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Enhancing Scientific Writing Proficiency Through the Problem-Based Learning Model: A Novel Approach in Academic Education

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ABSTRACT

Writing scientific papers is a critical academic skill that students must develop to express ideas derived from observation, research, or analysis in a structured and methodical manner. However, students often face challenges in mastering this skill. This study investigates the effectiveness of the Problem-Based Learning (PBL) model in improving students' ability to write scientific papers. The research employed Classroom Action Research (CAR), implemented in two cycles at MA Mizanul Ulum YW UMI Sanrobone. Each cycle followed the stages of planning, implementation, observation, and reflection. The study involved student participants who were observed through activity sheets and assessed through writing assignments. Data were analyzed using both qualitative and quantitative descriptive techniques. Findings indicate a notable improvement in students' scientific writing performance after the implementation of the PBL model. In Cycle I, the average student score was 64, indicating that most had not yet met the minimum competency standard. After refining the instructional approach in Cycle II, the average score increased significantly to 81, demonstrating that all students achieved the required level of competence. The results suggest that the PBL model fosters student engagement and enhances their ability to develop and organize scientific content effectively. By actively involving students in problem-solving tasks, the model promotes deeper understanding and better writing outcomes. Implementing the PBL approach significantly improved students' scientific writing skills and learning outcomes. This model is recommended for broader application in similar educational settings.

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1. INTRODUCTION

Writing is one of the fundamental language skills that students must master in formal education settings. As a productive skill, writing not only reflects a learner's linguistic competence but also serves as a primary indicator of academic achievement and intellectual development (Gill & Janjua, 2020; Salem, 2022). Among the various forms of writing taught in schools, scientific writing—or the ability to produce structured, evidence-based texts—plays a pivotal role in fostering critical thinking and academic expression. Mastery of scientific writing is particularly significant in secondary education, where students begin engaging with research-like activities that mirror academic and professional practices.

Scientific writing allows students to communicate their thoughts, observations, or research findings in a systematic and coherent manner. It involves adhering to standardized formats and linguistic conventions, which helps in developing logical thinking and clarity of expression (Cargill & O'Connor, 2021). According to Ayu and Anggraeni (2020), scientific writing is not merely a product but a process that reflects students' understanding of knowledge, attitudes, and scientific reasoning. Furthermore, scientific writing supports the development of essential academic behaviors such as critical analysis, evidence-based argumentation, and precision in language use.

In the context of the Indonesian school curriculum, one of the core competencies in Indonesian language instruction is the ability to write effectively and accurately. Through writing, students are expected to express their ideas clearly and in a structured way. Vejayan and Yunus (2022) affirm that writing is a crucial means of indirect communication, requiring consistent practice and scaffolding. It is not an innate talent but a skill that must be cultivated through methodical instruction and iterative feedback (Wahidah, 2023).

The educational benefits of writing scientific papers are multifaceted. First, it provides students with hands-on experience in conducting small-scale research, including activities such as observation, data collection, and interviewing. These experiences cultivate confidence and competence, especially when students are tasked with presenting and defending their findings. Second, writing scientific texts enables students to internalize the norms of academic writing—such as the use of standard language, logical organization, and accurate referencing—while also reinforcing grammar and mechanics (Indriani & Jayanti, 2022; Pulungan & Nasution, 2021). Third, as noted by Didenko et al. (2022), writing also serves therapeutic and cognitive functions: it helps in organizing thoughts, solving problems, and developing a disciplined, systematic mindset.

Despite its significance, the state of scientific writing competency among students in Indonesia remains concerning. Data from international assessments reveal a persistent gap in scientific literacy among Indonesian students. For instance, the Program for International Student Assessment (PISA) has consistently placed Indonesia in the lower tiers in terms of reading and science literacy. In the 2015 assessment, Indonesia ranked 62nd out of 72 participating countries, with an average science score of only 403—far below the OECD average (OECD, 2019). These outcomes suggest that the national curriculum and teaching methods may not be adequately fostering the analytical and writing skills needed for scientific literacy.

