Mediating Effect Of Sports Engagement On The Relationship Between Metacognition And Mathematics Self-Efficacy

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Abstract

This study examines the mediating effect of sports engagement on the relationship between metacognition and mathematics self-efficacy among 304 Grade 10 students in Lupon, Davao Oriental. Using a predictive-explanatory research design and stratified random sampling, data were gathered through a validated survey questionnaire and analyzed using correlation and mediation analyses. The findings revealed high levels of metacognition ($M = 2.89$), sports engagement ($M = 3.05$), and mathematics self-efficacy ($M = 3.03$). Correlation analysis indicated significant positive relationships between metacognition and mathematics self-efficacy ($r = .59$, $p < .05$), metacognition and sports engagement ($r = .50$, $p < .05$), and sports engagement and mathematics self-efficacy ($r = .47$, $p < .05$). Mediation analysis further revealed significant total ($\beta = .72$, $p < .05$), direct ($\beta = .58$, $p < .05$), and indirect effects ($\beta = .14$, $p < .05$), indicating that sports engagement partially mediates the relationship between metacognition and mathematics self-efficacy. Grounded in Social Cognitive Theory, the findings suggest that students with higher metacognitive abilities tend to exhibit greater sports engagement and stronger mathematics self-efficacy. The study highlights the importance of strengthening metacognitive skills and promoting sports participation as complementary strategies for enhancing students' confidence and performance in mathematics.

Keywords: metacognition; mathematics self-efficacy; sports engagement; mediation analysis; academic confidence; students

1.Introduction

Mathematics remains one of the most challenging academic subjects for many learners, with students often demonstrating low confidence in their mathematical abilities despite the increasing emphasis on developing higher-order thinking skills. Recent studies have identified metacognition as an important factor in improving students' learning, problem-solving, and academic performance (Hayat et al., 2020; Thi-Nga, 2024; Xie, 2024). Likewise, research has shown that participation in sports contributes to students' motivation, discipline, cognitive functioning, and overall academic success (Claver et al., 2020; Sember et al., 2020; Ma et al., 2024). Despite these findings, many learners continue to experience difficulties in mathematics, emphasizing the need to explore factors that can strengthen mathematics self-efficacy and improve academic outcomes.

Although previous studies have established the relationships between metacognition and mathematics self-efficacy and between sports engagement and academic performance, limited research has examined the mediating role of sports engagement in explaining how metacognition influences mathematics self-efficacy. Existing studies have generally investigated these variables independently, providing insufficient evidence regarding the mechanism through which sports engagement enhances the relationship between students' cognitive regulation and confidence in mathematics. This research gap underscores the need for further investigation to provide empirical evidence that can guide educational interventions promoting both cognitive and physical development among learners.

This study was anchored on Bandura's Social Cognitive Theory (1986), which explains that learning and behavior result from the reciprocal interaction among cognitive, behavioral, and environmental factors. Within this framework, metacognition represents students' ability to plan, monitor, and regulate their thinking processes, while sports engagement reflects students' confidence, dedication, enthusiasm, and vigor in participating in sports-related activities. Mathematics self-efficacy represents students' beliefs in their capability to accomplish mathematics-related tasks successfully. The study proposed that sports engagement serves as a mediating variable through which metacognition influences mathematics self-efficacy.

Accordingly, this study aimed to determine the mediating effect of sports engagement on the relationship between metacognition and mathematics self-efficacy among Grade 10 students. Specifically, it sought to determine the levels of metacognition, sports engagement, and mathematics self-efficacy; examine the significant relationships among these variables; and determine whether sports engagement significantly mediates the relationship between metacognition and mathematics self-efficacy.

The findings of this study are expected to contribute to mathematics education by providing empirical evidence on the role of sports engagement in strengthening the influence of metacognition on mathematics self-efficacy. The results may assist educators, school administrators, and curriculum developers in designing holistic learning interventions that integrate cognitive development and sports participation to improve students' confidence and performance in mathematics. Furthermore, the study contributes to the growing body of literature on mathematics education and supports the attainment of the United Nations Sustainable Development Goal 4 (Quality Education) by promoting inclusive and quality learning experiences.

