



Comparative Effectiveness of PBL, PjBL, and Discovery Learning in Pesantren: Controlling for IQ

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Abstract

This study investigates the comparative effectiveness of three instructional models—Problem-Based Learning (PBL), Project-Based Learning (PjBL), and Discovery Learning—on students' academic achievement while controlling for Intelligence Quotient (IQ) using ANCOVA. Conducted at Pondok Pesantren Modern Nurul Ikhlas, the study employed a quasi-experimental design involving 120 Grade X students randomly assigned to three treatment groups. IQ was measured using Raven's Progressive Matrices and treated as a covariate. The post-test achievement scores were analyzed using ANCOVA to examine the adjusted effects of each instructional model. Results indicate that the instructional model had a statistically significant effect on student achievement ($p < 0.001$), with PjBL outperforming both PBL and Discovery Learning. No significant difference was found between PBL and Discovery Learning. The findings suggest that instructional strategies significantly influence learning outcomes independent of students' cognitive abilities. Furthermore, controlling for IQ increased the internal validity of the study and provided a clearer understanding of pedagogical impact. The study contributes to the development of evidence-based instructional strategies and supports the integration of constructivist models in diverse educational settings, including faith-based institutions. These findings underscore the importance of professional development and instructional innovation in enhancing academic achievement.

Keywords: academic achievement; ANCOVA; constructivism; instructional models; project-based learning



INTRODUCTION

Education is a fundamental pillar in shaping human resources that are competitive and excellent in the global era. In this context, the quality of the learning process is a key indicator of educational success. An effective learning process enhances academic achievement and optimally develops students' cognitive potential (Huy P et al., 2017; Stasolla et al., 2025). Various learning models have been developed to improve instructional quality, including constructivist-based approaches (Alafnan et al., 2024; Antonio et al., 2022; Atteh, 2023). Among them, Problem-Based Learning (PBL), Project-Based Learning (PjBL), and Discovery Learning have gained attention for their ability to engage students more actively.

These models emphasize student-centered learning, real-world problem solving, and active engagement in exploring concepts. PBL encourages students to think critically and collaborate through contextual problem solving (Mariani & Dewi, 2025; Ni et al., 2024; Wang & Wang, 2023). PjBL allows students to produce tangible outcomes through project work (Condliffe et al., 2017; P. Guo et al., 2020; Omelianenko & Artyukhova, 2024), while Discovery Learning enables students to discover scientific principles independently through exploration (Ayu et al., 2021; Maroungkas et al., 2023). These models are believed to not only enhance academic performance but also develop higher-order thinking skills. Consequently, many educational institutions are beginning to adopt these innovative instructional models.

However, the effectiveness of these three learning models in improving student achievement remains a topic of ongoing debate. Some studies have found PjBL to be more effective than PBL and Discovery Learning in enhancing students' cognitive abilities (Elems-ikwegbu et al., 2025; Elfira & Santosa, 2023; Lethulur et al., 2025; Saputri et al., n.d.). Conversely, other research shows that Discovery Learning may be more beneficial for deep conceptual understanding (Muhammad et al., 2023; Taye, 2023). These discrepancies highlight the importance of comparative studies that consider confounding variables that may influence learning outcomes. One such variable is students' Intelligence Quotient (IQ). IQ is a strong indicator of cognitive ability that significantly affects academic performance (Lo, 2017; Lozano-blasco et al., 2022; Peng, 2020). Students with higher IQ levels tend to comprehend material more easily, solve complex tasks more efficiently, and achieve better learning outcomes. In educational experiments, IQ serves as a covariate that can influence final results if not statistically controlled (Hyatt et al., 2020; Landingham et al., 2020). Therefore, it is essential to account for IQ when analyzing the impact of learning models. This necessitates the use of appropriate statistical approaches such as Analysis of Covariance (ANCOVA).

