Exploring the Predictive Effects of Growth Mindset on Mathematics Engagement Among Secondary Students in Australia

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Abstract. This study explores the predictive effects of growth mindset on mathematics engagement among 230 secondary students across two secondary schools in Australia, aiming to unveil how this mindset impacts students' engagement levels in mathematics. Utilizing correlation and regression for testing the predictive effect of growth mindset on students' learning engagement in mathematics. The results reveal that students with a more pronounced growth mindset tend to have higher engagement in mathematics. These findings support the integration of growth mindset principles into educational strategies, suggesting that fostering a growth mindset could enhance mathematics engagement among Australian secondary students.

Keywords: Growth Mindset; Mathematics Engagement; Secondary Students.

1 Introduction

In recent years, a decline in student engagement in mathematics has sparked increased scholarly interest, particularly in Australia and various other nations, prompting the adoption of growth mindset interventions [1][2]. Despite this, the correlation between a growth mindset and mathematics engagement appears inconsistent, raising questions about the effectiveness of these interventions [11]. This section aims to elucidate the context and motivation behind the current study, offering a detailed review of extant research and highlighting existing gaps.

Empirical evidence presents a mixed picture regarding the impact of a growth mindset on mathematics engagement. In Western contexts like Australia and the United States, a growth mindset is often seen as a positive influence on student engagement in mathematics [1][13]. Conversely, studies in the Czech Republic and various Eastern regions, including Hong Kong and mainland China, show no significant or even negative associations between a growth mindset and mathematics outcomes [6][9]. Notably, a research found no significant link between growth mindsets and mathematics outcomes in China, a finding echoed by PISA data [9][10]. Moreover, a cross-cultural study indicated a positive relationship between a growth mindset and mathematics outcomes in the US but a negative correlation in China, highlighting the need for

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re-investigating the predictive effect of growth mindset on students' mathematics engagement [11]. Consequently, although there is a positive correlation between a growth mindset and mathematics engagement within the Australian context, it remains necessary to re-evaluate this relationship due to the observed decline in mathematics engagement among secondary students.

2 Mindset Theory and Engagement

Mindset Theory differentiates views on intelligence into two: growth and fixed mindsets [5]. Individuals with a growth mindset see intelligence as malleable, improved by effort and perseverance, fostering resilience and a proactive approach to learning challenges. Conversely, those with a fixed mindset view intelligence as static, often leading to reduced perseverance in the face of difficulties. This theory is supported by Social Cognitive Theories, emphasizing the role of internal and external attributions in shaping one's approach to success and failure.

Students with growth mindset predominantly align their perceived setbacks and failures with effort-attribution [4]. Such a stance invariably leads to heightened resilience, a commitment to consistent practice, and the resilience in the face of learning challenges [12]. It may heightened probability that these students will exhibit more engagement (e.g., behavior and cognitive engagement) throughout their learning trajectory. While those with a fixed mindset attributing failures to ability-attribution, often exhibit diminished perseverance and engagement when faced with obstacles [4][12]. In synthesizing these insights, it becomes increasingly evident that fostering a growth mindset holds significant promise for bolstering student engagement.

The present study examined students' engagement in mathematics from three dimensions: cognitive, behavioral, and affective [3][7]. Students who demonstrate active engagement in mathematics display a considerable level of cognitive effort in their learning (cognitive engagement), actively participate in classroom settings behaviorally (behavioral engagement), and report heightened levels of enjoyment in their mathematics classes emotionally (emotional engagement) [8].

According to the above discussion, the question of the present research is 'How do students' growth mindset predict mathematics engagement?' The Hypothesis (H1) is students' growth mindset predict mathematics engagement.

3 Research Method

3.1 Participants

This study has investigated 230 Australian secondary students via online survey questionnaire.

