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The Influence of Self-Efficacy and Gender on Students' Mathematical Learning Outcomes on the Topic of Circle Equations

Ibrahim Hasan[1], Rika Mulyati Mustika Sari[2], Kiki Nia Sania Effendi[3], Rafiq Zulkarnaen[4]
[1,2,3,4]Universitas Singaperbangsa Karawang, Indonesia

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ABSTRACT

This quantitative study aimed to examine the simultaneous and partial effects of self-efficacy and gender on mathematics learning outcomes related to circle equations among high school students. Employing a multiple regression design, the research involved 139 twelfth-grade students from SMA Negeri 7 Tambun Selatan, selected via simple random sampling. Data were collected through a self-efficacy questionnaire analyzed using the Successive Interval Method and an essay-based test for learning outcomes. Multiple regression analysis, after fulfilling classical assumptions, revealed that self-efficacy and gender significantly influenced learning outcomes simultaneously ($F = 1025$, $p < 0.00$). Partially, self-efficacy emerged as a significant predictor, with a positive coefficient ($\beta = 0.585$, $t = 5.969$, $p < 0.001$), indicating that higher self-efficacy is associated with improved cognitive achievement. Conversely, gender showed no significant partial effect ($p > 0.05$). Additional correlation analysis indicated a stronger relationship between self-efficacy and learning outcomes in male students ($\rho = 0.545$) compared to female students ($\rho = 0.348$). Nonetheless, self-efficacy remained the primary explanatory factor for cognitive achievement in both groups. These findings underscore the dominant role of self-efficacy as the key determinant of success in learning circle equations, surpassing the influence of gender.

Corresponding Author:

Ibrahim Hasan
Faculty of Teacher Training and Education, Universitas Singaperbangsa Karawang, Indonesia
Email: 2510632050005@student.unsika.ac.id

1. INTRODUCTION

Mathematics education plays a vital role in the secondary school curriculum, not merely as a core subject, but also as a means to shape students' abilities in logical, analytical, and structured thinking. This underscores that mathematics is a fundamental science that serves as essential supporting knowledge for the success of student education at higher levels and is a universal necessity in daily life [1]. Nevertheless, in practice, mathematics lessons are often perceived as boring, confusing, time-consuming, and difficult [2]. This condition, often accompanied by anxiety towards mathematics, ultimately leads to suboptimal learning outcomes at various levels.

One essential topic studied in advanced-level mathematics subjects at Senior High School (SMA) is Circle Equations. This topic is part of Analytic Geometry, which is conceptually and historically based on the principles of Euclidean Geometry [3]. Elective subjects in Phase F (grades XI and XII of SMA) in the independent curriculum are strategically designed to strengthen students' abilities to abstract. Thus, mastery of basic mathematical knowledge, concepts, and skills can be enhanced, making it an essential competence. This essential competence serves as a solid foundation across various disciplines, especially in engineering and technology, as well as for broader applications of mathematics in daily life [4].

The topic of Circle Equations requires students to integrate two areas of mathematics: algebra and geometry. The relevance of this material extends because it is often linked to other topics in mathematics, including trigonometry, calculus, and algebra [5]. The algebraic aspect involves mastery of formula manipulation, especially the use of perfect square techniques to transform the general equation $ax^2 + by^2 + cx + dy + e = 0$ into the standard form $(x - h)^2 + (y - k)^2 = r^2$ or vice versa. Meanwhile, the geometric aspect encompasses visualization, distance measurement, and the determination of a point's position relative to the circle. This is further supported by the assertion that, in studying Circle Equation material, students must be able to illustrate figures effectively, as this material extensively uses visual representations, such as circles, lines, and points, to solve problems [6]. Students are required to apply both algebraic and geometric principles simultaneously, including using geometric visualization to derive the equation of a circle centered at (a, b) and to calculate distances. Difficulties often manifest as an inability to formulate the standard equation or determine the center and radius, indicating low mathematical problem-solving abilities [7].

These difficulties experienced by students indicate a significant gap between curriculum demands and students' conceptual mastery. This gap is reflected in the fact that although learning success should increase with better understanding and material absorption, student achievement in mathematics remains low [8]. Therefore, the teacher's role is crucial in optimizing students' mathematics learning outcomes by implementing key strategies: (1) designing relevant tasks; (2) actively observing and stimulating thinking; (3) encouraging engagement through discussion; (4) motivating the use of various resources; (5) creating a conducive learning atmosphere; and (6) directly analyzing activities [9].