ANCOVA is a statistical technique used to control the influence of covariates when comparing treatment effects (Schwarz, 2018; Wan, 2021; Wright, 2020). In educational research, ANCOVA helps isolate the effect of instructional models on learning outcomes by accounting for covariates like IQ (Cankaya & Martin, 2025; Toffalini et al., 2021). This enhances the validity of the analysis by controlling external factors that cannot be manipulated by researchers. Furthermore, ANCOVA improves statistical power, especially in randomized experimental designs. For this reason, it is well-suited to comparing the effectiveness of various learning models. Previous studies using ANCOVA have reported mixed results regarding the influence of instructional models on academic achievement. For instance, Guo et al (2024) found that PBL was more effective in enhancing mathematics performance after controlling for IQ. On the other hand, Triantafyllou et al (2024), Zhongtian Ji and Kang Guo (2023), Hasim et al (2022) revealed that while PjBL significantly improved students' problem-solving skills, it did not significantly affect cognitive outcomes when IQ was accounted for. These findings suggest that the impact of instructional models may vary when cognitive ability is statistically controlled. Therefore, further empirical studies are needed to combine pedagogical approaches with rigorous statistical analysis.

To establish a clear context for the study, preliminary observations were conducted among students at Pondok Pesantren Modern Nurul Ikhlas, Tanah Datar, West Sumatra, Indonesia. The observation focused on students' academic achievement in mathematics and their cognitive abilities as measured by IQ scores. The data revealed considerable variation in both aspects, suggesting diverse learning capacities within the student population.

Table 1. Students' Academic Achievement in Mathematics and Cognitive Abilities

No	Score Range	Achievement Category	Number of Students	IQ Range	IQ Category	Number of Students
1	85–100	Excellent	12	130–144	Superior	18
2	70–84	Good	35	115–129	Above Average	54
3	60–69	Sufficient	48	90–114	Average	34
4	Below 60	Poor	25	Below 90	Below Average	14
			Total = 120			Total = 120

These data indicate that 40% of students fell into the “sufficient” category, while 20.8% were classified as “poor” in terms of academic achievement. Similarly, IQ scores ranged from below average to superior, with 11.7% of students categorized as below average and 15% as superior. This wide distribution underscores the cognitive diversity among students and provides a strong rationale for including IQ as a covariate in analyzing the effectiveness of instructional models. The variation in both academic performance and cognitive ability justifies the use of ANCOVA to ensure a fair comparison across instructional strategies.

Studies in modern Islamic boarding schools (pesantren) have been scarce despite their increasing adoption of formal national curricula. Pondok Pesantren Modern Nurul Ikhlas implements structured classroom instruction that parallels mainstream education, making it a unique context for empirical study. The distinctive characteristics of this setting may affect the applicability and effectiveness of learning models. Therefore, it is essential to investigate the impact of innovative instructional models in pesantren environments to align with local needs and student characteristics.

In response to this gap, this study was designed to quantitatively compare the effectiveness of PBL, PjBL, and Discovery Learning models on student achievement. Conducted at Pondok Pesantren Modern Nurul Ikhlas, the study employed experimental procedures to examine how these instructional models perform in real classroom settings. IQ was measured before treatment to serve as a covariate, ensuring the statistical validity of the findings. Randomized design was applied to guarantee fairness and internal validity. This approach aims to provide objective insight into the impact of learning models in a distinct educational context. Referring to previous findings and identified research gaps, this study contributes new empirical evidence through a controlled experimental design in a pesantren setting. Its primary contribution lies in the application of ANCOVA to eliminate the confounding effect of IQ on learning outcomes. This allows for a clearer interpretation of the true effect of instructional models. Such methodological rigor strengthens the scientific novelty of this article. Additionally, the unique context of a pesantren provides new dimensions to experimental educational research.

Scientifically, this study offers two major contributions: first, the integration of ANCOVA in the context of a modern pesantren; second, the simultaneous comparison of three widely-used instructional models in a single study. Prior studies have mostly used quasi-experimental designs with only one or two models. Moreover, domestic studies often rely on ANOVA without controlling for covariates. Therefore, this research fills both methodological and contextual gaps in the literature. The novelty presented herein provides a strong foundation for evidence-based learning model selection in schools and pesantren.

The research problem addressed in this study is: Is there a significant difference in student achievement among PBL, PjBL, and Discovery Learning models after controlling for IQ? The null hypothesis states that no significant difference exists among the three models in terms of learning outcomes once IQ is accounted for. In contrast, the alternative hypothesis suggests that at least one of the models leads to significantly different achievement results. Through appropriate statistical methods, this hypothesis can be objectively tested. This problem formulation is central to the experimental quantitative design employed in this study.

