Volume 4 Number 2 (2026)
July - December 2026
Page: 725-730

EDUJAVARE: International Journal of Educational Research
ISSN: 3031-2884
https://edujavare.com/index.php/edujavare
DOI: 10.70610/edujavare.1737

An Analysis of Gender-Based Differences in Critical Thinking Skills in Geography Education through a Problem-Based Learning Approach

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Article history Submitted: 2026/05/05; Revised: 2026/07/02; Accepted: 2026/07/29

Abstract

This study is motivated by the importance of instructional innovation in improving students' learning outcomes in Geography, as well as the potential differences in academic achievement based on gender. Problem-Based Learning (PBL) was selected as it is considered effective in fostering critical thinking, problem-solving, and collaborative skills. This study aims to analyze gender-based differences in Geography learning outcomes at SMP Negeri 1 Gebang through the implementation of PBL. A quasi-experimental method with a nonequivalent control group design was employed. The participants were eighth-grade students, grouped by gender to compare their learning outcomes after experiencing PBL. The research instrument was a validated Geography achievement test. Data were analyzed using an independent samples t-test to determine significant differences between male and female students. The results indicate that PBL effectively improves students' learning outcomes in Geography. However, a difference was found between male and female students, with female students achieving higher average scores, although both groups showed significant improvement. In conclusion, PBL is effective in enhancing Geography learning outcomes, and gender differences should be considered in designing more inclusive instructional strategies.

Keywords Critical Thinking Skills; Geography Education; Gender; Problem-Based Learning Approach

INTRODUCTION

Geography learning at the junior high school level plays a crucial role in developing students' knowledge, critical thinking skills, and awareness of both social and physical environments. However, students' learning outcomes in Geography are often influenced by internal and external factors, one of which is gender (Ramadani & Noviantari, 2024; Rumtini; Kasimin; Ease Arent; Abdul Jalil, 2022). Previous studies have indicated that gender differences may affect learning styles, motivation, and academic achievement (Abouelenein & Selim, 2022).

Therefore, it is important to further examine how gender-based differences in Geography learning outcomes emerge when students engage in innovative instructional approaches.

One relevant approach is Problem-Based Learning (PBL). PBL emphasizes students' active involvement in solving contextual problems, thereby promoting higher-order thinking skills, collaboration, and independent learning (Anjelina et al., 2021; Sianturi & Panggabean, 2019; Zahara et al., 2021). Recent studies have shown that PBL is effective in improving learning outcomes and critical thinking skills across various subjects, including Geography (Adilah & Rosyida, 2024). However, studies specifically analyzing gender-based differences in learning outcomes within the implementation of PBL, particularly in Indonesian junior high school contexts, remain limited.

This study aims to analyze gender-based differences in Geography learning outcomes through the implementation of PBL at a public junior high school in Gebang, Indonesia. The significance of this study lies in: (1) providing empirical contributions to the study of Geography learning outcomes by considering gender factors, (2) offering practical insights for teachers in designing inclusive and gender-responsive instructional strategies, and (3) enriching the literature on the effectiveness of PBL in junior secondary education. The hypothesis of this study is that there is a significant difference in Geography learning outcomes between male and female students after participating in Problem-Based Learning.

METHODS

This study employed a quasi-experimental method using a nonequivalent control group design. This design was chosen due to the inability to fully randomize participants within the school setting. The study focuses on examining differences in Geography learning outcomes between male and female students after the implementation of Problem-Based Learning (PBL). The scope of this study includes the Geography learning outcomes of eighth-grade students at a public junior high school in Gebang, Indonesia, categorized by gender. The research participants consisted of two classes selected purposively, with a relatively balanced number of male and female students.

The main materials and instruments used in this study included PBL-based instructional tools (lesson plans, student worksheets, and Geography teaching materials) and a learning achievement test in the form of multiple-choice questions that had been validated and tested for reliability. The study was conducted during the first semester of the 2025/2026 academic year. Data were collected through pretests and posttests administered before and after the implementation of PBL. Additional data were obtained through classroom observations of students' learning activities during the instructional process. Data analysis techniques included: (1) tests of normality and homogeneity as prerequisites for analysis, (2) an independent samples t-test to examine differences in learning outcomes between male and female students after treatment, and (3) descriptive analysis to illustrate overall improvements in learning outcomes. All data analyses were conducted using the latest version of SPSS.

RESULTS AND DISCUSSION

Results

The descriptive analysis of pretest and posttest scores based on gender is presented in Table 1. Male students obtained a mean pretest score of 38.39 ± 18.28, which increased substantially to 83.97 ± 9.45 in the posttest. Similarly, female students showed an improvement from 39.41 ± 17.62 in the pretest to 81.17 ± 8.06 in the posttest. These findings indicate that both male and female students experienced significant improvements after the implementation of the learning intervention. The relatively similar pretest scores suggest that both groups had comparable initial abilities. However, the slightly higher posttest scores among male students indicate a potential difference in learning outcomes after the treatment.

From a pedagogical perspective, this improvement reflects the effectiveness of the learning approach in enhancing students' understanding. The increase in mean scores for both genders suggests that the intervention successfully facilitated knowledge acquisition and skill development. The results of Levene's test indicated that the data were homogeneous for both class and gender variables, as all p-values were greater than 0.05. This confirms that the assumption of homogeneity of variance was met, allowing the use of parametric statistical analyses such as the independent t-test and ANCOVA. Ensuring this assumption is critical for maintaining the validity of inferential statistical conclusions.

