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Attitude, self-esteem, and mathematics performance of the students in a collaborative learning environment

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Abstract: To develop 21st century competencies, it is crucial to comprehend multiple factors that influence students' mathematics performance. Collaborative learning is a key factor in boosting self-esteem, leading to better academic results. This study explores students' attitudes toward collaborative learning, their self-esteem in learning mathematics, and their mathematics performance. It also investigates the mediating role of self-esteem between students' attitudes and their mathematics performance and the moderating role of specialization in the relationship between self-esteem and performance. A descriptive-correlational research design was employed, utilizing regression, mediation, and moderation analyses to interpret the data. The sample comprised 64 second-year Industrial Technology students specializing in Architectural Drafting, Automotive Technology, and Electrical Technology. Findings revealed that students exhibited a very positive attitude toward collaborative learning, reported high levels of self-esteem, and demonstrated average mathematics performance. Self-esteem has a significant predictive relationship with mathematics performance. While the attitude toward collaborative learning does not directly influence mathematics performance, it exerts a significant indirect effect through self-esteem. Furthermore, specialization does not moderate the relationship between self-esteem and mathematics performance. Therefore, self-esteem is crucial in students' mathematics performance, as it bridges the gap between collaborative learning attitudes and academic results, regardless of specialization. The need to promote collaborative environments and improve students' self-esteem is recommended to achieve better mathematics outcomes.

Keywords: *Attitude, Self-esteem, Collaborative learning, Mathematics performance, Mediation, Moderation, Specialization.*

1. Introduction

In today's rapidly evolving world, the educational landscape demands that students acquire more than just memorization—they must develop 21st-century skills to thrive academically and professionally. These skills encompass critical thinking, creativity, collaboration, and communication, which are necessary for students to solve complex problems, adapt to change, and work effectively in diverse environments. Kennedy and Sundberg [1] argue that for students to function as 21st-century learners, they must be equipped with these competencies. However, traditional learning approaches, which often rely on passive reception of information and rote memorization, fail to meet these modern expectations. Instead, more dynamic and interactive methods are required to foster the skills necessary for success in the current era.

Collaboration, as one of the core 21st-century learning skills, is essential in helping students learn more effectively and develop broader social and cognitive abilities. According to Ojobor, et al. [2] collaborative learning encourages student teamwork to achieve a shared goal, fostering a sense of responsibility, interdependence, and active engagement. It enhances content retention and academic performance and supports the development of oral communication, higher-order thinking, and self-esteem. Furthermore, collaboration allows students with differing abilities to support and learn from one

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another, providing a more inclusive and supportive learning environment where even those who struggle can gain confidence and improve.

Numerous studies have supported the positive impact of collaborative learning, especially in subjects like mathematics, where students often experience anxiety or disinterest. For instance, research shows collaborative learning strategies improve students' attitudes toward mathematics [3, 4] and significantly enhance their academic achievement [5, 6]. These outcomes can be better understood through Ajzen and Fishbein's theory of reasoned action, which posits that beliefs shape attitudes. Suppose students believe that collaboration will improve their performance. In that case, they are more likely to develop a positive attitude toward both the method and the subject, influencing their performance. On the contrary, negative attitudes and reduced motivation may follow if they believe such efforts are ineffective or not worthwhile.

Another key factor significantly influencing learning outcomes is self-esteem, which refers to a person's overall evaluation of their worth and capability. It is shaped by social experiences, including interactions with peers and teachers, and is crucial in determining how students engage with academic challenges [7, 8]. A student with high self-esteem is more likely to persist in solving problems, participate actively in class, and take educational risks. In contrast, a student with low self-esteem may avoid challenges and fear failure. Studies confirm that self-esteem positively correlates with mathematics achievement [9-11] reinforcing that academic success is not just about cognitive ability but also emotional and psychological readiness.

Teachers play a vital role in shaping students' self-esteem in this context. Their words, actions, and teaching strategies can build or diminish a student's confidence. Encouraging feedback, respectful treatment, and a supportive classroom environment help students feel valued and capable [12, 13]. For example, recognizing a student's progress, regardless of how small, can instill pride and motivate further effort. On the other hand, constant criticism or neglect can damage self-worth. As highlighted by researchers, self-confidence and self-acceptance are essential to healthy self-esteem, and students who take pride in their academic abilities are more likely to perform better [14, 15].

Given these insights, it is understandable that collaborative learning is increasingly being integrated into curriculum designs, particularly in subjects like mathematics, where student engagement and confidence are often low. The inclusion of collaborative learning strategies in the course syllabus signifies a shift toward more student-centered and skill-oriented teaching. It not only aligns with the requirements of 21st-century education but also addresses the emotional and social dimensions of learning.

Therefore, the current study examines the relationships among students' attitudes toward mathematics, self-esteem, and academic performance within a collaborative learning environment. By understanding how these elements interact, educators can refine their teaching strategies to support better students' holistic development—intellectually, emotionally, and socially.

At present, the mathematics course syllabus incorporates collaborative learning as a key instructional strategy, which reflects a shift towards more interactive and student-centered pedagogies. In line with this instructional approach, the present study examines how collaborative learning influences key learner outcomes—specifically, students' attitudes, self-esteem, and academic performance in mathematics.

In this context, the study investigates the interrelationships among students' attitudes toward collaborative learning, self-esteem related to mathematics learning, and mathematics performance among Bachelor of Science in Industrial Technology students during the First Semester of the Academic Year 2024–2025 within a collaborative learning environment.

The study specifically seeks to address the following research questions:

1. What are the levels of students' attitudes toward collaborative learning, self-esteem in learning mathematics, and mathematics performance in a collaborative learning environment?
2. Do students' attitudes toward collaborative learning and self-esteem significantly predict their mathematics performance?
3. Does self-esteem mediate the relationship between students' attitudes toward collaborative learning and their mathematics performance?

