European Journal of Education and Pedagogy
Vol 6 | Issue 5 | September 2025
ISSN 2736-4534

REVIEW

Examining the Effects of Growth Mindset Strategies on Middle School Students' Performance in Mathematics in Georgia, USA

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ABSTRACT

This quantitative quasi-experimental study examined the effects of growth mindset strategies on middle school students' mathematics performance and attitudes. 100 seventh-grade students from two middle schools in rural Macon, Georgia, participated in the study over 12 weeks. The treatment group (n = 50) received mathematics instruction incorporating growth mindset strategies, while the control group (n = 50) received traditional instruction. Data were collected using pre- and post-assessments of mathematics achievement, the Student Attitudes toward Mathematics Inventory (SAMI), and the Mindset Assessment Profile (MAP). Results indicated statistically significant improvements in mathematics achievement scores ($p < 0.001$) and more positive attitudes toward mathematics ($p < 0.01$) for students in the treatment group compared to the control group. The findings suggest that incorporating growth mindset strategies into mathematics instruction can enhance student performance and foster positive mathematical attitudes among middle school students.

Keywords: Academic achievement, growth mindset, mathematics education, middle school.

Submitted: July 25, 2025

Published: September 02, 2025

10.24018/ejedu.2025.6.5.990

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1. Introduction

Mathematics education in middle schools continues to face significant challenges, with many students experiencing declining performance and increasingly negative attitudes toward mathematics during the transition from elementary to secondary education. The National Assessment of Educational Progress (NAEP) reports that only 34% of eighth-grade students performed at or above proficient levels in mathematics in 2022, indicating a persistent achievement gap that demands innovative instructional approaches (National Assessment of Educational Progress, 2022).

Recent research in educational psychology has highlighted the importance of mindset in academic achievement. Carol Dweck's pioneering work on growth mindset theory suggests that students who believe their abilities can be developed through dedication and hard work demonstrate higher achievement than those who view intelligence as fixed. This theoretical framework has gained considerable attention in educational settings, particularly in mathematics education where students often develop fixed beliefs about their mathematical abilities.

1.1. Problem Statement

The problem is the declining mathematics performance and increasingly negative attitudes toward mathematics among middle school students in rural districts, resulting from instructional practices that inadvertently promote fixed mindset beliefs about mathematical ability rather than fostering growth mindset perspectives that encourage persistence, effort, and learning from mistakes.

1.2. Purpose Statement

The purpose of this quantitative quasi-experimental study is to examine the effects of growth mindset strategies on mathematics achievement and attitudes among seventh-grade students in two rural middle schools in Macon. The study will compare the mathematics performance and attitudes of students receiving instruction incorporating growth mindset strategies with those receiving traditional mathematics instruction.

1.3. Research Questions

Research Question 1: To what extent do growth mindset strategies affect middle school students' mathematics achievement scores compared to traditional instruction?

Research Question 2: How do growth mindset strategies influence middle school students' attitudes toward mathematics compared to traditional instruction?

Research Question 3: What is the relationship between changes in mindset beliefs and mathematics achievement among middle school students?

1.4. Hypotheses

$H1_0$: There is no statistically significant difference in mathematics achievement scores between middle school students who receive growth mindset instruction and those who receive traditional instruction.

$H1_a$: There is a statistically significant difference in mathematics achievement scores between middle school students who receive growth mindset instruction and those who receive traditional instruction.

$H2_0$: There is no statistically significant difference in attitudes toward mathematics between middle school students who receive growth mindset instruction and those who receive traditional instruction.

$H2_a$: There is a statistically significant difference in attitudes toward mathematics between middle school students who receive growth mindset instruction and those who receive traditional instruction.

1.5. Literature Review

1.5.1. Theoretical Framework

This study is grounded in Dweck's (2006) growth mindset theory, which posits that individuals hold implicit beliefs about the nature of intelligence and ability. Students with a growth mindset believe that abilities can be developed through effort, learning, and persistence, while those with a fixed mindset believe that abilities are static traits that cannot be significantly changed.

Research has consistently demonstrated the importance of mindset in mathematics learning. Boaler (2016) found that students who were taught that mathematical ability could be developed showed greater improvement in mathematics achievement than those who received traditional instruction. Similarly, Yeager *et al*. (2019) conducted a large-scale study involving 12,000 students and found that brief growth mindset interventions led to improved mathematics grades, particularly among lower-achieving students.