Efforts to improve learning outcomes cannot be limited to teaching strategies and teacher roles alone. Low learning outcomes on the topic of circle equations do not always stem from cognitive ability deficiencies but are also significantly influenced by non-cognitive or affective elements. One affective aspect that has proven important in human function and behavior, including academic performance, is self-efficacy. Self-efficacy constitutes a key theoretical framework useful for understanding students' beliefs in their own capabilities to successfully complete specific tasks or activities [10]. This belief is not merely optimism but a primary determinant of activity choices, the level of effort invested, 43 13 and resilience in the face of difficulties [11]. Self-efficacy is a core concept that is very important for enhancing understanding and learning outcomes, as it is defined as an individual's perception of their ability to organize and execute actions to perform certain skills, which will ultimately correlate with the development of self-confidence and improved student learning outcomes [12].

Various studies have concurred that self-efficacy (self-confidence) is a crucial affective variable that positively correlates with students' Mathematics learning outcomes. At the high school level, this positive relationship has been widely confirmed. For instance, 39 it has been similarly concluded that self-efficacy is an internal factor that significantly influences the general Mathematics learning achievements of high school students [13], [14]. This evidence is also consistent in more specific topics, where a strong correlation was found 1 between self-efficacy and student learning outcomes in combinatorics material [15]. Beyond specific topics, even in different learning contexts, such as online learning, self-efficacy has 12 been demonstrated to continue to play an important role in achieving learning outcomes [16]. 45 At lower educational levels, the positive influence of self-efficacy on students' Mathematics learning achievements has also been confirmed [17].

This comprehensive evidence clearly establishes self-efficacy as a strong and consistent predictor of mathematics learning outcomes in general. Not only does it influence final achievements, but self-efficacy also underpins the mastery of specific cognitive abilities that form those learning outcomes. Findings show that high self-efficacy plays a role in mastering various competencies, including understanding mathematical concepts in matrices [18], mathematical literacy [19], problem-solving in linear algebra [20], and creative thinking [21]. Furthermore, self-efficacy is closely related to metacognitive factors (including planning and self-checking) and emotional achievements, all of which significantly correlate with students' mathematical modeling competencies [22]. This positive influence encourages various intervention efforts, including the development of effective learning modules that increase student self-efficacy [23], [24]. These intervention efforts are also aligned with modern approaches in mathematics learning, such as the use of problem-based learning models that are relevant and contextual [25].

Research findings on inter-variable relationships are not always uniform and often yield contrasting results. Although most studies show a positive correlation, some findings do not align entirely with the dominant view in the literature. The study, which serves as a 49 methodological reference for this research, reported no significant relationship between self-efficacy and learning motivation towards the Grade Point Average (GPA) in university students [26]. This diversity of findings, coupled with evidence of significant gender differences in cognitive achievement, further emphasizes that inter-variable relationships are not always universal. For example, there is diversity in the findings of several studies: one found no significant difference in mathematical self-efficacy by gender [27], while another found that gender factors influence problem-solving abilities in Geometry topics, which are highly relevant to circle equations [28]. Environmental factors, specific materials, and the analysis instruments used may greatly influence how self-efficacy translates into cognitive learning outcomes.

The diversity of findings and the critical role of gender further underscore the urgency of conducting more focused research that employs robust statistical analysis. Although the study is close to using Senior High School subjects and circle equation materials, it limited its analysis to relationships between categorical levels (high, medium, low), whereas learning outcomes are more appropriately tested using continuous data [29]. Therefore, this research aims to bridge that research gap by using multiple regression analysis (parametric method) to test the influence of self-efficacy (continuous score) and the contribution of gender as predictors of mathematics learning outcomes in circle equations. The main novelty of this study lies in testing the simultaneous influence of self-efficacy and gender in a single regression model, as well as separately assessing the strength of self-efficacy's correlation with learning outcomes across gender groups. This analysis is expected to provide a deeper, more precise understanding of the contributions of both factors to students' cognitive achievement.