Scientific literacy is a foundational component of modern education, enabling individuals to make informed decisions about scientific and social issues. According to Nasution, Liliawati, and Hasanah (2019), fostering scientific literacy requires more than content knowledge; it necessitates active engagement in problem-solving, inquiry, and communication. One instructional model that aligns well with these goals is Problem-Based Learning (PBL). PBL emphasizes student-centered learning through authentic, real-world problems that require collaboration, investigation, and synthesis.

In PBL, the teacher's role shifts from being a knowledge transmitter to a facilitator who guides students through the process of inquiry. The model's core structure includes identifying problems, conducting investigations, hypothesizing, and proposing solutions. These activities mirror the stages of scientific research and naturally align with the process of writing scientific texts (Suwono & Dewi, 2019). During the investigation stage, students gather data from diverse sources, engage in analytical thinking, and produce written reports—skills that are central to scientific writing. Moreover, PBL promotes metacognitive development, allowing students to reflect on their learning strategies and adapt accordingly (Nurhaliza, 2023).

The pedagogical benefits of PBL in enhancing students' writing and reasoning skills have been well documented. Alghamdy (2023) highlights that team-based PBL environments foster improved planning, greater peer feedback, and increased engagement. Similarly, research by Hussin, Harun, and Shukor (2019) demonstrates that PBL enhances students' critical thinking and collaborative abilities, which are integral to producing high-quality written work. These findings suggest that integrating PBL into writing instruction can not only improve students' content knowledge but also enhance their communication and argumentation skills.

However, despite the theoretical and empirical support for PBL, challenges persist in its implementation, particularly in relation to students' readiness and motivation. Observations from MAN 5 Jakarta indicate that students often lack the confidence to participate in writing competitions and exhibit low motivation to engage in writing tasks. Interviews with teachers further reveal that students perceive scientific writing as a complex and time-consuming activity. These perceptions are exacerbated by students' limited mastery of writing mechanics, such as spelling, punctuation, and the use of standard Indonesian (Nisa, Ramadhan, & Thahar, 2023).

In response to these challenges, this study seeks to explore the implementation of the PBL model in the context of teaching scientific writing in secondary schools. The aim is to determine whether PBL can serve as an effective pedagogical approach to address the common barriers in scientific writing instruction—particularly low motivation, inadequate writing skills, and lack of structured thinking. As Djumingin (as cited in Nisa et al., 2023) suggests, PBL compels students to engage in "learning how to learn," thereby transforming passive recipients of information into active knowledge constructors.

Given the alignment between PBL's inquiry-based structure and the process of writing scientific texts, this model is considered highly suitable for use in Indonesian language instruction focused on academic writing. PBL offers students a meaningful context for learning, encouraging them to explore real-life issues, formulate questions, gather evidence, and present solutions through structured writing. This integrative approach not only improves writing outcomes but also cultivates essential 21st-century competencies such as collaboration, critical thinking, and scientific reasoning.

2. METHODS

This study employed a Classroom Action Research (CAR) approach to investigate the implementation of the Problem-Based Learning (PBL) model in improving students' ability to write scientific papers. Classroom Action Research is a method commonly used by educators to improve teaching and learning processes through iterative cycles. Each cycle typically involves four stages: planning, implementation, observation, and reflection (Putra et al., 2022; Stuart et al., 2013). This cyclical nature allows for ongoing refinement of instructional strategies based on observed outcomes and feedback.

The research was conducted in two action cycles, with each cycle consisting of two meetings. The setting of this study was MAN 5 Jakarta, and the research participants included 26 students from one of the school's classes. A total sampling technique was applied, meaning that all students in the selected class were involved as research subjects.

Two primary forms of data were collected: process data and product data. The process data referred to students' participation and engagement during learning activities, while the product data consisted of student performance on scientific writing assignments, based on previously determined topics. These assignments were used to assess students' development in organizing ideas, applying scientific structure, and using proper academic language.

Data collection was carried out using two instruments:

1. Observation sheets – used to monitor and document student activity and engagement during classroom sessions.
2. Assignment/test assessments – used to evaluate students' written scientific papers.