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4. Does the students' field of specialization moderate the relationship between self-esteem and mathematics performance?

1.1. Theoretical and Conceptual Framework of the Study

This study is grounded in Collaborative Learning Theory, which is fundamentally informed by Lev Vygotsky's Social Development Theory, particularly his construct of the Zone of Proximal Development (ZPD). According to Vygotsky, cognitive development is significantly influenced by social interaction, wherein learners rely on more capable peers or collaborative group settings to perform tasks they cannot accomplish independently. This theoretical framework underscores the belief that learning is a socially mediated process where knowledge is constructed through interaction and cooperation. Collaborative learning is considered essential in cultivating critical thinking skills, with research suggesting that students exhibit greater retention and understanding of concepts when engaged in group-based learning environments.

The collaborative learning model promotes peer-to-peer interactions that deepen classroom discourse and foster the development of essential skills such as higher-order thinking, oral communication, self-regulation, leadership, and organizational competencies. These interactions create opportunities for learners to actively participate, articulate their ideas, and engage in collective problem-solving, which enriches their academic and personal growth.

Additionally, the study draws theoretical support from Jean Piaget's Theory of Cognitive Development, which emphasizes the learner's active role in constructing knowledge through interaction with the physical and social environment. Piaget posited that children progress through stages of cognitive development by reconciling discrepancies between their existing knowledge structures and new experiences. Through the complementary processes of assimilation and accommodation, learners reorganize their mental frameworks to adapt to new information. This theoretical orientation highlights the importance of active learning and discovery-based engagement, integral to collaborative learning contexts.

Collaboration, a key 21st-century learning competency, enhances students' academic engagement and personal development. It improves knowledge retention, critical analysis, communication, self-esteem, and a sense of responsibility [16]. Within this context, the present study examines the relationship between students' attitudes toward collaborative learning, their self-esteem in mathematics, and their performance in the subject.

This research conceptual framework incorporates key constructs and proposed interrelationships among variables to support data interpretation and analysis. The framework investigates the dynamic interaction between the following variables:

- Independent Variable: Attitude toward the Collaborative Learning Approach, categorized on a scale ranging from very negative to very positive. This variable captures students' beliefs, perceptions, and dispositions toward collaborative learning strategies in mathematics education.
- Dependent Variable: Mathematics Performance, operationalized through students' end-term grades in mathematics.
- Mediating Variable: Self-esteem in Learning Mathematics is proposed as a mechanism that may explain how students' attitudes toward collaborative learning influence their academic achievement. Self-esteem levels are assessed using descriptors ranging from very low to very high.
- Moderating Variable: Field of Specialization, included to explore potential variations in the relationships among the core variables based on students' field of specialization (e.g., Architectural Drafting, Automotive Technology, and Electrical Technology).

The conceptual model hypothesizes that students with more positive attitudes toward collaborative learning are more likely to exhibit higher self-esteem in learning mathematics, which, in turn, enhances

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their academic performance. The inclusion of the field of specialization as a moderating factor allows for the examination of whether these relationships differ across academic domains.

By analyzing the interplay among cognitive, affective, and contextual factors, this study aims to provide a better understanding of the determinants of mathematics performance. Specifically, it highlights the potential of non-cognitive factors, such as students' attitudes and self-esteem, in shaping mathematics outcomes. The findings inform pedagogical practices integrating collaborative learning to promote engagement, equity, and academic excellence in mathematics education. Additionally, the results could support the development of evidence-based interventions to strengthen students' self-esteem and encourage more effective use of collaborative strategies in classroom settings.

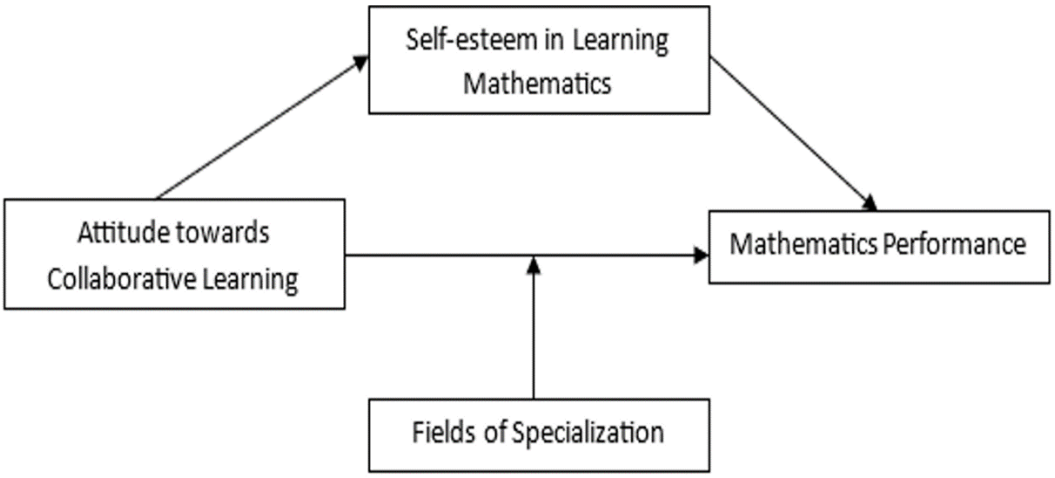

Figure 1.
Conceptual Framework of the Study.

2. Research Methodology

2.1. Research Design

This study employed a descriptive-correlational research design to examine the levels of students' attitudes toward collaborative learning, their self-esteem in learning mathematics, and their mathematics performance within a collaborative classroom environment. The primary aim of this design was to explore naturally occurring relationships among these variables without any experimental manipulation or intervention, thus maintaining ecological validity. The correlational approach allowed the researcher to identify associations that may serve as a foundation for more complex inferential analyses.