2. METHOD

This research uses a quantitative approach with a Multiple Regression design, which falls under the associative-predictive research category. This design was chosen to analyze and test the influence of independent variables, namely self-efficacy (as a continuous variable) and gender (as a categorical variable), on the dependent variable of mathematics learning outcomes in circle equations. This approach allows researchers to determine the significance of influence and the relative contribution of each predictor within a single statistical model.

The research population comprises all twelfth-grade students taking advanced-level mathematics subjects at SMA Negeri 7 Tambun Selatan, Bekasi Regency, in the 2025/2026 academic year, for a total of N = 212 students. The sampling technique used is Simple Random Sampling. The technique for determining the sample uses the Slovin formula [30]:

$$n = \frac{N}{1 + (N \times e^2)}$$

Where:
n = Sample Size
N = Population
e = Percentage of Tolerance for inaccuracy due to acceptable sampling error.

Based on the Slovin formula calculation with a 95% confidence level and 5% error rate, a sample size of n = 139 students was obtained, which was then designated as the research subjects.

Research data was collected using two main instruments. The first instrument is a self-efficacy questionnaire adapted from the research titled "The Relationship Between Self-Efficacy and Classroom Climate with Self-Regulated Learning of SMA Negeri 11 Medan Students" [31]. This instrument has been validated and produces data in the form of continuous scores (numeric) using a Likert scale. The second instrument is a circle equations learning outcome test in essay form, adopted from the research titled "Effectiveness of Using Inquiry-Based Student Worksheets with Geogebra Software Media Assistance in Teaching Circle Equation Material in Class XI IPA SMAN 4 Kota Bima" [32]. This instrument is designed to measure students' cognitive mastery of circle equation material. Since both instruments were adopted from previous research (theses) and utilized for similar purposes, they were considered construct-valid and reliable. Consequently, no re-testing of validity and reliability was conducted in the field.

Based on the literature review and the main research objective to test the influence of Self-Efficacy and Gender on Learning Outcomes using Multiple Regression, the hypotheses to be tested are as follows:

1. Simultaneous Hypothesis (F-test):
   a. H_1: At least one $\beta_i \neq 0$ (There is a significant simultaneous influence between Self-Efficacy and Gender on Mathematics Learning Outcomes in Circle Equations).
2. Partial Hypotheses (t-test):
   a. $H_{2.1} = \beta_1 \neq 0$ (Self-Efficacy has a significant influence on Mathematics Learning Outcomes in Circle Equations).
   b. $H_{2.2} = \mu_L \neq \mu_P$ (There is a significant difference in Mathematics Learning Outcomes in Circle Equations between Male and Female students).
3. Additional Correlation Hypothesis:
   a. $H_3 = \rho \neq 0$ (There is a significant relationship (Pearson Product-Moment Correlation) between Self-Efficacy and Circle Equations Learning Outcomes in the group of Male (ρ_L) and/or Female (ρ_P) Students.

The raw scores from the self-efficacy questionnaire will be processed using the Method of Successive Intervals (MSI) to normalize the data. Data analysis is carried out using JASP statistical software and follows the rules of parametric multiple regression. The initial stages include classical assumption tests, namely normality tests (residuals), multicollinearity, and heteroscedasticity, to ensure the data meet the requirements before regression is performed [14]. Subsequently, Multiple Regression tests are conducted to test the hypotheses, including the F-test (for simultaneous influence significance) and t-test (for partial influence significance of each variable, Self-Efficacy and Gender) [26]. In addition, the coefficient of determination (R^2) is used to assess the magnitude of the predictor's contribution. Finally, to specifically examine gender, a Pearson product-moment correlation test is conducted within each gender to compare the strength of the relationship between Self-Efficacy and Circle Equations Learning Outcomes.

3. RESULTS AND DISCUSSION

The results and discussion of this research begin with descriptive statistical analysis of the key variables. Subsequently, this section will discuss the research results that answer several hypotheses previously proposed. This analysis includes descriptive analysis, regression coefficient tests (t-test), simultaneous significance tests (F-test), and coefficient of determination (R^2).

3.1. Results

Descriptive statistics are presented to provide an overview of the distribution of self-efficacy scores and mathematics learning outcomes in circle equations across the entire research sample (n=139), including comparisons of averages and variations between male and female groups. The calculation results are presented in Table 1.