2. Methodology

2.1. Research Design

1. This study employed a quantitative, non-experimental predictive-explanatory research design to examine the mediating effect of sports engagement on the relationship between metacognition and mathematics self-efficacy among Grade 10 students. Specifically, the study determined the levels of metacognition, sports engagement, and mathematics self-efficacy; examined the significant relationships among the variables; and determined whether sports engagement significantly mediated the relationship between metacognition and mathematics self-efficacy.

2.2. Research Locale and Respondents

1. The study was conducted at a public secondary school in Davao Oriental, Philippines. The respondents consisted of 304 Grade 10 students selected through stratified random sampling to ensure adequate representation of the target population and to obtain reliable data for mediation analysis.

2.3. Research Instrument

1. The study utilized a self-constructed, validated, and reliability-tested questionnaire consisting of three sections that measured metacognition, sports engagement, and mathematics self-efficacy. Metacognition was assessed through the dimensions of cognitive confidence, positive beliefs, cognitive self-consciousness, negative beliefs, and need to control thoughts. Sports engagement was measured using confidence, dedication, enthusiasm, and vigor, while mathematics

self-efficacy was assessed through perceived control, competence, persistence, and self-regulated learning. Responses were measured using a four-point Likert scale.**2.4. Data Collection Procedure**

1. Data collection commenced after securing approval from the Graduate School, the Research Ethics Committee of Holy Cross of Davao College, and the school principal. Participation was voluntary, and informed consent (including parental consent for minor participants) was obtained before administering the validated survey questionnaires. The completed questionnaires were retrieved, checked for completeness, coded, tabulated, and prepared for statistical analysis.

2.5. Data Analysis

1. The collected data were analyzed using descriptive and inferential statistics through standard statistical software. Mean and standard deviation were used to determine the levels of metacognition, sports engagement, and mathematics self-efficacy. Pearson Product-Moment Correlation Coefficient was employed to examine the relationships among the variables, while mediation analysis was conducted to determine whether sports engagement significantly mediated the relationship between metacognition and mathematics self-efficacy.

2.6. Ethical Considerations

The study adhered to the ethical standards of the Holy Cross of Davao College Research Ethics Committee. Participation was voluntary, and informed consent was obtained from all respondents, with parental consent secured for minors. Respondents' anonymity and confidentiality were protected by excluding personally identifiable information from the questionnaires, and all collected data were used solely for academic purposes in accordance with established ethical research guidelines.

3. Results and Discussion

3.1. Descriptive Analysis of the Study Variables

Table 1. Descriptive Statistics of the Study Variables (n = 304)

Variables	SD	Mean	Descriptive Level
Metacognition	**0.42**	**2.89**	**High**
Cognitive confidence	0.52	2.93	High
Positive beliefs	0.53	2.91	High
Cognitive self- consciousness	0.55	3.09	High
Negative beliefs	0.69	2.60	High
Need to control thoughts	0.51	2.92	High
Sports Engagement	**0.67**	**3.05**	**High**
Confidence	0.74	2.93	High
Dedication	0.74	3.14	High
Enthusiasm	0.72	3.06	High
Vigor	0.74	3.09	High
Mathematics Self-Efficacy	**0.51**	**3.03**	**High**
Perceived control	0.62	2.92	High
Competence	0.59	2.85	High
Persistence	0.58	3.21	High
Self-regulated learning	0.58	3.14	High

1.00–1.74 Very Low, 1.75–2.49 Low, 2.50–3.24 High, 3.25–4.00 Very High

Table 1 presents the descriptive statistics of the study variables. The results revealed that the respondents demonstrated high levels of metacognition (M = 2.89, SD = 0.42), sports engagement (M = 3.05, SD = 0.67), and mathematics self-efficacy (M = 3.03, SD = 0.51). Among the dimensions of metacognition, cognitive self-consciousness (M = 3.09) obtained the highest mean, whereas negative beliefs (M = 2.60) obtained the lowest mean. For sports engagement, dedication (M = 3.14) registered the highest mean, while confidence (M = 2.93) recorded the lowest. Regarding mathematics self-efficacy, persistence (M = 3.21) obtained the highest mean, whereas competence (M = 2.85) obtained the lowest mean. Despite these variations, all dimensions were interpreted as High.