Following descriptive statistical procedures, which were used to summarize the levels of the key variables, mediation analysis was conducted to determine whether the relationship between the independent variable—students' attitudes toward collaborative learning—and the dependent variable—students' mathematics performance—operates indirectly through a mediating variable, specifically self-esteem in learning mathematics. This approach is grounded in the assumption that attitudes toward collaborative learning may influence self-esteem, which, in turn, affects academic outcomes in mathematics.

Regression-based mediation analysis was employed to estimate these relationships. Alternatively, structural equation modeling (SEM) was utilized to test the significance and magnitude of both direct effects (i.e., attitudes directly influencing mathematics performance) and indirect effects (i.e., attitudes influencing self-esteem, which then affects performance).

In addition to mediation analysis, moderation analysis was also performed to assess whether the strength or direction of the relationship between students' attitudes toward collaborative learning and their mathematics performance is conditional upon their field of specialization (e.g., Architectural Drafting, Automotive Technology, and Electrical Technology). The field of specialization was treated as

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a moderating variable. Including a moderating variable allows for the identification of interaction effects, which reveal whether the impact of collaborative learning attitudes on academic performance varies across different academic disciplines.

Together, these analyses (mediation and moderation) provide a more comprehensive understanding of the mechanisms (how) and conditions (when or for whom) under which students' affective and attitudinal factors contribute to their performance in mathematics. This dual analytic strategy aligns with the growing emphasis on examining direct and conditional educational research pathways to inform theory, practice, and policy.

2.2. Respondents of the Study

The study involved 64 out of 76 students from the BS Industrial Technology Programs, representing three areas of specialization: Architectural Drafting (21 students), Automotive Technology (16 students), and Electrical Technology (27 students). These students engaged in collaborative learning methods throughout their mathematics classes for the entire term. They also consented by responding positively to the Participation Informed Consent form before the study was conducted.

2.3. Research Instruments

The revised and validated questionnaires were used to gather data on students' attitudes toward collaborative learning and their self-esteem in learning mathematics. These questionnaires underwent expert validation, where four mathematics experts and two educational psychology experts reviewed each item, providing feedback on the questions' content, structure, and relevance. Based on their recommendations, the items were revised accordingly. The experts then assessed the overall validity of the questionnaire, giving it a rating of 4.85, which was interpreted as 'Excellent,' confirming that the instruments were valid.

The reliability of the instrument was assessed using the Cronbach's alpha method. A pilot test was conducted on BS industrial students not involved in the study to evaluate the reliability of the research instrument. The Cronbach's alpha reliability coefficient was 0.981 for the 'Attitude towards Collaborative Learning Scale' and 0.92 for the 'Self-Esteem Scale in Learning Mathematics.' Both coefficients, which exceed the acceptable threshold of 0.70, are considered excellent, confirming that the two scales used are reliable measures for this study.

Conversely, the students' end-term grades in mathematics, obtained through a collaborative learning approach, were used to assess their performance in the subject.

2.4. Data Gathering Procedure

Collecting data for this study began with obtaining formal permission to conduct the research. A letter requesting authorization was submitted to the dean of the CHMSU-Alijis Campus. This letter outlined the study's purpose, methodology, and significance, ensuring the research adhered to institutional policies and ethical guidelines. After receiving the dean's approval, permission was granted to proceed with the study.

With the dean's consent, the next crucial step involved ensuring informed consent from the participants. A Participation Informed Consent form was provided to each student, outlining the objectives of the study, the voluntary nature of their participation, and the privacy measures in place. Participants were assured that any information shared during the survey would remain confidential, addressing data security and privacy concerns. This step was essential in adhering to ethical research practices, ensuring that participants understood their rights and the scope of their involvement in the study.

Once the students read and fully understood the informed consent form, they were asked to sign it to indicate their voluntary participation. By signing the form, they acknowledged that they were aware of the study's purpose and their role in it, and they consented to participate with the assurance of confidentiality.

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Following the signed consent, the data collection phase involved administering the validated and reliability-tested questionnaires. These questionnaires assessed the students' attitudes toward collaborative learning and their self-esteem in learning mathematics. The instrument had already undergone expert validation and reliability testing, ensuring it was valid and reliable for measuring the constructs of interest.

In parallel, the study also required access to the students' End-term grades in mathematics. These grades were retrieved directly from the teacher's class records. This data was crucial for assessing the students' academic performance and correlating it with their questionnaire responses. Permission to access this information was sought in advance, ensuring that all data collected was appropriate and relevant to the study's objectives.

Once the data collection was complete, all gathered information was carefully encoded into a data management system. This encoding process ensured that all responses and grades were organized and ready for analysis. After encoding, the data underwent statistical treatment for meaningful interpretation and analysis. Various statistical methods were applied to examine the relationships between the variables, such as students' attitudes toward collaborative learning, self-esteem, and mathematics performance.

2.5. Data Analysis

For Problem 1, descriptive statistical analysis was utilized to determine the levels of students' attitudes towards collaborative learning, self-esteem in learning mathematics, and mathematics performance in a collaborative learning environment, specifically focusing on the mean and standard deviation. Descriptive statistics are essential tools for summarizing and describing the basic features of a dataset clearly and concisely.

To answer Problem 2, regression analysis was employed to determine if significant predictive relationships exist between students' attitudes towards collaborative learning, self-esteem in learning mathematics, and mathematics performance. Regression analysis is a powerful statistical tool used to examine the relationship between one or more independent variables (predictors) and a dependent variable (outcome). This technique allows researchers to understand how changes in the independent variables can impact the dependent variable, and it is beneficial for predicting outcomes based on certain factors. In this study, regression analysis was used to explore how students' attitudes toward collaborative learning and their self-esteem in mathematics impact their academic performance (e.g., End-term grades). The independent variables (attitudes and self-esteem) were used to predict the dependent variable (End-term grades). This analysis helps determine the strength and direction of these relationships, indicating whether and to what extent students' attitudes and self-esteem can predict their academic success. The regression model produces coefficients that describe the relationship between variables, and significance tests are used to determine whether these relationships are statistically meaningful. This allows researchers to quantify how much variance in students' grades can be explained by their attitudes and self-esteem.

