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The Influence of Project-Based Learning Model on Students' Argumentative Writing Ability Controlling for Initial Reading Ability

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Abstract

Argumentative writing ability was an essential higher-order thinking skill for high school students. However, the 2023 National Assessment data showed that only 34% of students in Central Java achieved minimum competency. This study aimed to examine the effect of Project-Based Learning (PjBL) on students' argumentative writing ability after controlling for initial reading ability. A quasi-experiment with a pretest-posttest nonequivalent control group design was used. The sample consisted of 128 eleventh-grade students of SMA Negeri 5 Kediri (64 experimental, 64 control) selected by purposive sampling. Instruments included a reading comprehension test (20 items, α = 0.88) and an argumentative writing rubric (4 indicators, α = 0.91). The experimental group received PjBL for 8 sessions (4 weeks), while the control group received conventional instruction. Data were analyzed using one-way ANCOVA with initial reading ability as a covariate. Results showed that after controlling for initial reading ability, there was a significant difference in argumentative writing ability between the two groups (F = 24.56; p < 0.001; η^2 = 0.32). The mean posttest score of the experimental group (82.4) was higher than that of the control group (71.6). Initial reading ability contributed significantly (F = 18.34; p < 0.001; η^2 = 0.13). These findings indicated that PjBL was effective in improving argumentative writing regardless of students' initial reading ability differences.

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INTRODUCTION

Argumentative writing ability was one of the core competencies in the Indonesian language curriculum at the high school level. Argumentative texts required students to express opinions supported by logical evidence and

reasons, thereby training critical and systematic thinking. However, the 2023 National Assessment results released by the Ministry of Education, Culture, Research, and Technology (2024) showed that only 34% of high school students in Central Java achieved minimum competency in writing argumentative texts. This achievement was even lower than the national average (41%). The low argumentative writing ability was also reflected in Indonesia's reading literacy score in PISA 2022, ranking 70th out of 81 countries with a score of 359, far below the OECD average of 476 (OECD, 2023). Since reading and argumentative writing had a very strong correlation ($r > 0.70$), low reading literacy directly impacted argumentative writing ability.

Preliminary observations conducted by the research team at SMA Negeri 5 Kediri in September 2025 revealed serious problems. From 256 eleventh-grade students given an argumentative writing assignment on school environmental issues, the average score was only 68.4 (on a 100-point scale). The main weaknesses were: (1) argument structure (45% of students could not distinguish facts from opinions), (2) evidence quality (52% of students used irrelevant or non-specific evidence), (3) coherence (48% of students had difficulty connecting paragraphs), and (4) language use (38% of students used inappropriate diction). Interviews with Indonesian language teachers revealed that the learning methods used were conventional: teachers explained argumentative text structure, provided examples, then asked students to write individually. This method was deemed insufficient to develop critical thinking and argumentative writing skills because students were not involved in deep investigation and revision processes.

Project-Based Learning (PjBL) emerged as a potential alternative. PjBL was a learning approach providing opportunities for students to learn through in-depth investigation of a topic and produce tangible products (Thomas, 2020). In the context of argumentative writing, projects might include creating opinion articles for wall magazines, letters to the editor, argumentative essays on social or environmental issues, or short videos accompanied by argumentative scripts. Research by Rahayu et al. (2024) at SMAN 1 Yogyakarta showed that PjBL effectively improved students' expository writing skills with an effect size of 0.78 (large category). Research by Silva el al. (2023) in Portugal also reported that PjBL positively impacted writing motivation and argumentative text quality among secondary school students. However, the effectiveness of PjBL in argumentative writing needed careful examination because initial reading ability might be a confounding factor.

Initial reading ability was the ability to understand written texts that students possessed before intervention. Research by Graham & Perin (2020) showed that reading comprehension ability correlated very strongly with argumentative writing ability ($r = 0.72$). Students with good reading ability tended to more easily identify argument structure from model texts, have richer vocabulary, and be more skilled in constructing coherent sentences. Conversely, students with low reading ability would struggle at every stage of argumentative writing. In experimental designs, if initial reading ability differences were not controlled, posttest result differences might be caused by

initial differences rather than treatment. Therefore, an appropriate design used Analysis of Covariance (ANCOVA) incorporating initial reading ability as a covariate.

Experimental research on PjBL for argumentative writing controlling for initial reading ability remained very limited, especially in Indonesia. A study by Clarke (2023) in the United States reported that after controlling for initial reading scores, PjBL still had a positive effect on argumentative writing (F = 18.45, p < 0.01), but the sample was middle school students. In Indonesia, research by Fatimah et al. (2024) on PjBL for explanatory text writing did not include covariates, so the magnitude of the pure treatment effect was unknown. Meanwhile, research by Parantika & Astawan (2024) developed an argumentative writing rubric but did not test it in an experimental context with controls. This gap indicated the need for studies specifically testing PjBL for argumentative writing with rigorous control.

