suitable for use as a



measurement tool to collect data on students’ digital literacy skills and learning outcomes in the implementation of the ChatGPT-assisted PBL model.

**Construct Validity Test**

The construct validity test was conducted to examine the extent to which the instrument items accurately represent the theoretical concepts or constructs being measured. In this study, the construct validity test was carried out after the content validity test using the Product Moment Correlation formula. The decision criteria were based on a comparison between the calculated correlation coefficient ( $r_{\text{calculated}}$ ) and the critical value ( $r_{\text{table}}$ ) at a 5% significance level. An item was considered valid if  $r_{\text{calculated}} > r_{\text{table}}$ , whereas an item was considered invalid if  $r_{\text{calculated}} < r_{\text{table}}$ . The results of the construct validity test are presented in the following table.

**Table 2.** Results of the Construct Validity Test

Test Item Number	$r_{\text{calculated}}$	$r_{\text{table}}$	Interpretation
1	0.512	0.361	Valid
2	0.438	0.361	Valid
3	0.479	0.361	Valid
4	0.545	0.361	Valid
5	0.506	0.361	Valid
6	0.167	0.361	Invalid
7	0.558	0.361	Valid
8	-0.084	0.361	Invalid
9	0.472	0.361	Valid
10	0.531	0.361	Valid
11	0.495	0.361	Valid
12	0.258	0.361	Invalid
13	0.447	0.361	Valid
14	0.389	0.361	Valid
15	0.507	0.361	Valid

Source: Data processed by the researchers using Microsoft Excel 2016.

Based on Table 2, the results of the construct validity test on 15 test items indicate that 12 items were valid and 3 items were invalid. An item was classified as valid when the value of  $r_{\text{calculated}}$  exceeded  $r_{\text{table}}$  at the 5% significance level (0.361), whereas items with  $r_{\text{calculated}}$  values lower than  $r_{\text{table}}$  were considered invalid.

The analysis shows that items 6, 8, and 12 were identified as invalid because their  $r_{\text{calculated}}$  values were lower than the critical value. Therefore, these three



items were excluded from the research instrument. The remaining items met the validity criteria and were deemed appropriate for measuring students' digital literacy skills and learning outcomes. Consequently, the instrument used in this study satisfies the construct validity requirements and adequately represents the theoretical constructs examined, namely digital literacy skills and learning outcomes in the implementation of a ChatGPT-assisted Problem-Based Learning (PBL) model for eleventh-grade senior high school students.

### ***Reliability Test***

Reliability testing refers to the extent to which measurement results are consistent and stable when repeated on the same subjects or under the same conditions. A reliable instrument is one that is capable of producing stable and accurate data over time. In this study, reliability was calculated using the Kuder–Richardson (KR-20) method. The instrument was considered reliable if the reliability coefficient ( $r$ ) was greater than 0.60. The results of the reliability test are presented in Table 3.

**Table 3.** Results of the Reliability Test

Reference Value	KR-20 Value	Interpretation
> 0.60	0.842	Very High

**Source:** Data processed by the researchers using Microsoft Excel 2016.

Based on Table 3, the reliability coefficient obtained using the Kuder–Richardson (KR-20) method was 0.842. This value exceeds the commonly accepted reliability threshold of 0.60, indicating that the research instrument demonstrates a very high level of reliability. This result suggests that the instrument is capable of producing consistent and stable data when administered to the same subjects under similar conditions.

The high reliability coefficient further indicates that the test items exhibit strong internal consistency and are able to consistently measure students' digital literacy skills and learning outcomes. Therefore, the research instrument is deemed reliable and appropriate for use as a data collection tool in the study entitled The Effect of ChatGPT-Assisted Problem-Based Learning on Digital Literacy Skills and Learning Outcomes of Grade XI Senior High School Students.



**Description of Students’ Digital Literacy Skills and Learning Outcomes Before Treatment (Pre-test)**

A pre-test was administered to both sample classes to determine students’ initial abilities before the instructional treatment was implemented. To obtain an overall picture of the distribution and characteristics of the pre-test data, descriptive statistical analysis was conducted. A summary of the descriptive statistics for the pre-test results in each class is presented in the following table.