The findings indicate that Grade 10 students generally exhibit favorable metacognitive skills, active engagement in sports, and positive beliefs in their mathematical capabilities. These results suggest that the respondents possess adequate cognitive regulation, demonstrate consistent participation in sports-related activities, and maintain confidence in performing mathematics-related tasks.

3.2. Relationship Between the Metacognition, Sports Engagement, and Mathematics Self-Efficacy

Table 2. Correlation Analysis of the Study Variables (n = 304)
Correlation Table (n=300)

Variables	r	p	Decision on Ho Ho	Interpretation
Metacognition → Mathematics Self-Efficacy	0.59	0.000	Reject Ho_1 Ho_1	Strong positive, moderately high correlation
Metacognition → Sports Engagement	0.50	0.000	Reject Ho_2 Ho_2	Moderate positive, moderately low correlation
Sports Engagement → Mathematics Self-Efficacy	0.47	0.000	Reject Ho_3 Ho_3	Moderate positive, moderately low correlation

Level of Significance: 0.05
Decision Rule: Reject H_0 if $p < 0.05$

Table 2 presents the correlation analysis among metacognition, sports engagement, and mathematics self-efficacy. The results revealed that metacognition exhibited a significant positive relationship with mathematics self-efficacy ($r = .59$, $p < .001$), indicating a moderately high positive correlation. Likewise, metacognition was significantly positively correlated with sports engagement ($r = .50$, $p < .001$), while sports engagement also demonstrated a significant positive relationship with mathematics self-efficacy ($r = .47$, $p < .001$), both indicating moderate positive correlations. These findings suggest that higher levels of metacognition are associated with greater sports engagement and stronger mathematics self-efficacy, while increased sports engagement is likewise associated with higher mathematics self-efficacy. Consequently, all null hypotheses on the relationships among the study variables were rejected.

3.3. Mediation Analysis Result on Metacognition, Sports Engagement, and Mathematics Self-Efficacy

Table 3. Mediation Analysis Table (n = 304)

Label	Path/Effect	Estimate	SE	Z	P	Decision on Ho Ho	Interpretation
C (Total Effect)	Metacognition → Mathematics Self-Efficacy (Total Effect)	0.72	0.06	12.67	0.000	Reject Ho_5 Ho_5	Significant
a x b	Indirect Effect (Mediation)	0.14	0.05	2.80	0.000	Reject Ho_5 Ho_5	Significant
c’	Metacognition → Mathematics Self-Efficacy (Direct Effect)	0.58	0.06	9.14	0.000	Reject Ho_5 Ho_5	Significant

Level of Significance: 0.05
Mediation Proportion: 19.44

Table 3 presents the mediation analysis of sports engagement on the relationship between metacognition and mathematics self-efficacy. The results revealed that the total effect of metacognition on mathematics self-efficacy was statistically significant ($\beta = 0.72$, $SE = 0.06$, $Z = 12.67$, $p < .001$). Likewise, the direct effect of metacognition on mathematics self-efficacy remained significant ($\beta = 0.58$, $SE = 0.06$, $Z = 9.14$, $p < .001$) after accounting for sports engagement. Moreover, the indirect effect through sports engagement was also statistically significant ($\beta = 0.14$, $SE = 0.05$, $Z = 2.80$, $p < .001$), indicating that sports engagement significantly mediated the relationship between metacognition and mathematics self-efficacy. The mediation proportion of 19.44% suggests a partial mediation, indicating that while sports engagement explains part of the relationship between metacognition and mathematics

self-efficacy, metacognition continues to exert a substantial direct influence on students' mathematics self-efficacy. Accordingly, the null hypothesis on the mediating effect of sports engagement was rejected.

Conclusion

Based on the findings, it was concluded that sports engagement partially mediates the relationship between metacognition and mathematics self-efficacy. Metacognition directly influences mathematics self-efficacy and also indirectly affects it through students' level of sports engagement. This conclusion supports the idea that both cognitive regulation and behavioral engagement contribute to the development of students' academic confidence in mathematics.

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