For Problem 3, mediation analysis was employed. Mediation analysis explores the process or mechanism through which one variable influence another through a third (mediating) variable. It helps to understand whether the effect of an independent variable on a dependent variable is indirect or mediated by a third variable. This study used mediation analysis to explore whether the relationship between students' attitudes towards collaborative learning and their End-term grades is mediated by their self-esteem in learning mathematics. In other words, it investigates whether self-esteem mediates how collaborative learning influences academic performance.

Finally, for Problem 4, moderation analysis was conducted. Moderation analysis is used to explore whether the relationship between two variables depends on the level of a third variable (the moderator). In other words, a moderator variable can change the strength or direction of the relationship between an independent and dependent variable. In this study, moderation analysis could investigate whether the field of specialization (e.g., Architectural Drafting, Automotive Technology, Electrical Technology) moderates the relationship between students' attitudes toward collaborative learning and academic

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performance. For instance, the relationship between collaborative learning and grades may be stronger in one field of study than in another.

3. Results and Discussions

3.1. Students' Attitude, Self-Esteem, and Mathematics Performance in a Collaborative Learning Environment

The descriptive analysis provided insights into the students' attitudes towards collaborative learning, their self-esteem in mathematics, and their performance within a collaborative learning environment.

Table 1.
Levels of Students' Attitude, Self-Esteem, and Mathematics Performance in a collaborative learning environment.

Levels	Mean	SD	Interpretation
Attitude	4.29	0.44	Very positive
Self-esteem	3.62	0.44	High
Mathematics Performance	84.20	7.12	Average

According to Table 1, the students' attitudes towards collaborative learning were very positive, with a high average score of 4.29. The relatively low standard deviation of 0.44 indicates minimal variability, meaning most students held similar views on collaborative learning. This finding suggests a consistent preference for working together in mathematics classes. Students, on average, are confident, comfortable, and satisfied with collaborative learning methods. They reported that working in small groups or pairs made learning mathematics easier, more enjoyable, and more engaging. Moreover, they felt that collaboration improved understanding, better results, and greater motivation. Students agreed that they achieved more and understood the material better when working together than when working alone.

Richards and Rodgers [17] define collaborative learning as a process where students engage in group activities that require socially structured exchanges of information, and each learner is held responsible for their learning while being motivated to support others. Active participation in collaborative learning activities is believed to positively impact academic performance [18] which aligns with the students' experiences in this study.

Additionally, Table 1 shows that students had a high level of self-esteem in learning mathematics (Mean=3.62) within the context of collaborative learning, though it did not reach the highest possible level. While not as high as the "very positive" category for attitudes, it is still above the scale's midpoint, indicating generally positive self-perception in their mathematical learning abilities. The standard deviation of 0.44 suggests a slight variation in the self-esteem scores. Most students' self-esteem levels are close to the mean, reflecting consistency in how students perceive their self-worth in the context of learning mathematics.

These findings indicate that students feel positively about their capacity to succeed in mathematics, which is further supported by their responses. They agreed that collaborative learning contributed to their positive attitude toward mathematics and that they took pride in their successes. This sense of accomplishment in mathematics, they indicated, also helped them develop a sense of self-worth. Self-esteem is shaped by one's favorable or unfavorable attitude toward oneself, and positive experiences in learning mathematics can enhance students' self-esteem [10].

Finally, the student's overall mathematics performance in the collaborative learning environment was average (Mean=84.20). The higher standard deviation of 7.12 indicates more variability in mathematics performance compared to the other two variables (attitude and self-esteem). This suggests that while some students performed excellently, others may have struggled, resulting in a wider spread of performance scores.

This indicates that, on average, students' mathematics performance is solid, but there is room for improvement for some students. While students achieved satisfactory results in meeting the expected learning outcomes, their performance was neither exceptionally high nor low. Previous studies have shown that collaborative learning approaches often lead to improved academic achievement in mathematics [19] which seems to align with the students' experiences in this study. "Peer Learning in

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Higher Education" by Boud, et al. [20] emphasizes the importance of students learning with and from each other rather than relying solely on instructor-led teaching. The book argues that peer learning fosters more profound understanding, critical thinking, and collaborative skills essential for success in higher education and beyond [10, 21, 22].

3.2. Predictive Relationships among Students' Attitude towards Collaborative Learning, Self-esteem in Learning Mathematics, and Mathematics Performance

This section analyzes the predictive relationships among students' attitudes toward collaborative learning, their self-esteem in learning mathematics, and their mathematics performance based on the hypothesized structural equation model depicted in Figure 2. The model investigates both direct and indirect effects, with particular attention to the mediating role of self-esteem in these relationships.