Argumentative writing ability was an important literacy competency to develop in high school students as it related to critical thinking, logical reasoning, and effective communication of ideas. However, various studies showed that students' argumentative writing ability remained relatively low, characterized by weak argument quality, lack of relevant evidence, and inability to organize ideas systematically. This condition demanded the application of learning models capable of providing more active, contextual, and problem-solving-oriented learning experiences. Project-Based Learning (PjBL) was considered a promising approach because it encouraged students to engage in investigation, collaboration, and meaningful product creation.

Several studies had reported that PjBL could improve various aspects of writing skills. However, empirical evidence on PjBL effectiveness in improving argumentative writing ability among high school students still showed several limitations. Most studies had not adequately controlled for the influence of students' initial reading ability, even though reading ability was a factor contributing to argumentative writing quality. Additionally, many studies used analytical designs that had not considered covariate effects, so treatment effect estimates might be less accurate. From a measurement perspective, reporting transparency of inter-rater reliability in writing assessment instruments was also relatively limited. Furthermore, information on effective PjBL implementation duration for improving argumentative writing ability in the Indonesian high school context remained scarce.

Based on these conditions, this study was designed to evaluate the effectiveness of Project-Based Learning on students' argumentative writing ability by controlling for initial reading ability as a covariate. This study used an argumentative writing assessment instrument that had been validated and had high inter-rater reliability, thus expected to produce more objective and consistent measurements. Conducted in real classroom learning contexts over eight sessions, this study also analyzed the magnitude of initial reading ability contribution and treatment effects through effect size reporting, providing a

more comprehensive picture of the strength of each factor's influence on students' argumentative writing ability.

Thus, this study not only provided empirical evidence regarding PjBL effectiveness compared to conventional learning but also expanded understanding of the role of initial reading ability in supporting the success of argumentative writing instruction. Therefore, this study focused on testing whether there were differences in argumentative writing ability between students learning using Project-Based Learning and those following conventional instruction after controlling for initial reading ability, as well as analyzing the extent to which initial reading ability contributed to students' argumentative writing ability.

METHODS

This study employed a quantitative approach with a quasi-experimental pretest-posttest nonequivalent control group design (Creswell & Creswell, 2023). This design was used because full randomization could not be performed due to pre-existing class constraints. The population comprised all eleventh-grade students of SMA Negeri 5 Kediri for the 2025/2026 academic year totaling 256 students in eight classes. Sampling used purposive sampling with criteria that classes had equivalent initial Indonesian language ability based on previous semester grades and willingness to participate in the entire research sequence. Based on these criteria, two classes were selected: XI IPA 2 as the experimental group (n = 64) and XI IPA 3 as the control group (n = 64) with relatively balanced gender composition.

Research instruments consisted of a reading comprehension test and an argumentative writing assessment rubric. The reading comprehension test contained 20 multiple-choice questions measuring critical and inferential reading ability based on Graham & Perin (2020), with reliability a = 0.88. The argumentative writing rubric encompassed aspects of argument structure, evidence quality, coherence, and language use on a 1-5 scale with a total score of 100. This instrument had been validated by experts with CVI = 0.89 and inter-rater reliability of a = 0.91.

The research procedure included preparation, implementation, and evaluation stages. The experimental group received Project-Based Learning through a wall magazine project on school environmental issues over 8 sessions, while the control group used conventional instruction. Before and after treatment, both groups were given pretest and posttest argumentative writing assessments with equivalent difficulty topics.

Data analysis used one-way ANCOVA with SPSS 29. Assumption tests included normality, homogeneity of variance, and homogeneity of regression slopes, all of which were met. Significance level was set at a = 0.05 with effect size using partial eta squared (η^2) based on Cohen's criteria (1988). Descriptive statistics of pretest and posttest for each group are presented below.

RESULTS AND DISCUSSION

Results

ANCOVA assumption tests were conducted before the main analysis. Normality testing of residuals using *Shapiro-Wilk* produced $p = 0.12$ (>0.05), indicating normally distributed residuals.

