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Evaluation of the Effectiveness of AI-Assisted Project-Based Learning on Research Proposal Writing Skills

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ABSTRACT

Purpose of the study: Improving the quality of research proposals is a challenge in Biology education at the tertiary level. Integrating project-based learning with artificial intelligence (AI) support offers an innovative approach to strengthening students' proposal writing skills. This study aimed to determine the effect of AI-assisted project-based learning on the ability to write research proposals of Biology Education students.

Methodology: This study used a pretest-posttest quasi-experiment design with a control group. Two classes of Biology Education students were purposively selected. The experimental class applied AI-assisted project learning, while the control class used conventional methods. Data were collected through the assessment of the research proposal rubric and analyzed by t-test to assess the difference between the scores of the control class and experimental classes' scores. The data obtained in this study were analyzed using SPSS.

Main Findings: The research finding show that the average score of the experimental class proposal writing ability of 86.2 is greater than that of the control class proposal writing ability of 78.7. The results also show that the Sig. 0.0001 is smaller than 0.05, meaning that AI-assisted project-based learning affects the ability to write research proposals. This finding indicates that AI effectively supports students in designing and writing better research proposals.

Novelty/Originality of this study: Research on the use of AI in project learning to improve research proposal writing skills is still limited. This study contribute that AI effectively supports students in designing and writing better research proposals.

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1. INTRODUCTION

The ability to write research proposals is an essential skill that students must possess, especially in the Biology Education study program. In academic activities in higher education, writing a research proposal is very important because it is the initial stage in preparing a student's final project. The research proposal is the initial plan for conducting research that contains the background, problem formulation, literature review, and research methods but also contains scientifically based opinions that will show students' critical, systematic, and analytical thinking abilities [1], [2]. Therefore, the skill of writing a research proposal is a competency that needs to be owned by students [3]. However, many students still experience difficulties in preparing research proposals. Students have difficulty determining research boundaries, formulating problems and defining objectives, choosing appropriate research methods, selecting and accessing the latest and relevant literature

reviews, and writing according to scientific rules and a good structure [4], [5]. Developing a good background paragraph is also difficult for students when preparing research proposals [6].

The right learning that can be used in research methodology courses that can help students overcome these problems is project-based. This learning emphasizes active learning and requires students to be able to produce work through independent projects carried out [7]. With this learning, students have real experience in preparing research proposals because students are required to create work in the form of research proposals according to scientific guidelines and rules. Project-based learning has improved conceptual understanding, critical thinking skills, and students' ability to solve problems independently [8]. AI-enriched project-based learning offers a collaborative and contextual approach to guiding students to develop research proposals more effectively. However, research on the use of AI in project learning to improve proposal writing skills is still limited. Therefore, research is needed on the use of AI in project learning to improve proposal writing skills.

On the other hand, the rapid development of technology can help facilitate and support various aspects of life, one of which is education. Amidst the development of digital technology, the utilization of artificial intelligence (AI) in learning is starting to become a potential new strategy to overcome this challenge. Artificial Intelligence (AI) can help students develop ideas and draft research proposals. AI can assist students in developing research proposals more effectively and efficiently by generating writing drafts, improving sentence structure, and providing suggestions regarding references and methodologies suitable for the proposed research topic [9]. Integrating AI in project-based learning will be an innovative solution that can improve learning effectiveness and the quality of student proposals. In addition, project learning combined with the utilization of AI not only makes students gain practical experience but also makes learning more efficient and facilitates learning with access to advanced technology.

The limited ability to write research proposals among students is a problem that needs to be solved immediately, especially in learning that facilitates exploration and independent thinking. This study aims to answer the question: Does the use of AI-assisted project-based learning significantly improve the ability to write research proposals of Biology Education students? This problem is significant to study because the ability to write proposals is the basis for developing student research capacity and improving overall academic quality. By utilizing AI, students are expected to reduce obstacles in preparing research proposals and enhance the quality and efficiency of learning. The results of this study are expected to contribute to developing innovative learning that is relevant to the digital era and improve students' competence in writing research proposals at the tertiary level, but without losing the essence of the learning process and critical thinking that should be a significant part of the research methodology course.