The data analysis followed a dual approach:

- Qualitative descriptive analysis was applied to the observational data, focusing on student behavior, participation, and the overall classroom dynamics.
- Quantitative descriptive analysis was used to measure student achievement in writing assignments, including the calculation of average scores and completion rates based on the minimum criteria for mastery learning (*Kriteria Ketuntasan Minimal* or KKM).

The research procedure began with identifying the core problems related to students' difficulties in writing scientific papers, followed by formulating appropriate instructional interventions. These steps are visually represented in the following Classroom Action Research flow model, adapted from Kemmis and McTaggart:

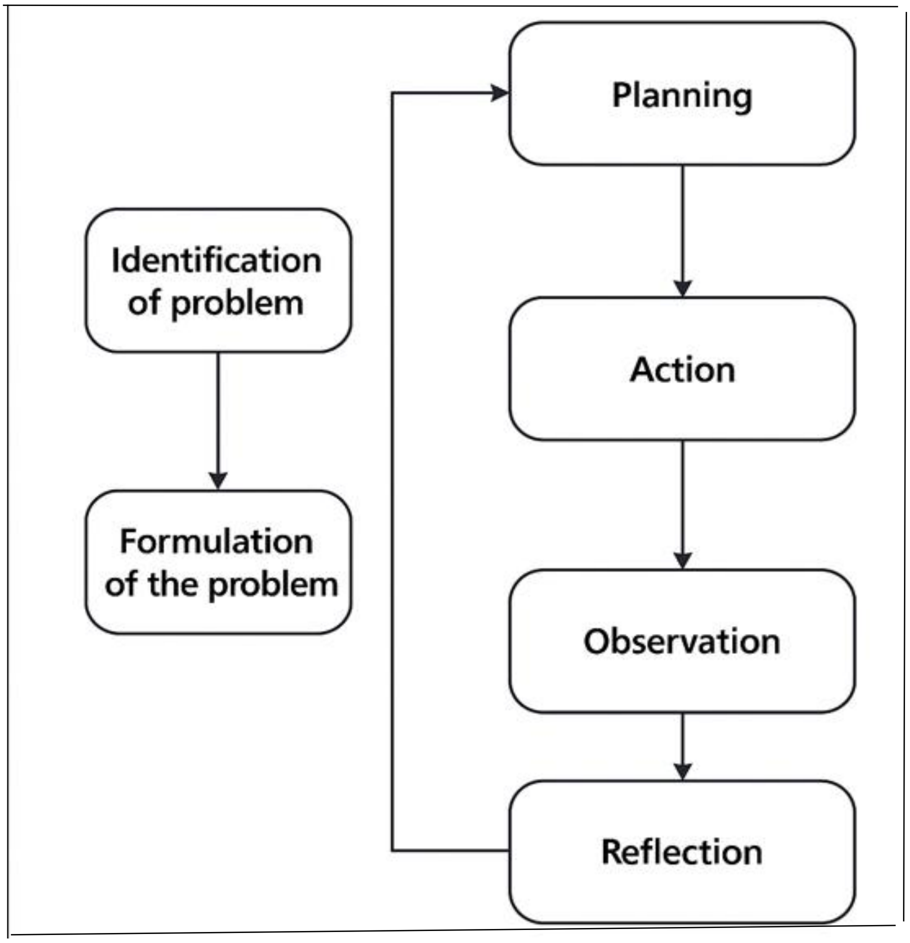

Figure 1. Classroom Action Research Flow adapted from Kemmis and Taggart

3. FINDINGS AND DISCUSSION

3.1 Findings

This study was conducted through two cycles of Classroom Action Research (CAR) at MAN 5 Jakarta, aiming to improve students' ability to write scientific papers through the implementation of the Problem-Based Learning (PBL) model. Each cycle consisted of two meetings and included four main stages: planning, implementation, observation, and reflection.

3.1.1 Cycle I

During the first cycle, data obtained from classroom observations indicated that student engagement in the learning process was still suboptimal. The average percentage of active student participation was recorded at 76%, based on observation sheets. Many students were not yet able to follow the PBL steps effectively. This limited engagement was likely due to the students' unfamiliarity with student-centered learning approaches, as they were more accustomed to traditional teacher-centered instruction methods such as lectures.