3.2 Procedure and Instruments

Mindset Belief. Mindset beliefs of students from Australia has been typically assessed using 4-item self-report scale based on the work of Dweck's theory of mindset scale. It is a six-point Likert Scale (1 = most strongly disagree, 6 = most strongly agree). An illustrative item from self-report scale, for instance, item 1 states, "you can change even your basic intelligence level considerably". The scale has divided mindset beliefs into growth mindset (scores 5-6), fixed mindset (scores 1-2), and mixed mindset (scores 2.1-4.9) [4]. It can be seen that higher scores on this scale are indicative of a stronger endorsement of the growth mindset.

Mathematics Engagement. Students' mathematics engagement has been evaluated utilizing the Tripartite Engagement Framework, encompassing three fundamental aspects of engagement: behavioral, cognitive, and emotional [7]. The engagement items, to ensure mathematical specificity, will be adapted from previously validated measures (α= 0.84-0.92) and assessed using a consistent response format, employing a 7-point Likert-style scale. Higher scores on this measure demonstrated higher engagement in mathematics.

4 Data Analysis

For Test H1, utilizing SPSS 26, this study begins with a correlation analysis to investigate the relationships between students' mindset beliefs and variables of engagement—Cognitive Engagement, Behavioral Engagement, Emotional Engagement—as well as demographic factors like age and gender. This initial step is essential to identify significant bivariate relationships and to provide an overview of the associations among the variables. Subsequent to the correlation analysis, this study employs a multiple regression analysis conducted in two phases. The first phase includes demographic variables as predictors to determine their base impact on students' mindset beliefs. In the second phase, engagement variables are added to the model to assess their incremental explanatory power over the demographic variables. Throughout this process, R-squared values, F-statistics, beta coefficients, standard errors, and p-values for each predictor will be meticulously reported. This detailed approach will elucidate the unique contributions of engagement dimensions to mindset beliefs, offering valuable insights for educational interventions aimed at nurturing a growth mindset.

5 Results

Table 1. Intercorrelations of Students Mindset and Their Learning Engagement.

Variables	Mean (SD)	1	2	3	4	5	6
1.Age	14.3 (2.12)	-					
2.Gender	0.41 (-)	0.02	-				
3.MB	4.32 (1.01)	0.12	0.07	(0.91)			
4.CE	6.08 (1.48)	0.11	0.06	0.64**	(0.93)		
5.BE	6.02 (1.53)	0.08	0.15	0.56**	0.52**	(0.97)	
6.EE	6.18 (1.51)	0.11	0.03	0.71**	0.53**	0.58**	(0.89)

Note. $n = 230$, Gender was scored as women = 0 and men = 1. The diagonal values in parentheses represent the alpha-reliability coefficients. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. MB = Mindset Belief, CE = Cognitive Engagement, BE = Behavioral Engagement, EE = Emotional Engagement.

Table 1 revealed significant correlations between Mindset Belief (MB) and various forms of learning engagement: MB was significantly correlated with Cognitive Engagement ($r = 0.64$, $p < 0.01$), Behavioral Engagement ($r = 0.56$, $p < 0.01$), and Emotional Engagement ($r = 0.71$, $p < 0.01$), indicating that a stronger mindset belief is significantly associated with higher levels of cognitive, behavioral, and emotional engagement in learning. In addition, there is positive correlation between Cognitive Engagement and Behavioral Engagement ($r = 0.52$, $p < 0.01$), between CE and Emotional Engagement ($r = 0.53$, $p < 0.01$), and between Behavioral Engagement Emotional Engagement ($r = 0.58$, $p < 0.01$).

Table 2. Results regression analysis

	MD β	（*SE*）	f^2
Phase 1			
Age	0.06	(0.02)	0.01
Gender	0.05	(0.02)	0.01
R^2	**0.02**		
$F(2，227)$	**1.21**		
Phase 2			
CE	0.31**	(0.12)	0.12
BE	0.29**	(0.13)	0.12
EE	0.33**	(0.13)	0.14
ΔR^2	0.21**		
$\Delta F(3，223)$	12.1**		

Note. $n = 230$, Gender was scored as women = 0 and men = 1. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. MB = Mindset Belief, CE = Cognitive Engagement, BE = Behavioral Engagement, EE = Emotional Engagement.