Based on the above considerations, the purpose of this article is to empirically examine the effectiveness of PBL, PjBL, and Discovery Learning models on students' academic achievement, by

controlling for IQ using ANCOVA. This study was conducted at Pondok Pesantren Modern Nurul Ikhlas as a direct application of innovative instructional models in a faith-based educational environment. It is expected that the findings will contribute both scientifically and practically to the development of instruction tailored to student characteristics. The results are also intended to serve as a foundation for broader future studies. Ultimately, this article offers new insights into how learning models can be optimized through a rigorous quantitative approach.

METHOD

This research adopted a quasi-experimental design with a pretest-posttest non-equivalent control group design. The purpose was to investigate the comparative effectiveness of three instructional models, Problem-Based Learning (PBL), Project-Based Learning (PjBL), and Discovery Learning on students' academic achievement while statistically controlling for Intelligence Quotient (IQ) using Analysis of Covariance (ANCOVA). The research was carried out in a real classroom setting to preserve ecological validity, with students randomly assigned to different instructional treatments.

This study used a quantitative approach with a quasi-experimental design. The design involved three groups that received different instructional treatments. Each group received a distinct model of instruction: PBL, PjBL, or Discovery Learning. IQ was treated as a covariate measured before treatment. After the treatment period, students took a standardized academic achievement test as the post-test.

The population in this study consisted of all Grade X students at Pondok Pesantren Modern Nurul Ikhlas, a modern Islamic boarding school integrating formal curricula and Islamic values. A total of 120 students participated in the research, distributed across three randomly selected intact classes, each assigned to one of the instructional models. The selected sample was considered representative of the student population based on academic records and IQ distribution obtained in preliminary observation.

A cluster random sampling technique was used by randomly selecting three classes from the total Grade X population, with each class exposed to a different instructional model. The covariate, IQ, was measured using the Raven's Standard Progressive Matrices (SPM), a widely accepted non-verbal test for general cognitive ability. The achievement test used to assess learning outcomes was developed by the research team and validated through expert review and item analysis. The test consisted of 40 multiple-choice questions covering mathematical reasoning, problem-solving, and conceptual understanding. Instrument reliability was tested using Cronbach's Alpha, resulting in a coefficient of 0.86 for the achievement test, indicating high internal consistency. Content validity was ensured through consultation with curriculum experts and mathematics educators.

Data analysis was conducted using Analysis of Covariance (ANCOVA) to determine the effect of instructional models on student achievement while controlling for IQ. The analysis process followed these steps: (1) testing the assumptions of normality, homogeneity of variance, linearity, and homogeneity of regression slopes; (2) conducting ANCOVA with instructional model as the independent variable, achievement as the dependent variable, and IQ as the covariate; (3) performing pairwise post hoc comparisons to identify specific differences between groups. All data analyses were performed using IBM SPSS Statistics version 26. All statistical assumptions for ANCOVA were met, including normal distribution (Kolmogorov–Smirnov, $p > 0.05$), homogeneity of variance (Levene's test, $p > 0.05$), and homogeneity of regression slopes (interaction between IQ and learning model, $p > 0.05$), indicating that ANCOVA was appropriate for this analysis.

RESULTS

Assumption Testing

To ensure the validity of the ANCOVA procedure, several assumptions were tested, including the normality of the data distribution, homogeneity of variance, a linear relationship between the covariate and dependent variable, and homogeneity of regression slopes.

Normality Test

The Kolmogorov–Smirnov test was used to examine the distribution of students' achievement scores. The results indicated that the data followed a normal distribution:

Table 2. Normality Test Result

Test	Kolmogorov-Smirnov Z	Sig. (2-tailed)
Academic Achievement	1.007	0.262

Since the significance value was greater than 0.05, it was concluded that the data were normally distributed.

Homogeneity of Variance

Levene’s test was used to examine the homogeneity of variance across groups:

Table 3. Levene’s test Result

F	df1	df2	Sig.
1.362	2	117	0.260

As the significance value was greater than 0.05, the assumption of homogeneity of variance was met.