In terms of learning outcomes, students' performance in writing scientific papers during the second meeting of Cycle I revealed that the average score was 64, which falls below the Minimum Completion Criteria (*Kriteria Ketuntasan Minimal* or KKM), set at 75. The data, as shown in Table 1, further illustrates that 25 students (96%) scored within the "enough" category (scores between 56–74), and only 1 student (4%) achieved a "good" score (75–85). No students reached the "very good" category, and none scored in the "not enough" range (≤55).

Table 1. Writing Scores – Cycle I

No	Score Range	Category	Frequency	Percentage (%)
1	86–100	Very Good	0	0%
2	75–85	Good	1	4%
3	56–74	Enough	25	96%
4	≤55	Not Enough	0	0%
	Total		**26**	**100%**

As reflected in Table 2, only 4% of the students reached the minimum passing criteria, while 96% did not meet the expected standard. These findings clearly indicate that the learning objectives had not been achieved in Cycle I, and thus, improvements were necessary for the subsequent cycle.

Table 2. Minimum Completion – Cycle I

No	Category	Frequency	Percentage (%)
1	Complete (≥ 75)	1	4%
2	Not Complete (< 75)	25	96%
	Total	**26**	**100%**

Based on these outcomes, it was concluded that students had not yet mastered the ability to structure and articulate their ideas within a scientific paper effectively. As a result, further refinement of the learning strategy was deemed necessary, and the research continued to Cycle II.

3.1.2 Cycle II

Improvements implemented in the second cycle focused on optimizing the application of the PBL model, providing clearer guidance during each phase, and increasing student interaction through collaborative problem-solving tasks. These adjustments resulted in a significant improvement in both student activity and writing outcomes.

Classroom observations showed a marked increase in student engagement, with the average participation rate rising to 92%, indicating that students had become more active and better able to follow the PBL steps independently.

Learning outcomes in Cycle II also improved significantly. The average student score for writing scientific papers increased to 81, surpassing the minimum competency threshold of 75. The distribution of scores is detailed in Table 3, where 7 students (27%) were categorized as "very good" (86–100), and 19 students (73%) achieved "good" scores (75–85). Notably, no students fell into the “enough” or “not enough” categories.

Table 3. Writing Scores – Cycle II

No	Score Range	Category	Frequency	Percentage (%)
1	86–100	Very Good	7	27%
2	75–85	Good	19	73%
3	56–74	Enough	0	0%
4	≤55	Not Enough	0	0%
	Total		**26**	**100%**

As summarized in Table 4, 100% of the students successfully achieved the minimum score for competency, indicating that all students met or exceeded the expected learning outcomes.

Table 4. Minimum Completion – Cycle II

No	Category	Frequency	Percentage (%)
1	Complete (≥ 75)	26	100%
2	Not Complete (< 75)	0	0%
	Total	**26**	**100%**

These findings demonstrate that the implementation of the PBL model significantly enhanced students’ ability to write scientific papers. The increase in student engagement and achievement indicates that students not only became more involved in the learning process but also developed stronger competencies in structuring, expressing, and presenting their scientific ideas in written form.

3.2 Discussion

This classroom action research was conducted over two cycles from April 5 to May 7, 2024, at MAN 5 Jakarta, aiming to enhance students’ scientific writing skills through the implementation of the Problem-Based Learning (PBL) model. The research followed the four-phase structure of CAR: planning, action, observation, and reflection (Putra et al., 2022; Stuart et al., 2013). Each cycle consisted of two meetings with a time allocation of 2 × 45 minutes per session.

Prior to the implementation, a pre-cycle diagnostic was conducted through discussion with the Indonesian language teacher. This discussion revealed key issues in the learning process, including students' low motivation, limited participation, and learning outcomes that did not meet the minimum passing criteria (KKM). Contributing factors included the lingering effects of online learning and the continued reliance on conventional teaching methods, such as lecturing, which limited student engagement and autonomy in the classroom.