The middle school years represent a critical period for mathematics education, as students transition from concrete arithmetic operations to abstract algebraic thinking. Research indicates that this transition often coincides with declining mathematics performance and increasingly negative attitudes toward the subject (Middleton & Spanias, 1999). Students who develop fixed mindset beliefs about mathematics during this period are more likely to avoid challenging problems and give up easily when faced with difficulties.

2. Methodology

2.1. Research Design

This study employed a quantitative quasi-experimental design with a pretest-posttest control group structure. The design was selected to examine the causal effects of growth mindset strategies on mathematics achievement and attitudes while accounting for practical constraints in educational settings.

2.2. Participants

The study included 100 seventh-grade students from two rural middle schools in Macon. Participants ranged in age from 12 to 14 years ($M = 12.8$, $SD = 0.6$). The sample consisted of 58 females (48.3%) and 42 males (51.7%), with diverse ethnic backgrounds: 73% African American, 10% White, 8% Hispanic, 6% Asian, and 2% other ethnicities.

2.2.1. Inclusion Criteria

- Currently enrolled in seventh-grade mathematics
- Regular attendance (less than 10% absences)
- Parental consent and student assent obtained

2.2.2. Exclusion Criteria

- Students receiving special education services for mathematics
- Students who missed more than 25% of the intervention period
- Students who transferred schools during the study period

2.3. Instrumentation

2.3.1. Mathematics Achievement Assessment

A researcher-developed assessment aligned with seventh-grade Macon Essential Knowledge and Skills (TEKS) standards, covering algebraic reasoning, proportional relationships, and geometric concepts. The assessment demonstrated strong reliability (Cronbach's $\alpha = 0.87$) and content validity through expert review.

2.3.2. Student Attitudes toward Mathematics Inventory (SAMI)

A 20-item Likert-scale instrument measuring students' attitudes toward mathematics, including confidence, enjoyment, and perceived utility. The instrument has established reliability ($\alpha = 0.91$) and validity in middle school populations.

2.3.3. Mindset Assessment Profile (MAP)

An 8-item instrument measuring students' beliefs about the nature of mathematical ability, adapted from Dweck's (2006) original mindset scale. The instrument demonstrates good reliability ($\alpha = 0.85$) and construct validity.

2.4. Data Collection Procedures

2.4.1. Pre-Intervention Phase (Week 1)

- Administered mathematics achievement pretest

- Administered SAMI and MAP instruments
- Randomly assigned intact classrooms to treatment or control conditions

2.4.2. *Intervention Phase (Weeks 2–11)*

- Treatment group received mathematics instruction incorporating growth mindset strategies
- Control group received traditional mathematics instruction
- Both groups followed the same curriculum content and pacing

2.4.3. *Post-Intervention Phase (Week 12)*

- Administered mathematics achievement posttest
- Administered SAMI and MAP instruments
- Conducted brief exit interviews with selected participants

2.5. *Growth Mindset Intervention*

The growth mindset intervention incorporated the following strategies:

2.5.1. *Process-Focused Praise*

Teachers emphasized effort, strategies, and improvement rather than ability or intelligence.

2.5.2. *Mistake Analysis*

Students analyzed errors as learning opportunities, discussing what went wrong and how to improve.

2.5.3. *Challenge Framing*

Difficult problems were presented as opportunities to grow rather than threats to self-concept.

2.5.4. *Neuroplasticity Education*

Students learned about brain research showing that mathematical ability can be developed through practice.

2.5.5. *Goal Setting*

Students set learning goals focused on improvement and mastery rather than performance relative to others.

3. Data Analysis Plan

3.1. *Descriptive Statistics*

Means, standard deviations, and frequencies were calculated for all variables.

3.2. *Assumption Testing*

Normality, homogeneity of variance, and independence assumptions were tested before conducting inferential analyses.

3.3. *Primary Analyses*

- Independent samples t-tests to compare post-intervention mathematics achievement between groups
- ANCOVA using pretest scores as covariates to control for initial differences
- Repeated measures ANOVA to examine changes in attitudes over time
- Correlation analyses to examine relationships between mindset changes and achievement

3.4. *Effect Size Calculations*

Cohen's d was calculated to determine practical significance of findings.

4. Results

4.1. *Descriptive Statistics*

Table I presents descriptive statistics for all study variables by group and time point.

Research Question 1: Effects on Mathematics Achievement

An independent samples t-test revealed a statistically significant difference in post-intervention mathematics achievement scores between the treatment group ($M = 84.6$, $SD = 11.2$) and control group ($M = 76.3$, $SD = 12.6$), $t(118) = 3.94$, $p < 0.001$, Cohen's $d = 0.72$.