Table 1. Descriptive Statistics

	Circle Equations		Self-Efficacy	
	Male	Female	Male	Female
Valid	66	73	66	73
Mean	69.67	78.62	124.5	121.1
Std. Deviation	18.34	17.36	14.87	12.92
Minimum	27.45	17.65	95.70	93.89
Maximum	98.04	100.0	163.40	148.2
Shapiro-Wilk	0.963	0.878	0.982	0.969
p-Value of Shapiro-Wilk	0.049	< 0.001	0.441	0.068

In the Circle Equation learning outcome variable, the mean score for females (78.62) is significantly higher than that for males (69.67), with a difference of approximately 9 points. Simultaneously, male scores (Std. Deviation 18.34) exhibit greater heterogeneity, or variability, than female scores (Std. Deviation 17.36), as indicated by the analysis of data distribution and relative variability. On the other hand, among all groups, female scores on the Self-Efficacy variable demonstrate the highest homogeneity (Std. Deviation 12.92), indicating that their values are highly concentrated around the mean (female mean 121.1 and male mean 124.5). Additionally, the data for each gender group were tested for normality using the Shapiro-Wilk test. According to the test results, the self-efficacy assessments for both Female ($p = 0.068$) and Male ($p = 0.441$) groups are normally distributed ($p > 0.05$). However, the learning outcomes in circle equations scores for the male group ($p = 0.049$) and female group ($p < 0.001$) are not normally distributed. However, the primary normality assumption in multiple regression is on the model's residuals, which will be tested later. Classical assumption tests, including tests for multicollinearity in Table 2, were conducted before regression testing to ensure the estimated multiple linear model is valid, efficient, and unbiased.

Table 2. Multicollinearities Statistics

Model		Colinearity Statistics	
		Tolerance	VIP
M_1	*Gender*	0.334	2.993
	Self - Efficacy	0.112	8.961

The regression model is free from multicollinearity, as all Variance Inflation Factor (VIF) values (highest VIF: 8.961; lowest: 2.993) are well below the threshold of 10, and the lowest Tolerance value (0.112) is above the threshold of 0.10. Since both VIF and Tolerance meet the established criteria, the independent variables used do not have excessively high

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correlations. The multicollinearity diagnostic results were further examined using the Condition Index (CI), as presented in Table 3.

Table 3. Multicollinearities Diagnostic (Condition Index)

Model	*Dimension*	Eigenvalue	Condition Index	Variance Proportion		*Self - Efficacy*
				Male	Female	
M_1	1	1.994	1.000	0.003	0.003	0.003
	2	1.000	1.412	0.013	0.012	0
	3	0.006	17.866	0.984	0.985	0.997

8 The Collinearity Diagnostics in Table 3 confirm that the regression model is free from serious multicollinearity issues, as the highest Condition Index (17.866) is below the critical threshold of 30. With multicollinearity established, the classical assumption tests examined residual normality (Shapiro-Wilk test on Standardized Residuals), with results 6 presented in Table 4.

Table 4. Results of the Residual Normality Test (Shapiro-Wilk) Based on Gender

	Residuals	
	Male	Female
Valid	66	73
Shapiro-Wilk	0.987	0.930
p-Value of Shapiro-Wilk	0.695	< 0.001

The results in Table 4 show that the residuals for the male group are normally distributed ($p = 0.695$). However, the residuals for the female group do not meet the normality assumption ($p < 0.001$). Although the residual normality assumption is not perfectly satisfied, the analysis proceeds because the multicollinearity assumptions have been met, and multiple regression is generally robust (resistant) to non-normality in sufficiently large samples (n=139). The heteroskedasticity assumption is checked through visual analysis of the residuals vs. fitted values plot in Figure 1.

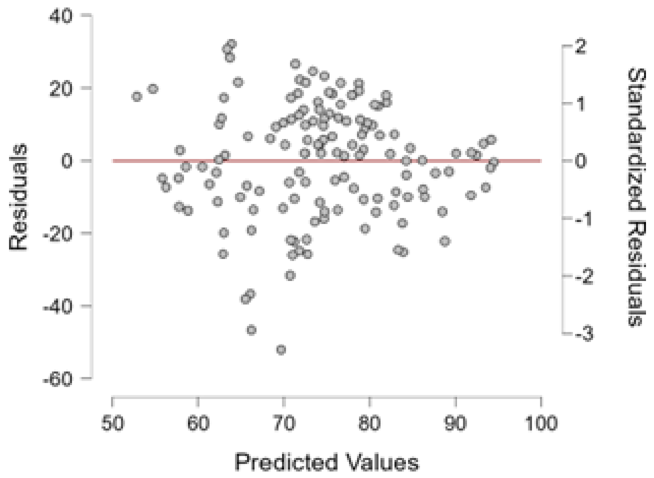

Figure 1. Plot residuals vs. Predicted values (heteroskedasticity test)