Linearity and Correlation between IQ and Achievement

A Pearson correlation analysis showed a strong and significant positive relationship between IQ and academic achievement:

Table 4. A Pearson correlation Result

Variables	r (Pearson)	Sig.
IQ ↔ Achievement	0.654	0.000

This confirms that the covariate (IQ) is linearly related to the dependent variable.

Homogeneity of Regression Slopes

To examine the homogeneity of regression slopes, the interaction between IQ and instructional model was tested:

Table 5. The homogeneity of regression slopes

Source	F	Sig.
Model * IQ Interaction	39.580	0.100

Homogeneity of regression slopes (interaction between IQ and learning model) shows that the interaction is not significant ($p > 0.05$), then the assumption of homogeneity of regression slopes was met, and ANCOVA can be used.

Hypothesis Testing Using ANCOVA

To assess the effect of instructional models on students’ academic achievement while controlling for IQ, the following hypotheses were formulated:

- Null Hypothesis (H_0): There is no significant difference in academic achievement among students taught using PBL, PjBL, and Discovery Learning after controlling for IQ.
- Alternative Hypothesis (H_1): There is a significant difference in academic achievement among students taught using PBL, PjBL, and Discovery Learning after controlling for IQ.

The hypothesis was tested using Analysis of Covariance (ANCOVA), with the instructional model as the independent variable, academic achievement as the dependent variable, and IQ as the covariate. The decision rule was as follows:

- If Sig. (p-value) < 0.05, then H_0 is rejected, indicating a significant difference in academic achievement between instructional models after adjusting for IQ.

- If Sig. (p-value) ≥ 0.05 , then H_0 is not rejected, indicating no significant difference between the groups.

This is the result:

Table 6. ANCOVA Results

Source	Sum of Squares	Df	Mean Square	F	Sig.
Model (Adjusted)	826.158	2	413.079	10.120	0.000
Error	4734.962	116	40.819		

Based on the ANCOVA results above, the effect of instructional models on academic achievement was statistically significant after adjusting for IQ ($F(2, 116) = 10.120, p = 0.000 < 0.05$). The rejection of the null hypothesis indicates that there is a statistically significant difference in students' academic performance depending on the instructional model used, even when IQ differences are taken into account. This implies that the type of instructional strategy plays a critical role in shaping learning outcomes, independent of innate cognitive ability. The use of ANCOVA ensures that the effect is attributable to the instructional intervention, not to variation in IQ, thereby strengthening the internal validity of the findings. Consequently, the instructional model chosen by educators can have a meaningful and measurable impact on student achievement, particularly in diverse educational environments such as pesantren.

Post Hoc Analysis (Pairwise Comparisons)

Following the significant result in the ANCOVA test, post hoc analysis was conducted to determine **which specific instructional models differed significantly** in their effect on student academic achievement. The hypotheses tested in pairwise comparisons are:

- **H₀₁**: There is no significant difference in academic achievement between PBL and PjBL.
- **H₀₂**: There is no significant difference in academic achievement between PBL and Discovery Learning.
- **H₀₃**: There is no significant difference in academic achievement between PjBL and Discovery Learning.

The post hoc comparisons were conducted using the Bonferroni **adjustment** to control for the family-wise error rate. The decision rule was:

- If **Sig. < 0.05**, then the null hypothesis for that pair is rejected, indicating a statistically significant difference in adjusted mean achievement scores.
- If **Sig. ≥ 0.05** , then the null hypothesis is not rejected, indicating no significant difference.

Table 7. Results of Post Hoc Test

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
PBL	PjBL	-7.086*	1.640	0.000	[-11.069, -3.103]
PBL	Discovery	-1.203	1.430	1.000	[-4.675, 2.270]
PjBL	Discovery	5.883*	1.615	0.001	[1.959, 9.807]

(*) Significant at $\alpha = 0.05$

The post hoc results reveal that **Project-Based Learning (PjBL)** is significantly more effective than both **PBL** and **Discovery Learning** in improving students' academic achievement, with adjusted mean differences of 7.086 and 5.883 points, respectively. These differences are statistically significant ($p = 0.000$ and $p = 0.001$), indicating that PjBL consistently leads to better outcomes. Meanwhile, no significant difference was found between

PBL and Discovery Learning ($p = 1.000$), suggesting that both models yield comparable effects on academic performance when IQ is held constant.