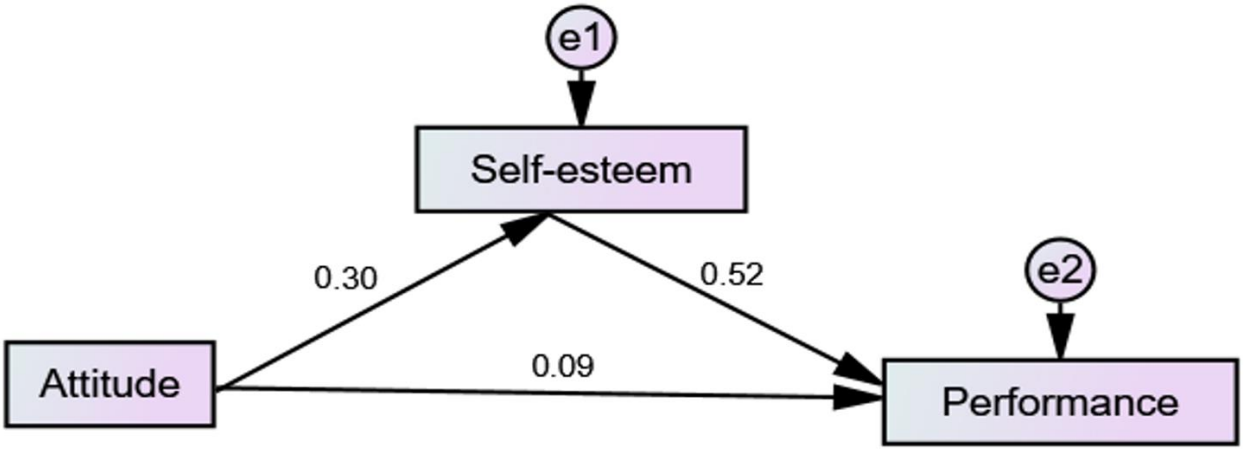

Figure 2.
Hypothesized Model.

As shown in Table 2, the results of the structural equation modeling indicate that attitude toward collaborative learning has a significant positive effect on self-esteem ($\beta = 0.295$, SE = 0.120, CR = 2.458, $p = 0.014$). This suggests that students with more favorable attitudes and a more positive outlook toward collaborative learning tend to exhibit higher levels of self-esteem in learning mathematics. The interpretation that a better attitude towards collaborative learning fosters a stronger sense of self-worth in tackling mathematics resonates logically with the idea that positive experiences in group learning can build confidence. The parallel is drawn to Siller and Ahmad [23] and the mention of collaborative learning as a nurturing pedagogical approach [24] provides external validation to this finding, anchoring it within the existing literature. Furthermore, acknowledging teaching methods [25] as a precursor to students' attitudes toward mathematics adds a layer of contextual understanding.

Table 2.
Interaction effects on Attitude towards Collaborative Learning, Self-esteem, and Mathematics performance.

Path	Estimate	S.E.	C.R.	P-value
Self-esteem ← Attitude	0.295	0.12	2.458	0.014
Performance ← Self-Esteem	8.431	1.77	4.764	0.000
Performance ← Attitude	1.399	1.762	0.794	0.427

Secondly, the analysis establishes a robust and highly significant positive predictive relationship between self-esteem and mathematics performance ($\beta = 8.431$, $p < 001$). This strong statistical link underscores that students with higher self-esteem in their mathematical capabilities are more likely to achieve better results in mathematics. The interpretation that high self-esteem translates to satisfactory

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mathematics performance aligns with intuitive understanding and is further supported by the findings of Ugwuanyi, et al. [26] who identified self-esteem as a significant psychological predictor of academic achievement in mathematics. However, the contrasting finding from Asika [27] which reported a positive but non-significant relationship, introduces a note of caution. This discrepancy highlights the potential for contextual variations and underscores the importance of continued efforts to bolster self-esteem to enhance mathematics performance.

Finally, the analysis reveals that the direct effect of attitude towards collaborative learning on mathematics performance is statistically non-significant (β = 1.399, p = 427). This crucial finding suggests that a positive attitude towards collaborative learning does not directly translate into improved mathematics scores in this context. The interpretation that self-esteem might mediate this relationship is a logical next step, implying that the positive influence of collaborative learning on performance operates through its impact on students' self-belief. The mention of self-esteem as a potential mediator offers a related, though distinct, avenue for future exploration, suggesting that the belief in one's ability to succeed in specific mathematical tasks might also play a crucial intervening role. Research on the mediating role of self-esteem in the relationship between psychological capital and academic performance in the study of Almurumudhe, et al. [28] indicates that self-esteem significantly mediates this relationship, highlighting its importance in academic contexts and suggests that nurturing self-esteem through the development of psychological capital and effective educational strategies can lead to better academic performance. In the study of Samuel and Okonkwo [25] metacognition contributes to academic achievement, and this process can be strengthened or weakened depending on the student's level of self-esteem. Both act as internal psychological resources that support effective, self-directed learning.

3.3. Mediation Analysis

This section analyzes the mediation model, outlining the process and the significant findings regarding the interplay between attitude towards collaborative learning, self-esteem in learning mathematics, and mathematics performance. The analysis is strengthened by the thorough assessment of model fit and the clear presentation of direct and indirect effects.

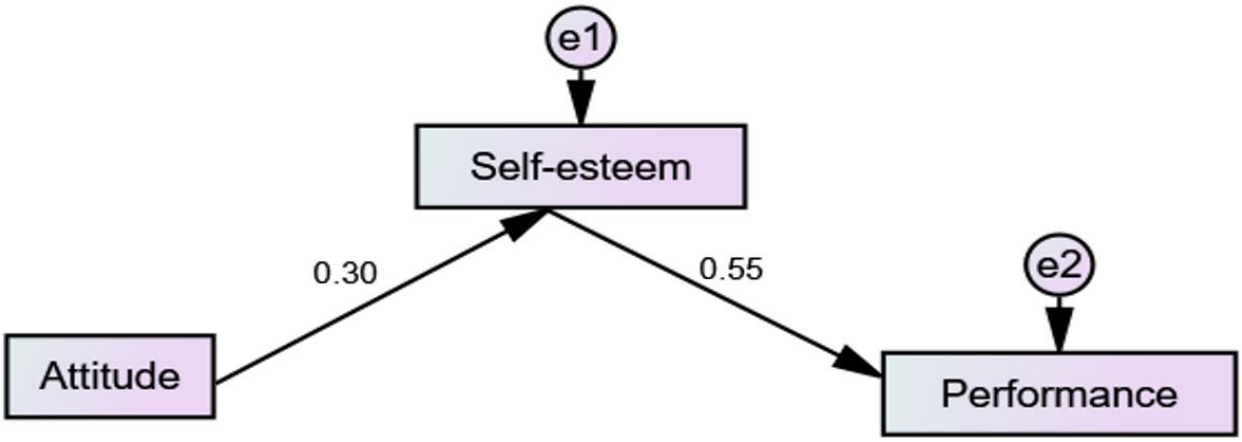

Figure 3.
Best Fit Model.