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The plot shows residual points scattered randomly around the zero line, with no specific patterns (such as a funnel or wave). Therefore, the homoskedasticity assumption is satisfied. Given that most classical assumptions are met, particularly multicollinearity and homoskedasticity, the multiple linear regression model is suitable for testing the main hypothesis. Hypothesis testing regarding the influence of *Self-Efficacy* and *Gender* on Learning Outcomes in Circle Equations then proceeds by examining the overall model strength, as shown in Table 5.

Table 5. Model Summary - Circle Equations

Model	R	R^2	Adjusted R^2	RMSE
M_1	0.979	0.958	0.957	15.93

Note. M_1 includes *Self-Efficacy*, *Gender*

Table 5 shows that a coefficient of determination (R^2) is 0.958, implying that Self-Efficacy and Gender jointly account for 95.8% of the variance in Circle Equations Learning Outcomes. This value reflects the model's very strong predictive power. Following the assessment of predictive strength, a simultaneous test (*F*-test) was performed to evaluate the collective significance of the predictors. The results are presented in Table 6.

Table 6. Simultaneous Test Results (ANOVA)

Model		Sum of Squares	df	Mean Square	F	p
M_1	Regression	780593	3	260197.5	1025	< 0.001
	Residual	34533	136	253.9		
	Total	815125	139			

Note. M_1 includes *Self-Efficacy*, *Gender*

Table 6 reveals an F-value of 1025 with $p < 0.001$. Given that the p-value falls below the 0.05 threshold, it can be inferred that Self-Efficacy and Gender exert a significant combined effect on Circle Equations Learning Outcomes. The analysis then progressed to partial significance tests (t-tests) to ascertain the individual contributions of each predictor variable. The t-test outcomes and regression coefficients are elaborated in Table 7.

Table 7. Regression Coefficients

Model		Unstandardized	Standar Error	standardized [a]	t	p
M_0	(Intercept)	74.369	1.555		47.839	< 0.001
M_1	*Self-Efficacy*	0.585	0.098	0.455	5.969	< 0.001
	Gender (Male)	-3.205	12.366		-0.259	0.796
	Gender (Female)	7.734	12.022		0.643	0.521

[a] standardized coefficients can only be computed for continuous predictors.

As shown in Table 7, the Self-Efficacy variable demonstrates a significant partial effect on Circle Equations Learning Outcomes ($t = 5.969$; $p < 0.001$). With the p-value under

0.05, the partial hypothesis for Self-Efficacy is supported. The positive unstandardized coefficient of 0.585 indicates a direct association, suggesting that higher student Self-Efficacy is associated with improved Circle Equations Learning Outcomes. In contrast, gender does not exhibit a significant partial influence on Circle Equations Learning Outcomes, as evidenced by the p-values for Males (p = 0.796) and Females (p = 0.521), both of which exceed 0.05. These findings suggest that differences in Circle Equations Learning Outcomes between the Gender groups become statistically non-significant once Self-Efficacy is controlled for in the regression model. Denoting the constant as a, the Self-Efficacy coefficient as b_1, and the Gender coefficient as b_2 from the Unstandardized Coefficients column, the regression equation is formulated as:

$$\hat{Y} = a + (\beta_1)x_1 + (\beta_2)x_2$$

By incorporating the verified values (where a = 74.369 and b_1 = 0.585), the regression equation can be formulated as:

$$\hat{Y} = 74{,}369 + 0.585\ x_1 + (\beta_2)x_2$$

Where:

a. 74.369 is the constant (a) or intercept from the intercept row in the Coefficients Table.
b. 0.585 is the coefficient β_1 for the variable x_1 (Self-Efficacy).
c. $(\beta_2)x_2$ denotes the Gender coefficient, with values of -3.205 for Males and 7.734 for Females.