This finding strengthens the conclusion that **PjBL provides superior pedagogical benefits**, potentially due to its emphasis on authentic problem-solving, collaboration, and tangible project outcomes that align more closely with students' real-life experiences and higher-order cognitive processes. The absence of difference between PBL and Discovery Learning also highlights that while both are rooted in constructivist principles, their effectiveness may plateau when implemented under similar conditions without strong scaffolding or differentiated support.

DISCUSSION

The Significant Effect of Instructional Models on Academic Achievement

The findings from the ANCOVA analysis revealed a statistically significant effect of instructional models on students' academic achievement after controlling for IQ. This means that even when students' cognitive abilities were statistically adjusted, the instructional model still had a measurable influence on learning outcomes. Such results support the idea that pedagogy plays a crucial role in shaping academic success, beyond innate intellectual capacity (Alam & Mohanty, 2023; Ghafar, 2023). This also implies that the design and implementation of learning strategies are as important as students' prior knowledge or intelligence. These findings are in line with studies by Milla (2025), Sun Dongji & Zakiah (2024), and Beenish & Goswami (2023) which showed that constructivist-based learning models significantly enhance student achievement.

Furthermore, this result affirms the relevance of instructional quality in improving educational outcomes in secondary education, especially in contexts with diverse student backgrounds. The implementation of effective learning models can serve as a compensatory mechanism for students with lower IQ, helping to bridge achievement gaps. Therefore, the role of instructional design should not be underestimated, particularly in religious-based educational institutions such as pesantren, which are often assumed to emphasize spiritual over cognitive development. By demonstrating that instructional models significantly impact achievement, this study provides empirical support for pedagogical reform in pesantren settings.

In addition, this significant result justifies the use of ANCOVA in the study. Without controlling for IQ, differences in achievement would likely have been attributed solely to instructional models, even if some were due to students' cognitive levels. Hence, the finding supports the necessity of including covariates in experimental educational research to ensure internal validity. The statistical significance observed here reflects not only the influence of teaching strategies but also the robustness of the research design.

Overall, the observed significance confirms the central thesis that instructional strategies do matter, especially when applied systematically with proper controls. This conclusion has strong implications for policymakers and educators seeking to optimize learning outcomes through evidence-based strategies. It reinforces the notion that effective teaching is not incidental but must be strategically designed and adapted to student needs (Ahmed, 2017; Mian et al., 2020).

This result also highlights the urgent need for professional development among teachers in pesantren, especially in mastering diverse instructional models that are proven to enhance academic achievement. When teachers are trained in multiple pedagogical strategies and supported with evidence-based resources, they are more likely to make informed instructional choices that align with student needs. In the long term, this can contribute to more consistent academic excellence across all student groups, regardless of their initial cognitive levels.

Finally, the broader implication of this finding is that instructional innovation should be encouraged not only in mainstream schools but also in faith-based institutions. This study demonstrates that when modern instructional models are applied systematically and evaluated rigorously, they can have a measurable and meaningful impact even in traditional learning environments. This opens new pathways for reforming pesantren education while maintaining its core values.

The Superiority of Project-Based Learning (PjBL) Compared to PBL and Discovery Learning

Among the three instructional models compared, Project-Based Learning (PjBL) demonstrated the highest adjusted mean scores in academic achievement. The post hoc analysis further confirmed that PjBL outperformed both PBL and Discovery Learning significantly. This finding can be attributed to the nature of PjBL, which emphasizes real-world application, collaborative work, and tangible outcomes, all of which enhance cognitive engagement and knowledge retention. The integration of project execution in learning appears to deepen understanding and link theoretical knowledge with practice. These attributes align with the principles of constructivism, which suggest that meaningful learning occurs when students actively construct knowledge through experience (Blown, 2024; Miriam & Costa, 2019).

Compared to PBL, which focuses more on problem-solving processes without necessarily producing a final product, PjBL provides students with ownership and a sense of accomplishment through project completion. This encourages sustained motivation and deeper engagement, which are critical for long-term academic success. The structure of PjBL also allows students to revisit and revise their understanding throughout the project phases, leading to more durable learning gains. Moreover, the collaborative nature of PjBL supports peer-to-peer learning, which reinforces cognitive processing.