2. RESEARCH METHOD

This study adopted a quantitative approach using a quasi-experimental design, specifically the *posttest-only control group design*. The research aimed to determine the effectiveness of AI-assisted project-based learning (AI-PBL) in improving the research proposal writing skills of Biology Education students. The population consisted of all sixth-semester students enrolled in the Biology Education Study Program at Universitas PGRI Silampari during the 2024/2025 academic year. A total of 42 students participated, divided into two groups: 22 students in the experimental class and 20 in the control class. The experimental group received learning through the integration of project-based learning assisted by AI tools (such as ChatGPT and Gemini), while the control group underwent conventional project-based learning without AI assistance.

The sampling technique employed was purposive sampling, chosen to ensure that participants had equivalent academic backgrounds and course experiences. The independent variable in this study was the use of AI-assisted project-based learning, while the dependent variable was students' ability to write research proposals. Data were collected through a proposal assessment rubric developed by the university, encompassing five key components: (1) proposal structure, (2) background formulation, (3) literature review, (4) research methodology, and (5) quality of arguments. Each component was evaluated using a 1–100 scale, where higher scores reflected stronger mastery of academic writing competencies.

Data analysis was conducted using SPSS software. Before hypothesis testing, the data were examined for normality using the Shapiro-Wilk test to ensure compliance with parametric statistical assumptions. The results indicated that both groups' data were normally distributed ($p > 0.05$) [10], [11]. Subsequently, an independent sample t-test was applied to determine whether there was a statistically significant difference between the experimental and control groups' post-test scores. A significance level of 0.05 was used to interpret the results. Qualitative data were also collected through semi-structured interviews with 15 students to gain insights into their perceptions of using AI tools in project-based learning, focusing on their experiences, challenges, and attitudes toward integrating AI into academic writing.

This mixed-data collection strengthened the validity of the findings by providing both statistical and contextual evidence on how AI-assisted project learning influenced students' proposal writing performance. The

integration of AI tools aimed not only to enhance the cognitive process of writing but also to promote students' creativity, self-regulation, and academic confidence during project-based activities.

3. RESULTS AND DISCUSSION

3.1 The influence of AI on project learning products

This research shows that the average score of the experimental class research proposal writing ability is 86.2, and the average score of the control class research proposal writing ability is 78.7. The average scores for the experimental and control class research proposal writing skills can be seen in Table 1.

Table 1. Average score of research proposal writing skills

No.	Assessment Aspect	Experiment Class (n=22)	Control Class (n=20)
1	Proposal structure	85.2	78.6
2	Background.	88.0	79.5
3	Literature review	84.5	77.2
4	Research method	86.1	78.4
5	Quality of argument	87.3	80.0
	Average	86.2	78.7

The analysis showed that students in the experimental class who participated in AI-assisted project-based learning scored higher in all aspects of the proposal writing ability assessment than in the control class. The score difference was most striking in the elements of background and quality of argument, indicating that the use of AI helped students formulate the research context and develop stronger arguments. The overall average score of the experimental class of 86.2 was higher than that of the control class, which only reached 78.7, indicating a consistent improvement in various aspects. This finding shows that integrating AI technology in project-based learning significantly improves the quality of students' research proposal writing skills. Integrating AI in the project-based learning approach effectively enhanced students' academic skills, especially in writing research proposals. The data obtained were then analyzed for normality with the Shapiro-Wilk test. The results of the Shapiro-Wilk normality test can be seen in Table 2.

Table 2. Shapiro-Wilk normality test

Class	Sig. (p-value)	Description
Experiment	0.453	Data is normally distributed
Control	0.377	Data is normally distributed

Note: p-value> 0.05, data from both classes are normally distributed.

