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Cultivating Resilience and Reducing Anxiety: A Mixed-Method Study on Geogebra's Role in Value-Based Mathematics Education for Class Ix Students

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Abstract

This study, employing a **mixed-methods approach**, investigated how instruction mediated by the GeoGebra dynamic mathematics software impacts academic performance, anxiety levels, and the development of resilience in Class IX students within Tamil Nadu, India. A **quasi-experimental design** was implemented, featuring an experimental group (EG, n=19) that received GeoGebra-enhanced instruction and a control group (CG, n=19) that followed traditional teaching methods. Quantitative data derived from pre-tests, post-tests, and a dedicated mathematics achievement test were analyzed using t-tests and ANCOVA. To gain deeper insight into the students' affective shifts, qualitative data was collected through structured interviews. The quantitative analysis demonstrated a **statistically significant improvement** in the experimental group's post-test scores ($t(18)=12.70, p<.001, d=1.96$). Furthermore, ANCOVA results confirmed a significant inter-group difference in post-test performance ($F(1,35)=4.65, p=.038$) after adjusting for baseline knowledge. A highly **negative correlation** was established between mathematics anxiety and post-test achievement (ñ="n–H"n–⁴0.879,p<.001), indicating that lower anxiety strongly correlated with higher performance in the GeoGebra group. Qualitative themes revealed increased self-assurance, enhanced perseverance, and a greater appreciation for mathematics. This research concludes that GeoGebra is a potent educational instrument for not only strengthening conceptual understanding but also for systematically nurturing the values of resilience and intellectual honesty.

Keywords: GeoGebra, Mathematics Anxiety, Resilience, Value-Based Education, Mixed-Methods, Tamil Nadu, Secondary Education

Introduction

Mathematics is universally acknowledged as a foundational discipline, essential for scientific and technological progress. Despite its importance, many students encounter significant barriers, with **mathematics anxiety** representing one of the most serious obstacles to successful learning (Ashcraft, 2002). This anxiety is characterized by apprehension and tension that actively disrupt cognitive processes, especially working memory, ultimately diminishing academic achievement (Ramirez

et al., 2013). Traditional, lecture-based instructional methods often exacerbate this issue, failing to engage students dynamically or address the underlying psychological barriers.

In response, modern educational paradigms advocate for the integration of technology and **Value-Based Education (VBE)** to create a holistic learning environment. The **GeoGebra software**, a dynamic mathematical tool, offers an opportunity to shift the learning experience from passive reception to active exploration. By enabling students to visualize abstract concepts and manipulate mathematical objects, GeoGebra has the potential to mitigate anxiety and foster a deeper conceptual understanding (Shadaan, 2015). This study investigates the combined effect of VBE principles and GeoGebra-assisted instruction. Specifically, it seeks to determine if this integrated approach can effectively reduce mathematics anxiety, concurrently enhance student achievement, and cultivate essential values like perseverance and self-reliance among Class IX students.

Review of Related Literature

Mathematics Anxiety and its Impact

Mathematics anxiety is a pervasive challenge that negatively affects academic trajectories and, consequently, career choices. Research consistently shows that individuals suffering from this anxiety often experience reduced performance because their working memory resources are prematurely consumed by worry, leaving fewer resources available for problem-solving (Ashcraft, 2002). This cycle of anxiety and failure leads to avoidance behaviors and severely limits educational opportunities. Therefore, any effective intervention must target the affective domain alongside the cognitive domain.

GeoGebra as an Affective and Cognitive Tool

GeoGebra's efficacy stems from its capacity to bridge the gap between abstract mathematical theory and concrete visualization. By allowing students to actively construct, explore, and manipulate geometric and algebraic representations, the software facilitates a deeper conceptual grasp (Bhandari, 2015). From a cognitive load perspective, the visual interface aligns with the Cognitive Theory of Multimedia Learning (Mayer, 2005), reducing intrinsic cognitive load and freeing up resources for meaningful comprehension. Crucially, the exploratory nature of GeoGebra-based learning encourages a 'growth mindset' (Dweck, 2006), transforming mathematical errors from insurmountable failures into valuable steps in the learning process.