This finding is consistent with studies by Xinke Song et al (2024), Megawati (2024), and Zhang Lu (2023) that's can be concluded that students taught with PjBL showed significantly better academic outcomes. These studies suggested that PjBL encourages active exploration, creativity, and practical reasoning, contributing to improved test performance. Within the context of pesantren, PjBL offers additional benefits by aligning with communal learning traditions and hands-on religious practices. Thus, PjBL not only fits modern pedagogical demands but also respects the cultural ethos of pesantren education.

The effectiveness of PjBL in this study provides a compelling argument for its broader adoption, particularly in educational settings that aim to balance academic excellence with character development. For pesantren, integrating PjBL could help modernize instructional approaches without undermining religious values. This dual impact makes PjBL a pedagogically and culturally appropriate model for contemporary Islamic education. Therefore, schools and pesantren alike should consider investing in teacher training and curriculum redesign to maximize the benefits of project-based instruction.

PjBL also supports the development of 21st-century competencies, including collaboration, communication, and critical thinking, which are essential for students' future success. In educational contexts where holistic development is a priority, such as pesantren, this model contributes to nurturing both cognitive and social skills. These competencies are often underemphasized in traditional instruction, making PjBL a valuable addition to educational reform agendas.

Moreover, PjBL encourages interdisciplinary learning and the application of knowledge across subject areas, fostering deeper conceptual understanding. In mathematics education, for example, integrating real-life projects helps students see the relevance of abstract concepts,

thereby increasing engagement and motivation. This interdisciplinary aspect reinforces the adaptability and scalability of PjBL across educational levels and contexts.

The Non-significant Difference between PBL and Discovery Learning

While PjBL showed clear superiority, the difference between Problem-Based Learning (PBL) and Discovery Learning was not statistically significant. This result suggests that both models, while differing in procedural emphasis, offer comparable benefits in terms of cognitive learning outcomes. One possible explanation is that both models require active student involvement, hypothesis formulation, and self-directed inquiry. These shared features may neutralize the differences in instructional structure, resulting in similar academic gains. As both are grounded in constructivist theory, it is reasonable to expect overlap in their learning outcomes.

PBL typically begins with a contextual problem and guides students through a structured problem-solving process, while Discovery Learning encourages learners to independently uncover principles through experimentation and exploration. However, in classroom practice, especially in pesantren settings, the lines between these models may blur. Teachers may intuitively combine elements of both models, leading to an instructional blend that yields similar results. This pedagogical convergence may explain the statistical similarity observed in this study.

Literature such as Nathalie Popa (2022) and George Wolford et al. (2021) also show mixed findings when comparing PBL and Discovery Learning, often reporting marginal or context-dependent differences. Therefore, the result of this study fits within a broader scholarly pattern, reinforcing the idea that both models are beneficial but not necessarily distinct in outcome. Additionally, factors such as teacher expertise, classroom culture, and student readiness can modulate the effectiveness of each model. These mediating variables were not controlled in the present study and may have contributed to the observed equivalence.

The non-significant difference also points to the flexibility teachers have in choosing either model depending on classroom needs. Educators may focus more on implementation quality rather than on the model label. In pesantren contexts, where adaptability is key, this flexibility can be an asset. Consequently, schools might consider developing hybrid approaches that draw from both PBL and Discovery Learning to maximize instructional impact. Another plausible interpretation is that the relatively short duration of the experimental treatment may not have been sufficient to fully differentiate the long-term impact of PBL versus Discovery Learning. Longer interventions may reveal subtler distinctions in learning outcomes and knowledge retention. Future research might consider longitudinal designs to better assess the delayed or cumulative effects of each model.

In practical terms, teachers can be encouraged to blend elements from both models based on students' interests and learning profiles. Doing so may enhance instructional responsiveness and increase learner autonomy. Such pedagogical fluidity can promote engagement and resilience, particularly among students with varying cognitive backgrounds.

The Importance of Controlling for IQ in Educational Research

One of the major methodological contributions of this study is the use of IQ as a covariate in ANCOVA analysis. The significant correlation ($r = 0.654$, $p < 0.001$) between IQ and academic achievement supports the decision to statistically control for IQ. By accounting for students' cognitive abilities, the study isolates the pure effect of instructional models, thus enhancing internal validity. Without this control, differences in achievement could be falsely

attributed to the instructional method, when in fact they may reflect innate intellectual differences.