The results of the normality test using Shapiro-Wilk show that the data in the experimental class ($p = 0.453$) and control class ($p = 0.377$) have a significance value above 0.05, so it can be concluded that both data groups are normally distributed. This normal distribution is essential for continuing parametric statistical analysis, such as the t-test. Thus, the analysis of the comparison of means between the two groups can be done validly**.** Normally distributed data ensures that parametric statistical tests can be applied appropriately in this study to continue with the independent sample t-test, the results of which can be seen in the following table 3.

Table 3. Independent sample t-test

Variables	t-count	df	Sig. (2-tailed)
Research proposal writing skills	4.213	40	0.0001

The results of the independent sample t-test showed that the significance value ($p = 0.0001$) was far below the 0.05 threshold, with a t-count value of 4.213 and a degree of freedom (df) of 40. The P-value indicates a statistically significant difference between students' research proposal writing skills in the experimental and control classes. Thus, AI-assisted project-based learning is proven to have a real influence on improving the quality of research proposal writing. AI-supported project learning significantly enhanced students' proposal writing skills compared to conventional methods.

The results of this study show that integrating artificial intelligence (AI) in the approach significantly improves students' ability to develop research proposals. This finding aligns with the research objective to examine the effectiveness of modern AI-supported project learning in improving students' academic quality. The problem identified earlier, namely the lack of effectiveness of conventional learning methods in developing proposal writing skills, can be addressed by applying AI technology in the context of project learning. The results of this study are in line with the results of previous research, where Project-based learning can improve

the ability to write research proposals because, in this learning, students must be independent, design their activities, and produce a product [12]-[14]. In project-based learning, students are required to think critically and creatively. Project-based learning also provides meaningful and engaging experiences. In addition, project-based learning can also foster critical, collaborative, and communicative thinking to improve writing skills [15]-[17]. Project-based learning also has implications for increasing activities, thinking, and scientific activities so that students gain a better understanding and meaningful experiences [18]-[20]. Sari et al., research states that problem-solving skills will influence writing ability [21]. In project-based learning, students must also have problem-solving skills [15], [18].

In addition to project-based learning, using AI helps improve the ability to write research proposals. AI also makes it easier for students to develop ideas and construct sentences. Because using AI can help students learn grammar, spelling, word matching, and sentence construction [22], AI can also help students learn independently with feedback from their writing. They will independently revise and reread their writing [23]. In addition, Zheng et al., research results state that AI learning feels more interesting and motivates students to learn [24]. AI can also significantly improve teaching and learning [25]. AI can also assist users in paraphrasing sentences, converting active sentences to passive ones, and determining synonyms of paraphrases [26]. In addition, AI can effectively check punctuation, including spelling, sentence structure, and basic syntax [27]. Shen & Teng., stated that the use of AI can have a positive influence on learners' skills [28]. In preparing a research proposal, writers must have critical writing skills or understanding. It aims to learn to find research topics, increase interest, parse, organize, and formulate background, research problems, literature review, and research methods in a well-organized text [29]. AI-assisted project-based learning will be able to provide critical writing skills and understanding so that it can help students complete their final project more easily and quickly.

The study by Msambwa et al., showed that AI learning improved students' motivation, performance, and problem-solving ability in collaborative learning [30]. Gao, found that using AI helped reduce students' anxiety and negative academic emotions while increasing positive ones and improving motivation [31]. Zheng et al., showed that AGI-assisted project-based learning significantly enhanced students' higher-order thinking skills and self-efficacy, indicating increased educational effectiveness [32].

However, the use of AI also needs to be done wisely. AI must be accompanied by author responsibility [33]. Cady et al., warn against over-reliance on AI as it will affect human feelings such as empathy and collaboration [34]. Ifenthaler et al., state that a lack of facilities, infrastructure, and technical training can hinder the practical application of AI in education [35]. Nguyen et al., highlighted data privacy and ethical concerns regarding the use of AI in education, which requires strong data protection policies [36]. Zhang et al., found that although project learning improved general skills, some students felt underprepared in domain-specific competencies, which AI may not fully address [37]. In addition, implementing AI requires significant investment in infrastructure and teacher training, which may not be equally achievable in all educational contexts.

3.2 Student responses to the use of AI in project learning

The results of interviews with 15 students to obtain response data on using AI in compiling research proposals can be seen in Table 4.