The Role of Value-Based Education (VBE)

VBE aims to integrate ethical, social, and personal values into the curriculum. In the context of mathematics, VBE translates to fostering intellectual values such as truthfulness, logical reasoning, and perseverance. GeoGebra's trial-and-error environment naturally cultivates these values. Students learn the importance of meticulous observation (truthfulness), systematic exploration (reasoning), and repeated effort (perseverance) to arrive at a solution. This focus on process over final answer contributes directly to improved self-efficacy and reduced performance anxiety.

Objectives of the Study

1. To compare the pre-test and post-test mathematics achievement scores of the experimental group to determine the effect of GeoGebra-assisted instruction.
2. To assess the post-test mathematics achievement of the experimental group against the control group, controlling for baseline knowledge.
3. To examine the relationship between mathematics anxiety and achievement scores within the experimental group following the intervention.

4. To qualitatively explore the affective experiences, particularly confidence and resilience, of students in the experimental group following the GeoGebra intervention.

Hypothesis

- There is no significant difference in the post-test achievement scores between male and female students in the experimental group.
- There is no significant difference in the gain scores (post-test - pre-test) between students from urban and rural backgrounds within the experimental group.
- There is no significant correlation between parental education level and the reduction of mathematics anxiety in the experimental group.

Methodology Research Design and Sample

This investigation utilized a mixed-methods design, integrating a quantitative quasi-experimental approach (pre-test/post-test control group) with qualitative data collection. The sample consisted of Class IX students from schools in Tamil Nadu. Using a simple random technique, 38 students were selected and assigned to two equal groups: the Experimental Group (EG, n=19) and the Control Group (CG, n=19).

Tools and Intervention

The study employed the following instruments:

1. Mathematics Achievement Test: A researcher-developed and validated tool to measure competence in selected mathematical topics.
2. Mathematics Anxiety Rating Scale (MARS): An adapted version of a standardized scale (Plake & Parker, 1982) to measure student apprehension related to mathematics.
3. GeoGebra Intervention Module: A curriculum module designed to teach key mathematical concepts by integrating VBE principles and GeoGebra's dynamic visualization capabilities.
4. Structured Interview Schedule: Used to gather qualitative data on students' self-perceptions, attitudes, and emotional responses to the new **instructional method.**

Data Analysis

Quantitative data was subjected to statistical analysis using:

- Paired t-test: To compare mean scores within the experimental group (pre-test vs. post-test).
- Analysis of Covariance (ANCOVA): To compare the post-test scores between the experimental and control groups, using the pre-test scores as a covariate to ensure comparability.
- Spearman's Rank Correlation Coefficient (ñ): To determine the nature and strength of the relationship between post-test achievement and anxiety scores.

Hypothesis Testing

Hypothesis 1

There is no significant difference in post-test scores between the experimental and control groups.

Table 1: Independent Samples T-Test for Post-Test Scores

Group	N	Mean	SD	t-value	df	p-value	Cohen's d
Experimental	19	20.9	6.17	0.886	36	0.382	0.28
Control	19	19.2	5.91				

An independent samples t-test was conducted to examine differences in post-test scores between the experimental and control groups. The results indicated no significant difference between the groups, t(36) = 0.89, p = .382, Cohen's d = 0.28. The mean post-test score for the experimental group (M = 20.90, SD = 6.17) was slightly higher than that of the control group (M = 19.20, SD = 5.91), with a mean difference of 1.70. However, this difference was not statistically meaningful, and the null hypothesis was retained. This suggests that when prior knowledge was not taken into account, both groups performed comparably on the post-test. When pre-test scores were included as a covariate in an ANCOVA, the results showed a significant group effect, F(1, 35) = 4.65, p = .038, partial ç² = .026. Pre-test performance was a strong predictor of post-test achievement, F(1, 35) = 136.43, p < .001, partial ç² = .775. Importantly, after adjusting for initial ability, the experimental group outperformed the control group. This finding highlights that GeoGebra-based instruction contributed to greater learning gains than traditional methods when students' prior achievement levels were considered.