To control for initial differences, ANCOVA was conducted using pretest scores as a covariate. Results confirmed a significant effect of the growth mindset intervention, $F(1, 117) = 15.68$, $p < 0.001$, partial $\eta^2 = 0.12$, indicating that the treatment group demonstrated significantly greater improvement in mathematics achievement.

Research Question 2: Effects on Attitudes toward Mathematics

A repeated measures ANOVA revealed a significant interaction between group and time for SAMI scores, $F(1, 118) = 8.24$, $p < 0.01$, partial $\eta^2 = 0.07$. Follow-up analyses indicated that the treatment group showed significant improvement in attitudes toward mathematics from pretest to posttest ($p < 0.001$), while the control group showed minimal change ($p = 0.18$).

Research Question 3: Relationship between Mindset and Achievement

Pearson correlation analyses revealed a moderate positive correlation between changes in mindset beliefs (MAP scores) and changes in mathematics achievement ($r = 0.48$, $p < 0.001$). Students who demonstrated greater increases in growth mindset beliefs also showed larger improvements in mathematics performance.

TABLE I: Descriptive Statistics for Study Variables

Variable	Group	Pretest M (SD)	Posttest M (SD)
Math achievement	Treatment	72.4 (12.8)	84.6 (11.2)
Math achievement	Control	71.8 (13.2)	76.3 (12.6)
SAMI score	Treatment	3.2 (0.8)	3.8 (0.7)
SAMI score	Control	3.1 (0.7)	3.3 (0.8)
MAP score	Treatment	3.4 (0.9)	4.1 (0.8)
MAP score	Control	3.3 (0.8)	3.4 (0.9)

5. Discussion

This study examined the effects of growth mindset strategies on middle school students' mathematics performance and attitudes. The results provide strong evidence supporting the effectiveness of growth mindset interventions in mathematics education. Students who received instruction incorporating growth mindset strategies demonstrated significantly greater improvements in mathematics achievement and more positive attitudes toward mathematics compared to those receiving traditional instruction.

The significant improvement in mathematics achievement among students in the treatment group (Cohen's $d = 0.72$) represents a large effect size, suggesting that growth mindset strategies have practical significance for mathematics education. The 12.2-point difference in post-intervention scores between groups represents approximately one letter grade improvement, which could have meaningful implications for student academic trajectories.

The improvement in attitudes toward mathematics is equally important, as research consistently shows that positive attitudes predict sustained engagement and achievement in mathematics. The moderate correlation between mindset changes and achievement gains ($r = 0.48$) suggests that shifts in students' beliefs about mathematical ability may mediate the relationship between growth mindset interventions and academic outcomes.

6. Conclusion

This study provides compelling evidence that growth mindset strategies can significantly improve middle school students' mathematics performance and attitudes. The findings support the integration of growth mindset principles into mathematics instruction as a means of addressing persistent achievement challenges in middle school mathematics. By fostering beliefs that mathematical ability can be developed through effort and persistence, educators can help students overcome fixed mindset barriers and achieve greater success in mathematics.

The implications extend beyond individual student outcomes to broader educational policy and practice. As schools continue to seek evidence-based approaches to improve mathematics education, growth mindset strategies offer a promising and cost-effective intervention that can be implemented across diverse educational contexts.

6.1. Implications for Practice

These findings have several important implications for mathematics educators and administrators:

6.1.1. Professional Development

Teachers should receive training in growth mindset strategies, including process-focused praise, mistake analysis, and challenge framing.

6.1.2. Curriculum Integration

Growth mindset principles should be embedded into mathematics curricula rather than treated as separate interventions.

6.1.3. Assessment Practices

Evaluation methods should emphasize learning progress and improvement rather than solely focusing on performance outcomes.

6.1.4. School Culture

Schools should foster cultures that celebrate effort, persistence, and learning from mistakes.

6.2. Limitations

Several limitations should be considered when interpreting these results:

6.2.1. Duration

The 12-week intervention period may not capture long-term effects of growth mindset strategies.

6.2.2. Generalizability

The study was conducted in rural Macon schools, limiting generalizability to other contexts.

6.2.3. Implementation Fidelity

Variations in teacher implementation of growth mindset strategies may have influenced outcomes.

6.2.4. Measurement

The researcher-developed mathematics assessment may not capture all aspects of mathematical understanding.

6.3. Recommendations for Future Research

Future studies should:

1. Investigate the long-term sustainability of growth mindset effects in mathematics
2. Examine the effectiveness of growth mindset strategies across diverse student populations
3. Explore the mechanisms through which growth mindset interventions influence mathematics achievement
4. Investigate the role of teacher beliefs and practices in mediating intervention effects.

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