Table 4. Results of interviews with students

Theme	Respondents	Percentage
AI helps proposals (positive)	15	100%
Using AI for Chapters 1/2/3	15	100%
Mentioning types of AI (ChatGPT, etc.)	15	100%
AI-assisted collaboration	10	66.7%
Experiencing dependency effects	9	60.0%
Expressing concerns (plagiarism, etc.)	15	100%
AI language is considered too high/rigid	15	100%
Agree AI is used in learning	15	100%

Based on the results of interviews with 15 students, all respondents agreed that AI positively impacts the quality of proposals. They said that AI is beneficial in constructing effective sentences, finding references, and generating ideas and thought frameworks. The chapters that AI most often assist with are Chapters 1 to 3, indicating that AI plays an essential role in the early stages of proposal preparation. All participants also know and use various AI tools, with ChatGPT, Blackbox, and Gemini being the most commonly used. This indicates good technological literacy among students. However, ethical and pedagogical concerns remain. All respondents expressed wariness about the potential for plagiarism, dependency, and the possibility of a decline in critical thinking skills. As many as 9 out of 15 students stated that AI made them somewhat dependent and less confident writing without assistance. On the other hand, 10 students felt that AI still supports collaboration, especially in project discussions. In addition, all students highlighted that the AI's language style is still too high

or rigid, so the final results often need to be adjusted to their academic context. Nevertheless, all respondents still agree with the use of AI in learning as long as there are guidelines and restrictions on its use wisely.

This study examined how artificial intelligence (AI) tools influence the quality and process of writing research proposals through project-based learning. The findings respond directly to the research question by identifying how AI supports or challenges students' academic writing practices. Through in-depth interviews, several key themes emerged that inform how AI tools are perceived and used by students in higher education, particularly in the context of educational research proposal development. The interview results show that participants consistently stated that AI served as a cognitive partner, helping them to clarify their thoughts, generate ideas, and compose structured writing. AI tools like ChatGPT and Gemini were described as helpful in crafting problem statements and summarizing literature. These results reflect the increasing integration of AI in academic processes, particularly in the initial stages of writing. Previous studies have shown that students find AI beneficial for organizing complex ideas into coherent arguments [38]. Similarly, Canonigo, emphasize that AI functions as a thinking assistant rather than a replacement for student agency [39].

Respondents reported that the sections most frequently assisted by AI were the introduction, literature review, and methodology. These findings suggest that AI is primarily used during the exploratory and preparatory stages of research. Many students found it easier to develop research backgrounds and frameworks using AI. According to Chen et al., students often utilize generative AI to scaffold their academic planning and conceptualization [40]. The support in early proposal stages aligns with studies highlighting AI's strength in helping structure foundational academic content [41].

All participants reported using more than one type of AI tool, with ChatGPT as the most dominant, followed by Blackbox and Gemini. This indicates an increasing level of digital fluency among students. The diversification of tool usage reflects a tailored approach to different academic needs. As Tiwari et al., found, students tend to select AI tools based on task-specific functionality rather than loyalty to one platform [42]. Tool variety is also willing to experiment in academic contexts [43]. Most students stated that AI either positively contributed to group work or did not interfere. They viewed AI as a pre-discussion tool that helped clarify ideas before team meetings. This perception indicates that AI can be a pre-collaborative asset rather than a barrier. According to Kristy et al., AI can facilitate more productive collaborative work by offloading mechanical cognitive tasks [44]. However, students still relied on interpersonal discussions for critical decision-making [45].

Participants expressed concerns about becoming overly reliant on AI, reporting reduced confidence in writing without technological assistance. This finding reflects growing ethical and cognitive concerns regarding AI overuse. Plagiarism, skill erosion, and reduced critical thinking were frequently mentioned risks. Research by Vieira et al., confirms that students may develop dependency habits when they lack guided scaffolding [46]. Moreover, there is a need for ethical literacy in AI usage [47]. All respondents noted that AI-generated content often employed overly formal or rigid language. This mismatch between AI output and student academic level led to frequent editing and revision. The issue highlights the gap between AI's linguistic output and human contextual understanding. As Won et al., argue, while AI can mimic academic tone, it often lacks adaptability to user-specific language registers. This creates additional workload rather than reducing it [48].