To complement the partial analysis, Pearson correlation (r) and Spearman correlation (ρ) tests were conducted separately to compare the strength of the association between Self-Efficacy (SE) and Circle Equations Learning Outcomes (PL) across Gender groups. The Spearman test served as a nonparametric test due to violations of the normality assumption in Circle Equations Learning Outcomes (PL) scores for both groups. Pearson correlation (r) was run concurrently with Spearman correlation (ρ) as a nonparametric check. The correlation results for both tests in each group are detailed in Table 8.

Table 8. Pearson Product-Moment Correlation and Spearman Correlation Tests

Gender	Pearson		Spearman	
	r	p	ρ	p
Male	0.521	< 0.001	0.545	< 0.001
Female	0.385	< 0.001	0.348	0.003

Table 8 shows that the association between Self-Efficacy and Circle Equations Learning Outcomes is positive and significant (p < 0.003) in both groups, whether assessed via Pearson or Spearman correlations. More precisely, the strength of the Self-Efficacy and Circle Equations Learning Outcomes relationship is stronger among male students (ρ = 0.545) than among female students (ρ = 0.348).

3.2. Discussion

The core statistical finding of this multiple regression analysis definitively positions Self-Efficacy as the most dominant and significantly positive predictor of Circle Equations Learning Outcomes ($\boldsymbol{\beta}$ = 0.585, t = 5.969, p < 0.001). This highly substantial regression coefficient provides robust evidence supporting the central hypothesis: students' academic self-efficacy is a primary determinant of their cognitive success in this specific mathematical domain. This significance transcends mere correlation, it establishes a strong predictive relationship, suggesting that interventions aimed at boosting this psychological factor will yield the most substantial returns in academic performance. This powerful link is deeply rooted in established psychological theory.

This dominance of Self-Efficacy is theoretically congruent with Bandura's Social Cognitive Theory, which defines self-efficacy not merely as optimism but as a key determinant of activity choice, the level of effort invested, and resilience in the face of difficulties [11]. In the context of the Circle Equations material, this translates into a higher willingness to engage with demanding tasks. Students with high self-efficacy are prepared to invest greater cognitive effort and exhibit the resilience needed when encountering setbacks, such as errors in complex algebraic manipulation or misinterpretations of geometric diagrams. Effort investment, however, is only one side of the coin; its efficacy relies on strategy.

The substantial influence of Self-Efficacy is mediated through the activation of superior cognitive strategies. Students who are confident in their abilities are more likely to perceive the complex algebraic manipulations inherent in Circle Equations [5] as surmountable challenges [29], rather than insurmountable obstacles. This positive challenge perception is crucial because it facilitates the effective activation of high-level cognitive strategies, such as metacognition. These strategies, which involve planning, monitoring, and evaluating the problem-solving process, are essential for developing higher-order skills such as Mathematical Modeling Competence [22]. The universal presence of this mechanism makes the finding broadly relevant.

The dominance of Self-Efficacy as a predictor is well established and widely confirmed across various mathematical domains and educational levels. This study extends that consensus by confirming its critical role specifically within the context of Circle Equations at the high school level. Prior research across general high school mathematics achievement consistently supports the notion that self-belief acts as a powerful antecedent to measurable cognitive outcomes [13]-[22]. This widespread empirical support enhances the validity and generalizability of the current study's primary conclusion regarding the salience of affective factors. Despite this strong affective influence, the analysis also revealed a crucial lack of influence from demographic variables.

A critical outcome of the multiple regression analysis is that the Gender variable has no statistically significant effect on Circle Equations Learning Outcomes ($p > 0.05$) after controlling for the powerful effect of Self-Efficacy. This is a crucial distinction. It implies that any observed mean differences in achievement between male and female students are rendered non-substantial once the strong psychological factor of Self-Efficacy is accounted for. This suggests that the successful mastery of Circle Equations material is fundamentally determined not by biological factors but by students' beliefs in their own capabilities. This conclusion aligns well with existing findings on affective mediation, and similar gender neutrality regarding efficacy has been observed in studies concerning teachers' efficacy in mathematics instruction [33].

This result aligns with prior literature suggesting that gender as a predictor often loses its significance when dominant affective factors are properly considered [34]. In this model, Self-Efficacy effectively acts as a gating factor or a powerful mediator. The implication is that when male and female students possess similar, high levels of confidence in their ability to solve geometric and algebraic problems, their cognitive performance converges. This finding offers an optimistic, actionable conclusion: the potential for cognitive achievement in mathematics is gender-neutral, underscoring the need to raise Self-Efficacy equitably across all student demographics. While the overall regression showed neutrality, a deeper look at the correlation structure uncovered subtle variations.