The model fit assessment in Figure 3 reveals a strong model fit based on various goodness-of-fit indices.

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Table 3.
Statistical Values Related to the Fitting of the Best Fit Model.

Measure	Level of Acceptance	Fit Index Values of the Model
RMSEA	<0.08	0.000
GFI	>0.90	0.993
AGFI	>0.90	0.961
CFI	>0.90	1.000
TLI	>0.90	1.043
NFI	>0.90	0.978
(χ^2/df)	<5.0	0.627

Table 3 shows that this section's initial part meticulously establishes the proposed model's statistical validity. The detailed reporting of multiple goodness-of-fit indices and their comparison against established thresholds provides strong evidence for a well-fitting model.

The observed covariance matrix and the model-implied covariance matrix do not differ significantly according to the non-significant chi-square statistic (CMIN = 0.627, DF = 1, p = 0.428). This signifies that the model adequately reflects the relationships in the data.

The CMIN/DF ratio of 0.627, well below the conservative threshold of 3.0 (and even the more lenient 5.0 mentioned in Table 3), further reinforces the good fit, indicating a parsimonious model that explains a significant amount of variance without being overly complex.

The Goodness of Fit Index (GFI = 0.993) and Adjusted Goodness of Fit Index (AGFI = 0.961), both significantly exceeding the 0.90 benchmarks, demonstrate that the model accounts for a substantial proportion of the observed variance, and this fit remains strong even after adjusting for model complexity.

The Model Fit's convergent validity increases due to the Normed Fit Index (NFI = 0.978), Tucker-Lewis Index (TLI = 1.043), and Comparative Fit Index (CFI = 1.000) exceeding the 0.90 threshold. The independence model is perfectly fit with a CFI value of 1.000. In well-fitting models with small degrees of freedom, the TLI value slightly above 1.000 is not uncommon and indicates a better fit than the null model.

The Root Mean Square Error of Approximation (RMSEA = 0.000), with a narrow 90% confidence interval (0.000 - 0.306) that includes zero and stays below the 0.08 criterion, indicates a very good model fit, suggesting minimal discrepancy between the model and the observed data. The model's adequacy can be more confidently assessed when the upper bound of the confidence interval is below 0.08.

Table 4.
Direct and Indirect Effects of Attitude and Self-esteem on Mathematics Performance.

Effect	Direct	Indirect	Total
On Performance			
Attitude	0.000	0.162	0.162
Self-esteem	0.549	0.000	0.549

Table 4 presents the analysis of the direct and indirect effects, offering critical insights into the interrelationships among the studied variables. Notably, the direct effect of self-esteem on mathematics performance is substantial and statistically significant ($\beta = 0.549$), underscoring the pivotal role of self-belief in academic success within the domain of mathematics. This coefficient indicates that a one standard deviation increase in self-esteem corresponds to a 0.549 standard deviation increase in mathematics performance, illustrating a substantial and measurable predictive relationship.

Conversely, the analysis shows that attitude toward collaborative learning does not directly affect mathematics performance ($\beta = 0$). This suggests that a favorable disposition toward collaborative learning does not directly enhance students' mathematics outcomes in this context.

However, the model reveals a significant indirect effect of attitude toward collaborative learning on performance, mediated through self-esteem ($\beta = 0.162$). This finding implies that while attitude alone does not directly impact performance, it contributes positively by enhancing students' self-esteem,

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subsequently leading to improved mathematics performance. In practical terms, a one standard deviation increase in positive attitude toward collaborative learning leads to a 0.162 standard deviation increase in performance via elevated self-esteem.

The total effect of attitude on performance is thus entirely attributable to this indirect pathway (β = 0.162), further emphasizing the mediating role of self-esteem in this relationship. These findings highlight the importance of psychological constructs in educational achievement and suggest that promoting collaborative learning environments may indirectly benefit academic outcomes by fostering students' confidence and self-perception in mathematics.

The findings of Fast, et al. [29] offer a relevant parallel, demonstrating that positive classroom environments are associated with increased self-efficacy, which, in turn, predicts improved mathematics performance. Although their study emphasized self-efficacy as the mediating variable, the underlying mechanism, wherein a psychological construct mediates the relationship between the learning environment and academic achievement, aligns closely with the current study's findings regarding self-esteem. Furthermore, the inclusion of Yu, et al. [11] reinforces this perspective by establishing a connection between social-environmental factors, such as collaborative learning practices, and students' self-esteem and by affirming the significant positive relationship between self-esteem and academic performance in mathematics. Their recommendation to implement interventions to enhance self-esteem provides empirical support for the present study's implication that fostering students' psychological well-being is crucial for improving academic outcomes.

3.4. Moderation Analysis

A moderation analysis was conducted using multiple regression to examine whether the student's field of specialization moderates the relationship between self-esteem and mathematics performance. This analysis used Architectural Drafting Technology as the reference category, while Automotive Technology and Electrical Technology were represented through dummy-coded variables. Interaction terms were computed between self-esteem and each specialization to test for moderation effects.

Table 5.
Regression Analyses of the Predictive effect of the Interaction between Self-esteem and Field of Specialization on Mathematics performance.