Before the multiple regression analyses, a descriptive analysis was conducted to ensure that the data-set met the necessary assumptions for regression analysis. The results indicated that all variables were within the acceptable range for normality, with skewness values ranging from -0.45 to 1.15 and kurtosis values from -0.50 to 0.85. Homoscedasticity was assessed using the Durbin-Watson statistic, with values ranging from 1.75 to 2.20, all within the ideal range of 1.50 to 2.50, confirming the independence of error terms. Additionally, multicollinearity was evaluated using the variance inflation factor (VIF) statistics. The VIF values for Cognitive Engagement, Behavioral Engagement, and Emotional Engagement were all below the commonly used cut-off of 2.5, indicating no multicollinearity concerns (Mela & Kopalle, 2002). These analyses substantiate the appropriateness of our dataset for multiple regression analysis, laying a solid foundation for the subsequent regression results.

Table 2 presented multiple regression analysis, demographic variables such as age and gender were initially entered as predictors in Phase 1, yielding an R^2 value of 0.02. This result indicates that these demographic factors explain a minimal 2% variance in the mindset belief, with $F(2, 227) = 1.21$, suggesting that their contribution is not statistically significant. In Phase 2, engagement variables—Cognitive Engagement, Behavioral Engagement, and Emotional Engagement—were added to the model, leading to a substantial increase in the explained variance. The ΔR^2 value of 0.21** indicates that these engagement factors collectively explain an additional 21% of the variance in mindset belief, with a significant $\Delta F(3, 223) = 12.1$**. Specifically, Cognitive Engagement ($\beta = 0.31$, $p < 0.01$, $SE = 0.12$), BE ($\beta = 0.29$, $p < 0.01$, $SE = 0.13$), and Emotional Engagement ($\beta = 0.33$, $p < 0.01$, $SE = 0.13$) all showed significant positive contributions to predicting mindset belief, highlighting the pivotal role of engagement in shaping individuals' mindset beliefs. H1 thus is supported.

6 Discussion

This discussion section delves into the dynamic interplay between students' growth mindset beliefs and their engagement with mathematics, an area where engagement has notably waned, particularly highlighted in the Australian educational sphere. The adoption of growth mindset interventions, celebrated for their potential to transform educational outcomes, faces scrutiny in the realm of mathematics engagement. The literature presents a fragmented picture: while Bostwick and Yeager document positive outcomes in Western settings [1][13], findings from Eastern studies by Li and Bates, and PISA data paint a more complex and sometimes contradictory picture [9][10]. These mixed results emphasize the need to delve deeper into the specific attributes of mathematics education that might interact with growth mindset principles, suggesting that the relationship between growth mindset and mathematics engagement may be more nuanced than previously understood.

Furthermore, the current study's findings align with the Mindset Theory posited by Dweck and Legget, which distinguishes between growth and fixed mindsets. Students with a growth mindset, who perceive intelligence as malleable, tend to show higher engagement levels across cognitive, behavioral, and emotional dimensions [5]. This aligns with our results, showing significant correlations and predictive relationships between growth mindset beliefs and various engagement facets. Such findings reinforce the theory that adopting a growth mindset can foster enhanced engagement, thereby suggesting that interventions aimed at nurturing a growth mindset could be beneficial in the educational domain, particularly in mathematics.

7 Conclusion

In conclusion, this study underscores the significant relationship between growth mindset and mathematics engagement among Australian secondary students, highlighting the profound impact of growth mindset beliefs on students' engagement levels. The findings advocate for the integration of growth mindset principles into educational strategies, particularly in mathematics, to foster deeper learning and engagement. As educators and policymakers seek to enhance student outcomes in mathematics, emphasizing a growth mindset may offer a key pathway to invigorating students' interest, perseverance, and success in the subject.

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