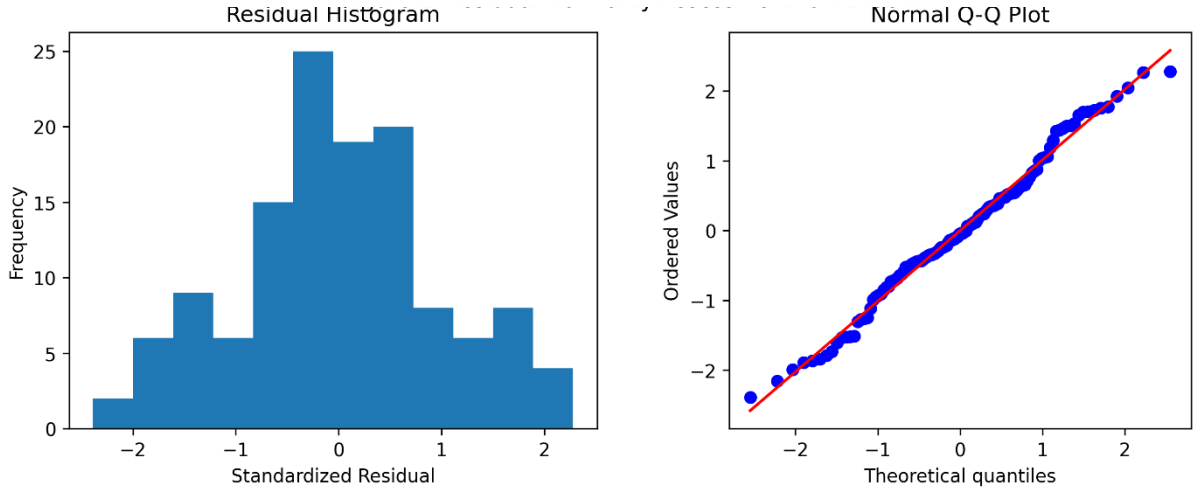


Figure 1. Residual Normality Assessment for ANCOVA

Figure 1 shows a symmetrical residual histogram and Q-Q plot following the diagonal line. Homogeneity of variance testing using Levene's test on posttest scores showed $F = 1.42$ ($p = 0.28 > 0.05$), satisfying the homoscedasticity assumption. Homogeneity of slopes testing (interaction between group and covariate) was conducted by entering the group × reading ability interaction into the model. The interaction result was not significant ($F = 0.87$; $p = 0.353$), so the homogeneity of slopes assumption was met. Thus, ANCOVA analysis could proceed.

Table 1. ANCOVA Results of PjBL Effect on Argumentative Writing

Source of Variance	Sum of Squares (SS)	df	Mean Square (MS)	F	p	η^2
Covariate (initial reading)	1245.6	1	1245.6	18.34	<0.001	0.13
Group (PjBL vs conventional)	1784.2	1	1784.2	24.56	<0.001	0.32
Error	8492.3	125	67.9	-	-	-
Corrected Total	11522.1	127	-	-	-	-

Based on Table 1, the covariate of initial reading ability had a significant influence on posttest argumentative writing ($F = 18.34$; $p < 0.001$; $\eta^2 = 0.13$). This meant that differences in initial reading ability explained 13% of variance in posttest argumentative writing. After controlling for the covariate, the group effect (learning model) was also significant ($F = 24.56$; $p < 0.001$; $\eta^2 = 0.32$). The partial eta squared value of 0.32 fell into the large effect category (Cohen,

1988), meaning the learning model explained 32% of posttest variance after removing the influence of initial reading ability.

The unadjusted posttest mean argumentative writing scores showed the experimental group (82.4) higher than the control group (71.6). After controlling for initial reading ability, the adjusted mean for the experimental group was 82.1 (SE = 0.92), while the control group was 71.9 (SE = 0.94). The difference in adjusted means was 10.2 points (95% CI: 6.5 to 13.9). Figure 2 presents a bar chart comparing adjusted means.

Table 2. Comparison of Adjusted Mean, Raw Mean, and Gain Score

Indicators	Experimental Group	Control Group
Raw mean posttest	82.4	71.6
Adjusted mean posttest	82.1	71.9
Gain score (posttest-pretest writing)	+14.2	+3.8

The experimental group's gain score (+14.2) was more than three times the control group's gain score (+3.8), indicating a very meaningful improvement. This improvement was equivalent to approximately one and a half proficiency levels (from adequate to good category).

Table 3. Comparison of Argumentative Writing Indicator Achievement Proportions (Posttest)

Indicators	Experimental (posttest) Mean±SD	Control (posttest) Mean±SD	Difference	t	p
Argument structure (max 25)	21.4 ± 2.2	18.3 ± 2.5	+3.1	7.45	<0.001
Evidence quality (25)	20.8 ± 2.4	17.2 ± 2.8	+3.6	8.12	<0.001
Coherence (25)	20.1 ± 2.1	18.0 ± 2.4	+2.1	5.23	<0.001
Language use (25)	20.1 ± 2.0	18.1 ± 2.3	+2.0	4.98	<0.001

The greatest improvement occurred in the evidence quality indicator (+3.6 points), followed by argument structure (+3.1). This indicated that PjBL, which required students to independently seek field data and reading sources, improved their ability to use relevant and credible evidence.