In response, the PBL model was adopted in Cycle I, with learning activities structured to promote student-centered, inquiry-based exploration. While the planning stage included preparation of lesson plans (RPP), observation instruments, and writing assignments, the implementation stage revealed that students were still adapting to this new model. Observations showed limited participation, with only a few students actively engaging in discussions or collaborative activities. The average student activity score was 76%, and the average assignment score for writing scientific papers was 64—well below the established KKM.

These findings are consistent with prior studies suggesting that students initially struggle with independent learning tasks when transitioning from traditional to constructivist models (Burgess et al., 2018). As noted by Brown et al. (2016) and Kassem (2018), introducing PBL in environments where teacher-centered instruction predominates requires a period of adjustment, during which students gradually develop confidence, autonomy, and collaborative skills.

Nonetheless, the foundation laid in Cycle I provided the groundwork for improved performance in Cycle II. In this second cycle, several enhancements were made: clearer instructions were provided, more structured guidance was given during group work, and additional scaffolding was used to help students better organize their ideas. These adjustments yielded a significant increase in student activity, with an average score of 92%. Students also demonstrated a greater ability to follow the PBL steps, including identifying problems, gathering data, analyzing information, and composing structured written reports.

More importantly, all students in Cycle II reached or exceeded the minimum passing grade, with an average writing score of 81. This achievement reflects a clear progression in students' ability to conceptualize and write scientific papers. They showed improved mastery of the components of scientific writing—such as writing introductions, formulating problems, conducting investigations, presenting data, and concluding findings. Students also appeared more confident and motivated during collaborative discussions and presentations.

These results align with existing literature highlighting the effectiveness of PBL in improving academic writing and scientific thinking. For example, Wulandari and Hastini (2024) found that PBL significantly improved students' ability to write structured exposition texts in Indonesian language classes. Similarly, Bilgin and Yildiz (2024) reported that the PBL model contributed to greater student motivation and achievement in English writing classes. The findings of this study are further supported by Nurmaini and Sukenti (2024), who emphasized the role of PBL in helping students connect writing with real-life issues through research and inquiry-based learning.

Furthermore, PBL is known to promote metacognitive development and critical thinking. According to Nainggolan, Situmorang, and Hastuti (2021), integrating information literacy into PBL can help students engage in deeper research processes, enhancing their ability to construct evidence-based arguments. This was evident in the current study, where students not only improved their writing skills but also demonstrated greater understanding of the research process, including how to gather and present data meaningfully.

The improvement in learning outcomes also validates the assertion by Suwono and Dewi (2019) that PBL encourages long-term retention and transfer of knowledge by engaging students in authentic problem-solving experiences. The iterative cycle of observation and reflection in CAR allowed for continuous adjustments to teaching strategies, which in turn led to measurable improvements in student performance.

In conclusion, the implementation of the Problem-Based Learning model in this study proved effective in addressing the key issues identified during the pre-cycle, including low student engagement and underachievement in scientific writing. The results of Cycle II indicate that with appropriate scaffolding and teacher facilitation, PBL can foster meaningful improvements in students' writing abilities and learning motivation. These findings suggest that the PBL approach is not only suitable but highly recommended for teaching scientific writing in secondary education contexts, particularly in schools transitioning from traditional to more active, student-centered methodologies.

4. CONCLUSION

Based on the findings of this classroom action research conducted at MAN 5 Jakarta, the implementation of the Problem-Based Learning (PBL) model significantly improved students' scientific writing skills and engagement. Student activity increased from 76% in Cycle I to 92% in Cycle II, while average writing scores rose from 64 to 81, surpassing the minimum completion criteria (KKM) of 75. These results indicate that PBL effectively enhances both motivation and the ability to produce structured scientific texts. However, this study is limited by its small sample size and single-school context, which may affect the generalizability of the findings. Additionally, the short duration of implementation may not capture long-term learning retention. Future research should explore the application of PBL across diverse educational settings, involve larger and more varied participant groups, and examine the integration of digital tools within PBL to support scientific writing development. Expanding the scope and duration of studies will help generate more comprehensive insights into the sustained impact of PBL on students' academic writing competencies.

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