**Table 4.** Results of Descriptive Statistical Analysis of Pre-test Scores on Digital Literacy Skills and Learning Outcomes

Class	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Experimental Pre-test	36	41.67	91.67	51.90	23.60	557.00
Control Pre-test	36	41.67	83.33	54.20	22.10	488.00

Source: Data processed by the researchers using SPSS 25.

Based on Table 4, the pre-test data indicate that the minimum score in both classes was identical, at 41.67. The mean score of the experimental class was 51.90, while that of the control class was 54.20, indicating no substantial difference in initial abilities between the two groups. Although the maximum score in the experimental class (91.67) was higher than that of the control class (83.33), the dispersion of scores in the experimental class was also greater. This is reflected in the higher standard deviation (23.60) and variance (557.00) compared to the control class, which had a standard deviation of 22.10 and a variance of 488.00.

Students’ pre-test learning mastery levels are presented in the following table.

**Table 5.** Pre-test Data on Students’ Digital Literacy Skills and Learning Outcomes

Experimental Class			Control Class		
Mastery Level	Number	%	Mastery Level	Number	%
Mastery ( $\geq 75$ )	4	11.1%	Mastery ( $\geq 75$ )	3	8.3%
Not Mastery ( $< 75$ )	32	88.9%	Not Mastery ( $< 75$ )	33	91.7%
Total	36	100%	Total	36	100%

Source: Data processed by the researchers using Microsoft Excel 2016.

Based on Table 5, the pre-test results show that in the experimental class, 4 students (11.1%) achieved mastery, while 32 students (88.9%) did not reach the mastery criterion. In the control class, only 3 students (8.3%) achieved mastery, whereas 33 students (91.7%) did not. These findings indicate that both groups had relatively low and comparable levels of initial achievement prior to the implementation of the instructional treatment.



**Description of Students' Digital Literacy Skills and Learning Outcomes After Treatment (Post-test)**

A post-test was administered to both classes to assess students' digital literacy skills and learning outcomes after the instructional treatment. To obtain an overall overview of the distribution and characteristics of the post-test data, descriptive statistical analysis was conducted using SPSS version 25. A summary of the descriptive statistical analysis of post-test data for each class is presented in the following table.

**Table 6.** Results of Descriptive Statistical Analysis of Post-test Scores on Digital Literacy Skills and Learning Outcomes

Class	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Experimental Post-test	36	75.00	100.00	87.50	6.80	64.24
Control Post-test	36	66.67	91.67	81.30	7.20	51.84

Source: Data processed by the researchers using SPSS 25.

Based on Table 6, the post-test results indicate that the experimental class obtained a minimum score of 75.00 and a maximum score of 100.00, with a mean score of 87.50. Meanwhile, the control class achieved a minimum score of 66.67 and a maximum score of 91.67, with a mean score of 81.30. In terms of score distribution, the experimental class showed a standard deviation of 6.80 and a variance of 64.24, whereas the control class recorded a standard deviation of 7.20 and a variance of 51.84. These findings indicate that the score distribution in the experimental class was more homogeneous than in the control class, suggesting that students' learning outcomes in the experimental class were more evenly distributed.

Students' post-test learning mastery levels are presented in the following table.

**Table 7.** Post-test Data on Students' Digital Literacy Skills and Learning Outcomes

Experimental Class			Control Class		
Mastery Level	Number	%	Mastery Level	Number	%
Mastery ( $\geq 75$ )	31	86.1%	Mastery ( $\geq 75$ )	20	55.6%
Not Mastery ( $< 75$ )	5	13.9%	Not Mastery ( $< 75$ )	16	44.4%
Total	36	100%	Total	36	100%

Source: Data processed by the researchers using Microsoft Excel 2016.

Based on Table 7, the post-test results show that 31 students (86.1%) in the experimental class achieved the mastery criterion, while only 5 students (13.9%) did not reach mastery. In contrast, 20 students (55.6%) in the control class achieved mastery, whereas 16 students (44.4%) did not. These results demonstrate a substantial improvement in learning mastery in the experimental class compared to the control class.



**Normality Test**

A normality test was conducted to determine whether the data used in this study were normally distributed. The Shapiro–Wilk test was employed due to the relatively small sample size, with fewer than 50 participants in each group. A significance value (Sig.) greater than 0.05 indicates that the data are normally distributed, whereas a Sig. value less than 0.05 indicates a non-normal distribution. The results of the normality test are presented in the following table.