Table 4. Inter-Rater Homogeneity Test Results for Argumentative Writing

Rater	Experimental Mean	Control Mean	Inter-rater Correlation	Alpha
Rater 1	82.7	71.4	0.89	0.91
Rater 2	82.1	71.8	-	-

Inter-rater reliability was very good (a = 0.91), indicating objective and consistent argumentative writing assessment. The results showed that Project-Based Learning was more effective than conventional models in improving high school students' argumentative writing ability, even after statistically controlling for initial reading ability differences. The treatment effect was classified as large (η^2 = 0.32), with the greatest improvement in evidence quality.

Discussion

This study demonstrated that Project-Based Learning (PjBL) was significantly more effective than conventional instruction in improving high school students' argumentative writing ability after controlling for initial reading ability (F = 24.56; p < 0.001; η^2 = 0.32). The magnitude of this effect indicated a strong contribution. This finding aligned with Thomas's study (2020), which affirmed that PjBL improved argumentative writing skills through student engagement in investigative activities and authentic text production. This result was also consistent with Rahayu et al. (2024), who reported significant improvement in writing skills through PjBL with a large effect size.

The advantage of PjBL in this study related to the characteristics of authentic, collaborative, and inquiry-based learning. The project activity of creating a wall magazine on school environmental issues provided authentic contexts that encouraged student engagement in the writing process. Additionally, the data collection process through observation and other sources strengthened the quality of evidence in arguments constructed. This finding aligned with Graham & Perin (2020) that argumentative quality was strongly influenced by the ability to evaluate and use evidence appropriately. Collaborative activities and peer review within groups also contributed to writing quality improvement through exchange of feedback among students.

Initial reading ability was proven to play a significant role as a covariate (F = 18.34; p < 0.001; η^2 = 0.13). This confirmed the close relationship between reading and writing skills as posited in literacy literature (Graham & Perin, 2020). Students with better reading ability tended to have stronger text structure understanding and richer vocabulary. However, the PjBL effect remained more dominant than the covariate, indicating that writing improvement was not solely determined by initial reading ability.

The absence of interaction between group and covariate (F = 0.87; p = 0.353) indicated that PjBL effectiveness was relatively consistent across various levels of students' initial reading ability. This finding suggested that PjBL could be applied inclusively without widening achievement gaps among students. This result reinforced the view that scaffolding in PjBL allowed students with low initial ability to still follow the learning process effectively.

The improvement in argumentative writing ability in the experimental group was higher than the control group. This showed that project-based learning not only focused on the final written product but also on the process of idea

development, information gathering, collaboration, and repeated revision. This process contributed to improving argument quality, particularly in structure and evidence use. From a pedagogical perspective, these findings indicated that PjBL could serve as an effective alternative strategy for argumentative writing instruction at the high school level. PjBL implementation did not have to take the form of large projects but could be adapted to learning contexts through authentic tasks relevant to students' lives. Implementation effectiveness was greatly influenced by the availability of sufficient learning time to complete all project stages, including exploration, drafting, feedback, and revision.

Theoretically, these findings supported social constructivism, which emphasized the importance of social interaction in learning. PjBL provided space for students to build knowledge through collaboration and scaffolding within groups. Additionally, these findings aligned with self-regulated learning theory, which emphasized the role of planning, monitoring, and self-evaluation in the learning process, inherently facilitated within the PjBL structure. Nevertheless, this study had limitations, including the use of a quasi-experimental design that might still leave selection bias, research scope limited to one school, and a relatively short intervention duration. Additionally, this study had not analyzed process factors such as motivation, self-efficacy, and student engagement in depth, which could enrich understanding of PjBL effectiveness mechanisms.

These limitations opened opportunities for future research to use randomized experimental designs across schools, extend intervention duration, and integrate mixed methods approaches. Future studies could also explore moderating variables such as learning motivation and learning styles, as well as compare PjBL with other learning models such as Problem-Based Learning or Inquiry-Based Learning. This study provided empirical evidence that PjBL was an effective approach for improving high school students' argumentative writing ability with control for initial reading ability. These findings contributed to the development of literacy learning practices and strengthening project-based learning implementation in schools.

CONCLUSIONS

This study concluded that the project-based learning model was more effective than conventional instruction in improving high school students' argumentative writing ability, even after considering initial reading ability. This model proved capable of improving various important aspects of writing, especially in using relevant and credible evidence, followed by argument structure, coherence, and language aspects. Initial reading ability did influence writing outcomes but did not affect the effectiveness of the learning model, so this approach could be applied inclusively across various student ability levels. Based on these findings, Indonesian language teachers were advised to implement project-based learning with careful planning, including the use of clear assessment rubrics, directed inquiry processes, and peer assessment activities. Support from schools and policymakers was also

needed through provision of training, resources, and curriculum flexibility, while future research was expected to examine long-term effectiveness and explore other factors influencing the success of this learning approach.

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