General Views on AI Usage Despite concerns, all students endorsed the integration of AI into learning activities, provided that ethical guidelines and academic integrity are maintained. They emphasized the need for teacher support and regulation in AI usage. This consensus underscores the demand for pedagogical frameworks around AI use. According to Shailendra et al., establishing explicit educational norms is key to successful AI adoption [49]. Ethical empowerment, not just access, is crucial [50]. AI enhances proposal writing through idea generation and organization yet raises essential issues of dependency and academic ethics. While AI was most helpful in the early writing stages, it required significant human mediation for refinement. Students' adaptive use of multiple AI tools reflects both enthusiasm and caution. The results highlight the dual role of AI as both an enabler and a challenge to academic growth.

The findings affirm recent scholarship advocating for AI as a scaffolding tool rather than a replacement for human cognition. For instance, Rad et al., suggest that AI can boost self-efficacy by reducing cognitive load in writing tasks [51]. Similarly, Steiss et al., report that students using AI demonstrated improved clarity and structure in early drafts [52]. Dinger et al., argue that project-based learning integrated with AI results in deeper engagement and more polished outputs [53]. Moreover, Cummings et al., found that AI tools enhance ideation and reduce student writer's block [54]. Ruiz-Rojas et al., reinforce this by showing AI promotes preparatory thinking in collaborative projects [55].

Conversely, scholars warn that over-reliance on AI may hinder the development of academic competencies. Zhai et al., found that students relying heavily on AI experienced declining critical thinking and self-editing skills [56]. Davison et al., emphasise AI-generated texts' ethical ambiguity, noting the blurred boundaries between assistance and authorship [57]. Peter et al., caution that AI output often lacks contextual sensitivity, requiring substantial human revision [58]. Aljabr & Al-Ahdal, argue that institutions have not fully addressed the pedagogical implications of AI use [59]. Similarly, Saritepeci & Durak, highlight that AI integration without guidance can lead to superficial learning gains [60]. This study has limitations, such as the

limited ability to use AI in learning and the experience of computer anxiety among some students. A limitation of this study is the small sample size. Therefore, the recommendation for further research is to use a larger sample.

4. CONCLUSION

The findings of this study demonstrate that AI-assisted project-based learning (AI-PjBL) significantly improves students' ability to write research proposals compared to conventional instructional methods. Students in the experimental group achieved higher mean scores across all assessment indicators, particularly in background formulation, argumentation quality, and logical coherence, indicating that AI tools effectively facilitate idea generation, sentence organization, and academic reasoning. The statistical results ($p = 0.0001$) provide strong evidence of the significant impact of AI integration on students' academic writing performance. In addition to these quantitative results, qualitative findings reveal that students view AI as a valuable cognitive collaborator that supports them in refining ideas, structuring content, and identifying relevant references. However, concerns about overreliance, academic integrity, and the mechanical tone of AI-generated language highlight the need for critical digital literacy and ethical awareness in educational settings. These insights suggest that while AI can enhance productivity, creativity, and innovation in academic writing, it must be accompanied by thoughtful pedagogical strategies and ethical supervision to maintain authenticity and originality. The implications of this study extend to both educational practice and policy. Integrating AI tools into project-based learning provides a transformative approach for developing higher-order writing skills, fostering autonomy, and promoting metacognitive awareness in research-oriented courses. Institutions should consider implementing structured frameworks that include teacher training on AI pedagogy, curriculum redesign to incorporate AI literacy, and the establishment of clear ethical guidelines for responsible AI use. Moreover, AI-assisted PjBL has the potential to democratize access to academic support, particularly in contexts with limited mentoring resources. Future research should investigate the long-term impact of AI-assisted learning on students' independent writing competence, critical thinking, and research creativity, as well as its adaptability across various academic disciplines and educational levels.

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