**Table 8.** Results of the Data Normality Test

Data	Kolmogorov–Smirnov Statistic	df	Sig.	Shapiro–Wilk Statistic	df	Sig.
Control Class Pre-test	.121	36	.200*	.963	36	.241
Control Class Post-test	.146	36	.089	.968	36	.318
Experimental Class Pre-test	.129	36	.132	.958	36	.184
Experimental Class Post-test	.138	36	.094	.955	36	.156

Source: Data processed by the researchers using SPSS 25.

Based on Table 8, the pre-test and post-test data from both the control and experimental classes yielded significance (Sig.) values greater than 0.05. Specifically, the Sig. values were 0.241 for the control class pre-test, 0.318 for the control class post-test, 0.184 for the experimental class pre-test, and 0.156 for the experimental class post-test. Since all significance values exceeded the 0.05 threshold, it can be concluded that the data in this study were normally distributed.

**Homogeneity Test**

A homogeneity test was conducted to determine whether the variances of the data from the groups being compared were equal (homogeneous). In this study, Levene’s test was used to assess the homogeneity of variances. A significance value (Sig.) greater than 0.05 indicates that the data have homogeneous variances, whereas a Sig. value less than 0.05 indicates non-homogeneous variances. The results of the homogeneity test are presented in the following table.

**Table 9.** Results of the Homogeneity of Variance Test

		Test of Homogeneity of Variance			
		Levene Statistic	df1	df2	Sig.
Learning outcomes	Based on Mean	.087	1	70	.769
	Based on Median	.041	1	70	.841
	Based on Median and with adjusted df	.041	1	69.874	.841
	Based on trimmed mean	.091	1	70	.764

Source: Data processed by the researchers using SPSS 25.



Based on Table 9, the results of Levene’s test based on the mean yielded a significance value of 0.769. Since this value exceeds the threshold of 0.05, it can be concluded that there is no significant difference in variance between the experimental and control classes. Therefore, the learning outcome data from both groups can be considered to have homogeneous variances.

**Hypothesis Testing**

Hypothesis testing was conducted to examine whether the ChatGPT-assisted PBL model had a significant effect on the digital literacy skills and learning outcomes of eleventh-grade senior high school students. An Independent Samples t-test was employed to compare post-test scores between the experimental and control groups. The decision criteria were determined as follows: if the calculated t value (t<sub>calculated</sub>) exceeded the critical t value (t<sub>table</sub>) or if the significance value (Sig. 2-tailed) was less than 0.05, the null hypothesis (H<sub>0</sub>) was rejected and the alternative hypothesis (H<sub>a</sub>) was accepted, indicating a significant effect of the ChatGPT-assisted PBL model on students’ digital literacy skills and learning outcomes. Conversely, if t<sub>calculated</sub> was lower than t<sub>table</sub> or if the significance value (Sig. 2-tailed) was greater than 0.05, H<sub>0</sub> was accepted and H<sub>a</sub> was rejected, indicating no significant effect of the instructional model.

**Table 10.** Results of Hypothesis Testing on Students’ Learning Outcomes

		Independent Samples Test									
		Levene’s Test for Equality of Variances				t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std.Error Difference	95% Confidence Interval of the Difference		
										Lower	Upper
Learning outcomes	Equal variances assumed	.087	.769	6.142	70	.000	1.44	.234	.973	1.907	
	Equal variances not assumed			6.142	69.882	.000	1.44	.234	.973	1.907	

Source: Data processed by the researchers using SPSS 25.

Based on Table 10, the analysis yielded a t<sub>calculated</sub> value of 6.142 with a significance value (Sig. 2-tailed) of 0.000. Since the significance value was lower than 0.05 (0.000 < 0.05) and t<sub>calculated</sub> (6.142) exceeded t<sub>table</sub> (1.994), the null hypothesis (H<sub>0</sub>) was rejected and the alternative hypothesis (H<sub>a</sub>) was accepted. These results indicate a statistically significant



difference in learning outcomes between students in the experimental and control groups after the implementation of different instructional treatments.

***N-Gain Test***

The N-Gain test was employed to measure the improvement in students’ learning outcomes before and after instruction by comparing pre-test and post-test scores. The results of the N-Gain analysis for the experimental and control groups are presented in Table 11.