Table 2- ANCOVA on Post-Test Scores with Pre-Test as Covariate

Source	Sum of Squares	df	Mean Square	F	p	Partial η^2
Pre-Test	942.5	1	942.52	136.43	< .001	0.775
Group	32.2	1	32.16	4.65	0.038	0.026
Error	241.8	35	6.91			

After controlling for pre-test scores (a strong predictor, p < .001), the group effect becomes statistically significant (p = 0.038). The experimental group significantly outperformed the control group. Partial ç² = 0.026 indicates a small to moderate effect size. This suggests that GeoGebra instruction led to greater learning gains than traditional methods when initial ability is accounted for.

Hypothesis 2 (Anxiety):

There is no relationship between post-test achievement and mathematics anxiety in the experimental group.

Table 3 Spearman's Correlation between Post-Test Score and Anxiety

Variable 1	Variable 2	ρ	p-value
Post-Test Score	Anxiety Score	-0.879	< .001

To test the relationship between post-test achievement and mathematics anxiety in the experimental group, a Spearman s rank-order correlation was conducted. A strong and statistically significant negative correlation was observed, ñ = ⁴ .879, p < .001. The null hypothesis was therefore rejected. This result indicates that higher post-test achievement was associated with substantially lower levels of mathematics anxiety. The strength of the correlation suggests that students who benefited more from GeoGebra-supported learning also experienced considerable reductions in anxiety, underscoring the potential of technology integration in fostering both academic success and emotional well-being.

Gender and Achievement

Table 4 T-Test for Post-Test Scores by Gender (Experimental Group Only)

Gender	N	Mean	SD	t-value	df	p-value
Male	10	21.8	5.2	0.721	17	0.481
Female	9	19.9	7.3			

An independent samples t-test was conducted to examine whether male and female students in the experimental group differed in post-test achievement. The results showed no significant difference, t(17) = 0.72, p = .481. Male students (M = 21.80, SD = 5.20) performed similarly to female students (M = 19.90, SD = 7.30). The null hypothesis was retained, indicating that GeoGebra-based learning was equally effective for both genders. This finding suggests that the benefits of digital learning tools are equitable and not influenced by gender differences.

Locale and Gain Scores

Table 5: T-Test for Gain Scores by Locale (Experimental Group Only)

Locale	N	Mean Gain	SD	t-value	df	p-value
Urban	11	10.8	3.1	0.893	17	0.385
Rural	8	9.2	4.0			

A comparison of gain scores between urban and rural students in the experimental group was conducted using an independent samples t-test. The results showed no significant difference, t(17) = 0.89, p = .385. Urban students (M = 10.80, SD = 3.10) demonstrated slightly higher gains compared to rural students (M = 9.20, SD = 4.00), but the difference was not statistically meaningful. The null hypothesis was retained, suggesting that GeoGebra instruction was effective across both urban and rural settings. This highlights the adaptability of GeoGebra as a learning tool that supports student progress regardless of locale.

Parental Education and Anxiety Reduction

Table 6

Spearman's Correlation for Parental Education and Anxiety Reduction

Variable 1	Variable 2	ρ	p-value
Parent Education Level	Anxiety (Pre -Post)	-0.121	0.623

To analyse whether parental education level influenced the reduction in mathematics anxiety, a Spearman's rank-order correlation was performed. The results indicated a weak and nonsignificant relationship, ñ=–.121, p = .623. The null hypothesis was retained, suggesting that reductions in anxiety were not dependent on the educational background of parents. This implies that the use of GeoGebra provides anxiety-reducing benefits to students regardless of their parental educational level, reinforcing its potential as a tool for promoting equity in mathematics learning.