Controlling for IQ also aligns with best practices in experimental education research, where covariates are used to reduce error variance and improve the precision of effect estimates. This strengthens the argument that educational outcomes are not solely the result of fixed traits but are significantly influenced by instructional design (Sweller et al., 2019; Yildirim et al., 2019). In this way, ANCOVA provides a powerful tool for disentangling instructional effects from learner characteristics. The study's methodology sets a precedent for future research, especially in settings where student ability varies widely.

Moreover, in pesantren environments where student backgrounds and prior knowledge can be highly heterogeneous, controlling for IQ is even more critical. It ensures that instructional effectiveness is evaluated on an equal playing field, avoiding biases that might stem from unmeasured cognitive differences. This methodological rigor enhances the credibility of the findings and supports more equitable educational decision-making. Therefore, educational researchers and practitioners alike should consider integrating covariates like IQ in their analyses to derive more accurate insights.

Finally, this approach promotes a more nuanced understanding of how students learn and respond to different teaching models. It moves beyond one-size-fits-all assumptions and opens pathways to personalized and differentiated instruction. By recognizing the interplay between cognitive ability and pedagogical approach, this study contributes to a more sophisticated and fair evaluation of instructional impact.

In addition, using IQ as a covariate sets a methodological benchmark for future research in educational settings where cognitive variability is a known factor. It encourages researchers to apply more rigorous statistical techniques in both quantitative and mixed-method designs. This shift can lead to deeper insights and more actionable recommendations for educators and policymakers.

Furthermore, acknowledging and adjusting for IQ highlights the ethical responsibility of researchers to report findings with fairness and objectivity. Educational outcomes should not be interpreted in isolation from learners' initial capabilities. By taking cognitive diversity seriously, studies like this one help build a more just and evidence-informed education system.

Limitations and Suggestions for Future Research

While this study controlled for IQ as a covariate, it did not account for other potentially influential variables such as student motivation, teacher competence, classroom climate, and instructional resources. These mediating factors may have contributed to the observed learning outcomes and should be considered in future research to gain a more comprehensive understanding of instructional effectiveness. Furthermore, the study was conducted in a limited setting, and its generalizability to broader educational contexts may be constrained. Future studies are encouraged to employ multi-site designs, longitudinal approaches, or mixed-methods analysis to deepen insights and validate findings across different learning environments.

CONCLUSION

This study concludes that instructional models significantly influence students' academic achievement, even after controlling for cognitive differences as represented by IQ. Specifically, Project-Based Learning (PjBL) demonstrated superior effectiveness compared to Problem-Based Learning (PBL) and Discovery Learning in improving student learning outcomes. The absence of a significant difference between PBL and Discovery Learning suggests that both models offer comparable benefits

when implemented under similar classroom conditions. These results highlight the critical role of instructional strategy selection in improving educational outcomes, particularly in diverse academic environments such as modern pesantren. Scientifically, the findings affirm that learning outcomes can be optimized not solely through fixed cognitive traits but more importantly through targeted, active, and engaging pedagogy. The use of ANCOVA reinforces the methodological rigor by ensuring that the effects observed are attributable to the instructional models rather than student IQ. These findings serve as a foundation for further pedagogical refinement and provide evidence-based justification for adopting constructivist models in varied educational contexts. Thus, the research achieves its aim of identifying and validating instructional approaches that significantly enhance academic performance while considering student cognitive diversity. This study concludes that instructional models have a significant effect on students' academic achievement, even after accounting for differences in cognitive ability such as IQ. Project-Based Learning (PjBL) proved to be the most effective, while Problem-Based Learning (PBL) and Discovery Learning showed relatively similar results. These findings emphasize the importance of choosing active and student-centered teaching strategies, especially in diverse educational settings like pesantren. However, the study has limitations, including the possible influence of teacher competence, the short duration of the intervention, and limited generalizability. Therefore, it is recommended that teachers receive training in implementing constructivist models, and that policymakers support curriculum reforms that promote active and contextual learning. Future research should involve broader samples and explore additional factors that may affect the effectiveness of instructional approaches.

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