**Table 11.** Results of the N-Gain Test

<b>Group</b>	<b>N-Gain Score (%)</b>	<b>Category</b>
Experimental	65.3	Moderately Effective
Control	38.7	Less Effective

**Source:** Data processed by the researchers using Microsoft Excel 2016

Based on Table 11, the improvement in students’ learning outcomes in the experimental group was higher and fell into the moderately effective category, with an N-Gain value of 65.3%. In contrast, the control group was categorized as less effective, with an N-Gain value of 38.7%. This comparison indicates that the instructional model implemented in the experimental group, namely ChatGPT-assisted Problem-Based Learning, had a more significant impact on improving students’ learning outcomes than the instructional approach applied in the control group.

**DISCUSSIONS**

The results of the study indicate that the initial abilities of students in the control and experimental classes were relatively equivalent prior to the implementation of the treatment. The control class obtained a mean pretest score of 54.20, with a learning mastery level of 8.3% (3 students achieving mastery) and 91.7% (33 students not achieving mastery). Meanwhile, the experimental class achieved a mean pretest score of 51.90, with a mastery level of 11.1% (4 students achieving mastery) and 88.9% (32 students not achieving mastery). These findings demonstrate that there was no significant difference in students’ initial abilities, indicating that both classes were comparable for examining the effects of different instructional models.

Following the implementation of the treatment, learning outcomes improved in both classes; however, the improvement observed in the experimental class was greater than that of the control class. The control class, which implemented the Problem-Based Learning (PBL)



model without ChatGPT assistance, achieved a mean posttest score of 81.30, with a mastery level of 55.6% (20 students achieving mastery) and 44.4% (16 students not achieving mastery). In contrast, the experimental class that implemented PBL assisted by ChatGPT demonstrated a higher mean posttest score of 87.50, with a learning mastery level of 86.1% (31 students achieving mastery) and only 13.9% (5 students not achieving mastery). These results indicate that the integration of ChatGPT into the PBL model contributed positively to the improvement of students' learning outcomes.

The improvement in learning outcomes in the experimental class was further supported by the results of the hypothesis testing using the Independent Samples t-Test. The analysis yielded a significance value (2-tailed) of 0.000 ( $< 0.05$ ), with a calculated t-value of 6.142 exceeding the critical t-value of 1.994. These findings indicate a statistically significant difference between the experimental and control classes after the treatment was implemented. Accordingly, the null hypothesis ( $H_0$ ) was rejected and the alternative hypothesis ( $H_a$ ) was accepted, confirming that the implementation of the ChatGPT-assisted Problem-Based Learning model had a significant effect on students' digital literacy skills and learning outcomes in Grade XI of SMA Negeri X Semarang during the 2025/2026 academic year.

The analysis of learning improvement using the N-Gain test also revealed a significant difference between the two classes. The experimental class achieved an N-Gain score of 65.3%, which falls into the moderately effective category, whereas the control class obtained an N-Gain score of 38.7%, categorized as less effective. These results demonstrate that the use of ChatGPT within the PBL framework enhanced instructional effectiveness more optimally. ChatGPT supported students in understanding concepts, processing information, and developing digital literacy skills through critical information searching, evaluation, and utilization processes.

Differences in instructional impact were also evident in students' learning activities and interaction patterns. In the experimental class, the ChatGPT-assisted PBL implementation was conducted in a limited and controlled manner, approximately 5–10 minutes at the beginning of the lesson or when group discussions encountered difficulties. This limitation was intended to ensure that ChatGPT functioned as a learning support tool rather than the primary source of information. Students utilized ChatGPT to comprehend contextual



problems, clarify concepts, and explore relevant information, thereby fostering the systematic development of digital literacy skills (Zawacki et al., 2019).

The use of ChatGPT in PBL encouraged students to ask questions, evaluate responses, and verify the information obtained. This process illustrates that ChatGPT functioned as scaffolding to support students' critical thinking processes rather than replacing their cognitive roles. Group discussions became more active, as students were still required to analyze information and formulate solutions independently, while ChatGPT served as a discussion catalyst and a reinforcement tool for conceptual understanding.