Predictor	B	SE	CR	p
Self-esteem	9.360	2.441	3.834	<0.001
Automotive Technology (Dummy)	-13.503	16.549	-0.816	0.415
Electrical Technology (Dummy)	15.400	12.271	1.255	0.209
Self-esteem × Automotive Technology	2.957	4.558	0.649	0.516
Self-esteem × Electrical Technology	-3.274	3.394	-0.965	0.335

Note: Architectural Drafting Technology was the reference category for specialization.

Table 5 presents the results of the regression analysis. The findings indicate that self-esteem significantly predicts mathematics performance (B = 9.360, SE = 2.441, CR = 3.834, p <. 001), confirming that students with higher levels of self-esteem tend to perform better in mathematics. This reinforces the study's central finding that self-esteem is a critical psychological factor influencing academic achievement in mathematics.

However, the main effects of specialization were not statistically significant. Specifically, students specializing in Automotive Technology (B = -13.503, SE = 16.549, CR = -0.816, p =. 415) and Electrical Technology (B = 15.400, SE = 12.271, CR = 1.255, p =. 209) did not differ significantly in mathematics performance when compared to students in Architectural Drafting Technology. These results suggest that, at a direct level, the student's area of specialization does not significantly influence mathematics outcomes.

Furthermore, the interaction effects between self-esteem and specialization were also non-significant, indicating no moderating effect. The interaction term for Self-Esteem × Automotive Technology (B =

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2.957, SE = 4.558, CR = 0.649, p =. 516) and for Self-Esteem × Electrical Technology (B = -3.274, SE = 3.394, CR = -0.965, p =. 335) did not yield significant results. These findings suggest that the relationship between self-esteem and mathematics performance remains consistent across the different fields of specialization and that specialization does not significantly alter this predictive relationship.

These results indicate that self-esteem strongly and consistently influences mathematics performance, regardless of the student's technical specialization. One plausible interpretation is that self-esteem's motivational and confidence-related aspects function as domain-general academic enablers, exerting similar effects across different program tracks. This underscores the importance of addressing self-esteem as a universal academic support factor rather than one contingent on students' field of study.

The findings of this study align with existing literature emphasizing the pivotal role of self-esteem in academic performance across various disciplines, irrespective of technical specialization. A survey by Quílez-Robres, et al. [30] found that self-esteem significantly contributes to academic performance, with executive functions mediating this relationship. The authors suggest that self-esteem enhances cognitive and motivational variables, positively impacting academic achievement. This indicates that the influence of self-esteem on academic performance is not confined to specific disciplines but is a generalizable factor across various fields of study. Furthermore, Vicente, et al. [31] examined the relationship between self-esteem, study habits, and academic performance among business college students. The findings revealed a significant relationship between self-esteem and academic performance, suggesting that self-esteem is crucial to academic success across different disciplines.

4. Conclusions and Recommendations

Several key conclusions can be drawn based on this study's findings. First, students demonstrated a very positive attitude toward collaborative learning, reported high self-esteem in mathematics, and exhibited average performance in the subject. Second, the analysis revealed that self-esteem significantly influences mathematics performance, while students' attitudes toward collaborative learning positively shape self-esteem. Third, the results confirmed a mediating effect of self-esteem in the relationship between attitude toward collaborative learning and mathematics performance, indicating that a positive attitude enhances self-esteem, improving academic outcomes. Finally, self-esteem is a significant and stable predictor of academic performance in mathematics, irrespective of students' technical specialization or other contextual variables. The absence of a moderating effect of specialization indicates that the influence of self-esteem on academic success operates uniformly across diverse program tracks.

These conclusions support the idea that self-esteem is a psychological resource that enhances motivation, confidence, and persistence, which is essential for academic achievement across disciplines. The findings emphasize the importance of fostering collaborative learning environments that cultivate positive attitudes and support the development of self-esteem. Such environments can serve as critical mechanisms for enhancing students' mathematical achievement, regardless of their specialization. Therefore, educators, administrators, and parents should actively reinforce these factors within the school, classroom, and home contexts to promote sustained academic success in mathematics.

In the field of Education, it is therefore recommended that educators, administrators, and parents actively reinforce these factors within the school, classroom, and home contexts to promote sustained academic success in mathematics. Educational institutions should prioritize building students' confidence and emotional well-being, not just cognitive skills. Integrating structured group-based learning models into curricula can be a strong strategic tool since a positive attitude towards collaborative learning leads to higher self-esteem and improved academic performance.

The findings of this study may also be used to develop educational technology (EdTech) tools or platforms, like mathematical applications, integrating collaborative tools to support students' self-esteem, self-reflection, and peer collaboration.

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Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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References

[1] T. J. Kennedy and C. W. Sundberg, *21st century skills, Science education in theory and practice: An introductory guide to learning theory*. USA: Springer, 2020.

[2] R. C. Ojobor, E. T. Babarinde, and G. S. Ezeh, "Assessing the impact of collaboration in improving students' information literacy skills in the digital environment," *Global Review of Library and Information Science*, vol. 17, no. 2, pp. 1-15, 2021.

[3] Y. k. Law, "Effects of cooperative learning on second graders' learning from text," *Educational Psychology*, vol. 28, no. 5, pp. 567-582, 2008.

[4] A. Veloo, F. Ab Rahman, and S. Chairany, "Students' mathematics attitude towards cooperative learning, teams-games-tournament," presented at the 1st International Conference on Intellectuals' Global Responsibility (ICIGR 2017), Atlantis Press, 2018.

[5] R. M. Gillies, "The effects of cooperative learning on junior high school students during small group learning," *Learning and Instruction*, vol. 14, no. 2, pp. 197-213, 2004.

[6] S. Johnsen, "Improving achievement and attitude through cooperative learning in math class," *Journal of Educational Research*, vol. 102, no. 4, pp. 271-279, 2009.