Table 1. Homogeneity Test Results (Levene's Test)

Kelas	*p-value* (*Levene*)	Keterangan	*Gender*	*p-value* (*Levene*)	Interpretation
Pretest	0.674	Homogen	Sistole	0.664	Homogen
Posttest	0.903	Homogen	Diastole	0.125	Homogen

The independent t-test analysis revealed no significant difference between male and female students in the pretest scores ($p = 0.824 > 0.05$), indicating that both groups had equivalent baseline abilities. However, a statistically significant difference was observed in the posttest scores ($p = 0.022 < 0.05$), suggesting that gender influenced learning outcomes after the intervention. This result implies that while the intervention was effective for all students, its impact varied across gender. Male students achieved slightly higher scores, which may be associated with differences in engagement, confidence, or responsiveness to problem-based learning environments. Nevertheless, this difference should be interpreted cautiously, as both groups still demonstrated substantial improvement.

Table 2. Independent t-test Results by Gender

Grup	n	Mean±SD Pretest (n=62)	Mean±SD Posttest (n=62)
Male	33	38.39 ± 18.28	83.97 ± 9.45
Female	29	39.41 ± 17.62	81.17 ± 8.06

The ANCOVA results demonstrated a significant effect of class (experimental vs. control) on posttest scores ($p = 0.000 < 0.05$), indicating that the intervention had a strong

impact on student achievement. The experimental group achieved a higher mean score (87.23) compared to the control group (78.09), confirming the effectiveness of the applied learning model. In addition, gender also showed a significant effect ($p = 0.025 < 0.05$), and a significant interaction between class and gender was identified ($p = 0.019 < 0.05$). This interaction indicates that the effectiveness of the intervention varied depending on gender. Specifically, male students in the experimental group achieved the highest mean score (91.36), compared to female students in the same group (83.82). This suggests that the intervention may have been more beneficial for male students, although it remained effective for both genders overall.

Table 3. Results of the posttest comparison analysis on Class*Gender

Dependent Variable: Posttest

Kelas	Gender	Mean	Std. Deviation	N	*p-value* (kelas)	*p-value* (Gender)	*p-value* (kelas*Gender)
Eksperimen	Male	91.36	4.79	14	0.000 (beda nyata)	0.025 (beda nyata)	0.019 (beda nyata)
	Female	83.82	7.84	17			
	Total	87.23	7.57	31			
Kontrol	Male	78.53	8.28	19			
	Female	77.42	7.05	12			
	Total	78.09	7.72	31			
Total	Male	83.97	9.45	33			
	Female	81.17	8.06	29			
	Total	82.66	8.87	62			

The effect size analysis using Cohen's d revealed a large effect of the intervention on learning outcomes between the experimental and control groups ($d = 1.194$). This indicates that the intervention had not only statistical significance but also strong practical significance, demonstrating its effectiveness in improving student performance. For gender, the effect size was moderate ($d = 0.617$), suggesting that gender differences contributed to variations in learning outcomes, but were not the primary factor influencing achievement.

Tabel 4. Results of Cohen's d effect size test on groups (experimental and control) with gender (male and female)

Variabel	*Cohen's d* Estimasi	95% *Confidence Interval* (CI)	Keterangan
Berdasarkan Kelas			
Pretest	-0.162	-0.660 – 0.337	Efek Kecil
Posttest	1.194	0.648 – 1.732	Efek Besar
Berdasarkan Gender			
Pretest	-0.057	-0.555 – 0.442	Efek Kecil
Posttest	0.617	-0.187 – 0.818	Efek Sedang

Description: Cohen (1988) 0.00 – 0.20 small; 0.21 – 0.50 moderate; 0.51 -0.80 and > 0.80 large.

Discussion

The results of this study provide strong evidence supporting the effectiveness of the implemented learning approach in improving students' learning outcomes. The substantial increase in posttest scores, particularly in the experimental group, aligns with constructivist learning theory, which emphasizes active engagement and problem-solving as key components of meaningful learning. The large effect size further confirms that the intervention had a meaningful impact in educational practice. This suggests that student-centered approaches, such as Problem-Based Learning (PBL), are more effective than traditional methods in promoting deeper understanding and higher-order thinking skills.

The absence of significant differences in pretest scores indicates that the groups were comparable at baseline, strengthening the internal validity of the study. Therefore, the observed improvements can be attributed to the intervention rather than pre-existing differences. The emergence of gender differences in posttest results suggests that instructional strategies may not affect all students equally. While male students demonstrated slightly higher performance, the moderate effect size indicates that gender is not the dominant determinant of learning success.

The significant interaction between class and gender highlights the importance of considering learner characteristics in instructional design. This finding implies that while PBL is generally effective, its implementation should be adapted to accommodate diverse learning preferences. Strategies such as collaborative learning, scaffolding, and differentiated instruction may help ensure more equitable outcomes. Overall, these findings emphasize the importance of adopting innovative, student-centered learning approaches while also considering individual differences among learners to optimize educational effectiveness.

CONCLUSION

This study concludes that the implementation of Problem-Based Learning (PBL) has a significant and meaningful effect on improving students' learning outcomes. The experimental group demonstrated substantially higher posttest scores compared to the control group, supported by a large effect size (Cohen's d = 1.194), indicating strong practical significance of the intervention. The findings also revealed that there was no significant difference between male and female students at the pretest stage, confirming comparable initial abilities. However, a significant difference emerged in the posttest results, suggesting that gender influences learning outcomes after the implementation of PBL. Despite this, the moderate effect size (d = 0.617) indicates that gender is not the primary determinant of learning success.

Furthermore, the significant interaction between class and gender highlights that the effectiveness of PBL varies across student characteristics. This suggests the need for adaptive and inclusive instructional strategies to ensure optimal learning outcomes for all students. Overall, this study provides empirical evidence that PBL is an effective and impactful instructional approach. Therefore, it is recommended that educators integrate PBL into classroom practice while considering student diversity to maximize learning effectiveness..

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