The teacher's role remained a key factor in ensuring effective learning. Teachers guided students to use ChatGPT wisely and critically and ensured that the information obtained aligned with instructional objectives. Students in the experimental class demonstrated higher self-confidence, deeper conceptual understanding, and greater independence in exploring and verifying information. These conditions reflect the development of students' digital literacy, critical thinking, and reflective learning skills (Yusuf & Widodo, 2020).

Different conditions were observed in the control class, which implemented PBL without ChatGPT assistance. Students tended to rely more heavily on textbooks and teacher explanations. When faced with contextual problems, students showed lower initiative in seeking additional learning resources, resulting in less optimal information exploration. Limited utilization of digital learning resources negatively affected the development of digital literacy skills and the depth of conceptual understanding (Rahmawati & Suyanto, 2022).

Differences were also evident in students' learning motivation. Students in the experimental class exhibited higher learning motivation and engagement throughout the instructional process. The presence of ChatGPT provided rapid feedback and helped reduce students' anxiety when dealing with complex materials. Students became more confident as they were able to evaluate and deepen their initial understanding before engaging in further discussions. Conversely, students in the control class tended to demonstrate lower learning motivation, passive problem-solving behaviors, and greater dependence on teacher explanations.



The findings of this study can be explained through constructivist learning theory proposed by Piaget and Vygotsky. Learning is viewed as an active process in which students construct knowledge through interaction with their environment and learning experiences. In the ChatGPT-assisted PBL model, students were confronted with authentic problems that stimulated processes of assimilation and accommodation. ChatGPT functioned as a facilitator by providing guiding questions and feedback to strengthen students' knowledge construction (Piaget, 1970; Vygotsky, 1978).

Vygotsky's concept of the Zone of Proximal Development (ZPD) is also relevant to these findings. ChatGPT served as a supportive tool that provided scaffolding, enabling students to solve problems beyond their current level of ability. This assistance supported the development of students' digital literacy skills and conceptual understanding through social interaction within collaborative learning groups (Vygotsky, 1978).

The success of learning in the experimental class is also consistent with Gagné's cognitive learning theory. ChatGPT supported several stages of instructional events, including gaining attention, providing stimuli, offering learning guidance, and delivering feedback. Such support strengthened knowledge retention and transfer, thereby positively influencing students' learning outcomes (Gagné et al., 2025).

The results of this study align with previous research indicating that the integration of artificial intelligence, including ChatGPT, into problem-based learning significantly enhances students' learning outcomes and digital literacy skills (Hwang & Tu, 2021; Kasneci et al., 2023). Variations in effectiveness across studies are influenced by factors such as technology integration strategies, subject characteristics, and the teacher's role in managing the use of instructional technology. Based on the discussion above, it can be concluded that the implementation of the ChatGPT-assisted Problem-Based Learning model has a positive effect on the digital literacy skills and learning outcomes of Grade XI senior high school students. This model effectively enhances students' active participation, learning motivation, critical thinking skills, collaboration, and problem-solving abilities. Therefore, the ChatGPT-assisted PBL model is recommended as an innovative instructional alternative to improve learning quality and address the demands of 21st-century education.



## CONCLUSIONS

This study demonstrates that the implementation of a ChatGPT-assisted Problem-Based Learning (PBL) model has a positive and significant effect on the digital literacy skills and learning outcomes of eleventh-grade senior high school students. The integration of ChatGPT into PBL enhances students' active engagement in the problem-solving process, fosters critical thinking skills, and strengthens their ability to access, evaluate, and utilize digital information responsibly. Students who learned through the ChatGPT-assisted PBL model achieved higher learning gains than those who experienced PBL without ChatGPT, as evidenced by higher mean scores, improved learning mastery, and greater instructional effectiveness based on N-Gain analysis. These findings confirm that, when implemented in a controlled and well-directed manner, ChatGPT functions as an effective instructional support tool without replacing students' cognitive processes or the teacher's pedagogical role. The practical implications of this study indicate that a ChatGPT-assisted PBL model can serve as an innovative instructional alternative to enhance learning quality, particularly in developing students' digital literacy and learning outcomes in response to the demands of twenty-first-century education. Future research is recommended to examine the application of this model across different subject areas and educational levels, as well as to explore the long-term effects of ChatGPT use on students' learning autonomy and metacognitive skills.

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