[7] M. V. Houtte, J. Demanet, and P. A. Stevens, "Self-esteem of academic and vocational students: Does within-school tracking sharpen the difference?," *Acta Sociologica*, vol. 55, no. 1, pp. 73-89, 2012.

[8] J. Zhao, F. Kong, and Y. Wang, "Self-esteem and humor style as mediators of the effects of shyness on loneliness among Chinese college students," *Personality and Individual Differences*, vol. 52, no. 6, pp. 686-690, 2012. https://doi.org/10.1016/J.PAID.2011.12.024

[9] S. Amri and W. Widada, "The effect of self-concept, self-efficacy, and self-esteem on the ability to understanding mathematics," *International Journal of Science and Research (IJSR)*, vol. 8, no. 1, pp. 201-206, 2019.

[10] L. Nabila and D. Widjajanti, "Self-esteem in mathematics learning: How to develop it through a contextual teaching and learning approach? ," presented at the Journal of Physics: Conference Series, 2020.

[11] W. Yu *et al.*, "The role of self-esteem in the academic performance of rural students in China," *International Journal of Environmental Research and Public Health*, vol. 19, no. 20, p. 13317, 2022.

[12] F. Kong, J. Zhao, and X. You, "Self-esteem as mediator and moderator of the relationship between social support and subjective well-being among Chinese university students," *Social Indicators Research*, vol. 112, no. 1, pp. 151-161, 2013.

[13] M. Standage and F. Gillison, "Students' motivational responses toward school physical education and their relationship to general self-esteem and health-related quality of life," *Psychology of Sport and Exercise*, vol. 8, no. 5, pp. 704-721, 2007.

[14] Å. Diseth, E. Meland, and H. J. Breidablik, "Self-beliefs among students: Grade level and gender differences in self-esteem, self-efficacy and implicit theories of intelligence," *Learning and Individual Differences*, vol. 35, pp. 1-8, 2014. https://doi.org/10.1016/J.LINDIF.2014.06.003

[15] L. Hilmy and B. Takwin, "Self-esteem of adolescents as a predictor of academic achievement of adolescents in orphanages x," *Jurnal RAP (Riset Aktual Psikologi Universitas Negeri Padang)*, vol. 9, no. 1, pp. 46-58, 2018.

[16] National Institute for Science Education, *Collaborative learning: Small group learning page*. United States: College Level One, 1997.

[17] J. C. Richards and T. Rodgers, *Approaches and methods in language teaching*, 2nd ed. Cambridge, UK: Cambridge University Press, 2001.

[18] D. W. Johnson, R. T. Johnson, and B. Stanne, *Cooperative learning methods: A meta-analysis*. Minneapolis, Minnesota: University of Minnesota, 2000.

[19] C. J. Torrego-Seijo, P. Á. Caballero-García, and E. M. Lorenzo-Llamas, "The effects of cooperative learning on trait emotional intelligence and academic achievement of Spanish primary school students," *British Journal of Educational Psychology*, vol. 91, no. 3, pp. 928-949, 2021.

[20] D. Boud, R. Cohen, and J. Simpson, *Peer learning in higher education*. London: Routledge, Taylor, and Francis Group, 2001.
[21] M. Britz, "The effects of peer tutoring on mathematics performance: A recent review," *BC Journal of Special Education*, vol. 13, no. 1, pp. 17-33, 1989.
[22] J. Rubin and M. Herbert, "Peer teaching-model for active learning," *College Teaching*, vol. 48, no. 1, pp. 26-30, 1998.
[23] H.-S. Siller and S. Ahmad, "Analyzing the impact of collaborative learning approach on grade six students' mathematics achievement and attitude towards mathematics," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 20, no. 2, p. em2395, 2024.
[24] A. D. Udu and J. Nmadu, "Students' interactive engagement, academic achievement and self concept in chemistry: An evaluation of cooperative learning pedagogy," *Chemistry Education Research and Practice*, vol. 24, no. 2, pp. 688-705, 2023.
[25] N. N. Samuel and I. G. Okonkwo, "Relationship between metacognition, locus of control, and academic achievement in secondary school chemistry students in Anambra State, Nigeria," *Education Research International*, vol. 2021, no. 1, p. 6698808, 2021.
[26] C. S. Ugwuanyi, C. I. Okeke, and C. G. Asomugha, "Prediction of learners' mathematics performance by their emotional intelligence, self-esteem and self-efficacy," *Cypriot Journal of Educational Sciences*, vol. 15, no. 3, pp. 492-501, 2020.
[27] M. O. Asika, "Self-concept, self-efficacy and self esteem as predictors of academic performance in mathematics among junior secondary school students in Edo state," *Sumerianz Journal of Education, LInguisticas and Literature*, vol. 4, no. 1, pp. 15-22, 2021.
[28] L. K. A. Almurumudhe, A. Mahdad, A. Abdulkadhim Johni, and Z. Yousefi, "The mediating role of self-esteem in the relationship between psychological capital, academic engagement, and academic procrastination with academic performance among students in Al-Diwaniyah, Iraq," *Iranian Journal of Educational Sociology*, vol. 7, no. 3, pp. 1-9, 2024. http://dx.doi.org/10.61838/kman.ijes.7.3.1
[29] L. A. Fast *et al.*, "Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance?," *Journal of Educational Psychology*, vol. 102, no. 3, p. 729, 2010.
[30] A. Quílez-Robres, N. Moyano, and A. Cortés-Pascual, "Executive functions and self-esteem in academic performance: A mediational analysis," *International Journal of Psychological Research*, vol. 14, no. 2, pp. 52-60, 2021.
[31] J. M. Vicente, N. I. Gonzales, M. A. Cabilan, V. C. Diaz, L. P. Sausa, and L. De Ocampo, "Self-esteem, study habits, and academic performance of business college students," *International Scholars Conference Proceedings*, vol. 10, no. 1, pp. 1–10, 2018.

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