The supplementary analysis using Pearson Correlation, separated by gender, introduces an important nuance: the Self-Efficacy correlation for Males (ρ = 0.545, Strong) proved stronger than for Females (ρ = 0.348, Moderate). This observation suggests a difference in the efficiency with which self-belief is converted into measurable cognitive scores. Male students appear to translate their sense of self-efficacy into higher performance more readily or efficiently than their female counterparts, even when the overall levels of self-efficacy are comparable. Understanding this conversion gap requires considering external, sociocultural pressures.

This difference in conversion efficiency may be linked to underlying sociocultural or pedagogical factors. For instance, male students might be more encouraged or feel more comfortable engaging in risk-taking behaviors or taking aggressive initiative when tackling complex geometric problems [28]. This behavioral tendency, rooted in social expectations, could potentially accelerate the link between high self-efficacy and high scores. While this variation exists, the paramount conclusion remains clear: Self-efficacy is the primary, significant explanatory factor for cognitive achievement in both groups. These findings lead directly to practical recommendations for the classroom.

The findings have clear practical implications for instruction. Since Self-Efficacy is the sole significant predictor, pedagogical interventions should prioritize building student confidence over traditional drill-and-practice methods. Educators should implement strategies such as presenting successful peer models, providing concrete mastery experiences through scaffolded problem sets, and offering specific, persuasive feedback to enhance students' beliefs in their competence. Given the subtle gender difference in the correlation, interventions must also address the efficiency with which self-efficacy translates into performance, ensuring that all students are comfortable with strategic risk-taking. Despite the robustness of the current model, this study acknowledges certain structural limitations.

While the model strongly supports the hypothesis, this study is subject to limitations typical of a cross-sectional design, primarily the inability to infer causality definitively. Future research should employ longitudinal or experimental designs to test the causal relationship between Self-Efficacy enhancement and subsequent Circle Equations learning outcomes. Additionally, future studies should investigate the mediating roles of specific learning behaviors (e.g., help-seeking, persistence metrics) to fully unravel the mechanism by which the stronger correlation in males translates into performance [28]. This would provide a more complete picture of how to optimize the conversion of self-belief into academic success.

4. CONCLUSION

The conclusions of this study are drawn from the Multiple Regression Analysis results, which test the influence of Self-Efficacy and Gender on Circle Equations Learning Outcomes. The main findings indicate that Self-Efficacy is a significant and dominant predictor of Circle Equations Learning Outcomes. The positive and significant regression coefficient value ($\beta_1 = 0.585$, $p < 0.001$) indicates that the higher the students' Self-Efficacy in their mathematical abilities, the higher their cognitive achievement in Circle Equations material. Conversely, the Gender variable has no statistically significant influence on Circle Equations Learning Outcomes in the Multiple Regression model ($p > 0.05$) after controlling for Self-Efficacy, suggesting that differences in Circle Equations Learning Outcomes between male and female students are not dictated by gender but by their psychological factors (Self-Efficacy). Additional Correlation Analysis shows differences in the strength of the relationship between Self-Efficacy and Circle Equations Learning Outcomes by gender, with the correlation in the Male group ($r = 0.545$, Strong) slightly stronger than in the Female group ($r = 0.348$, Moderate). However, Self-Efficacy remains the primary explanatory factor for both groups.

Based on findings identifying Self-Efficacy as the dominant predictor of learning achievement, Mathematics Educators are recommended to prioritize interventions to enhance Self-Efficacy before introducing complex material. This can be achieved through the provision of measurable mastery experiences and the use of collaborative learning to facilitate social modeling, supported by descriptive feedback focused on the process. School Institutions and Curricula are advised to integrate universal programs to develop academic self-confidence, regardless of gender, thereby ensuring that Self-Efficacy interventions are applied uniformly. Meanwhile, Future Researchers are encouraged to deepen their studies by employing more complex multivariate analysis techniques, such as Path Analysis or Moderated Regression, to examine the role of gender, as well as to conduct experimental studies to test the effectiveness of specific interventions to improve Mathematical Self-Efficacy.

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