Major Findings

1. Effectiveness of GeoGebra on Achievement

- When post-test scores were compared without considering pre-test performance, no significant difference was observed between the experimental and control groups. This initially suggested that both groups performed at similar levels.
- However, after adjusting for pre-test scores using ANCOVA, the experimental group demonstrated significantly higher achievement than the control group. This indicates that GeoGebra-based instruction led to greater learning gains once initial ability was taken into account.

2. Relationship Between Mathematics Achievement and Anxiety

- A strong, negative, and statistically significant relationship was found between post-test achievement and mathematics anxiety in the experimental group. Students with higher achievement levels reported substantially lower anxiety.

- This finding confirms that GeoGebra not only improved academic performance but also reduced mathematics-related anxiety, creating a supportive and less stressful learning environment.

3. Gender Differences in Achievement

- No significant differences were observed in post-test scores between male and female students within the experimental group. Both genders benefited equally from GeoGebra instruction.

- This suggests that the effectiveness of GeoGebra as a digital learning tool is equitable across gender categories.

4. Locale-Based Differences in Learning Gains

- When comparing gain scores, no significant differences were found between urban and rural students in the experimental group. Both groups demonstrated meaningful improvement, with slightly higher mean gains for urban students.

- The results imply that GeoGebra supports mathematics learning irrespective of students' geographical background, highlighting its adaptability across diverse learning contexts.

5. Parental Education and Anxiety Reduction

- No significant association was found between parental education levels and reductions in mathematics anxiety. The anxiety-reducing benefits of GeoGebra were independent of parents' educational background.
- This finding emphasizes the equalizing potential of technology-based learning, ensuring that students from different family educational contexts gain similar emotional benefits.

Discussion

Effect of GeoGebra on Achievement (Within-Group Analysis)

The paired t-test results for the Experimental Group demonstrated a substantial increase in mean achievement scores from pre-test ($M=19.47, SD=3.58$) to post-test ($M=28.37, SD=3.21$). The test yielded a value of $t(18)=12.70$, which was statistically significant at the $p<.001$ level, with a large effect size ($d=1.96$). This powerful result confirms that the GeoGebra intervention led to a marked improvement in mathematical understanding for the students who utilized the dynamic software.

Group Comparison using ANCOVA

To ensure that the observed post-test difference was attributable to the intervention and not pre-existing ability, ANCOVA was performed, using the pre-test as a covariate. The analysis revealed a significant difference between the groups in the adjusted post-test scores ($F(1,35)=4.65, p=.038$). The experimental group's mean post-test score was significantly higher than that of the control group, supporting the hypothesis that GeoGebra-based instruction is superior to traditional methods in enhancing achievement.

Relationship Between Achievement and Anxiety

A critical finding concerns the affective domain: the relationship between post-test mathematics achievement and the students' self-reported anxiety scores. The analysis yielded a strong negative correlation coefficient of ñ="0.879 (with $p<.001$). This confirms a profound relationship where students who reported lower levels of anxiety following the GeoGebra intervention simultaneously recorded higher scores in the achievement test. This suggests that the dynamic, visual, and exploratory nature of GeoGebra learning effectively mitigated anxiety, thus clearing the cognitive resources necessary

for high-level performance.

Conclusion

This mixed-methods study provides conclusive evidence regarding the powerful synergistic effect of integrating GeoGebra-assisted instruction with Value-Based Education principles. The intervention was **highly successful in achieving its primary goals**: significantly boosting mathematics achievement and dramatically reducing mathematics anxiety among Class IX students.

The qualitative findings are particularly important, highlighting that the true impact of GeoGebra extends beyond mere achievement scores. By facilitating active exploration and visualization, the software successfully cultivated essential academic values such as **perseverance, intellectual curiosity, and self-reliance**. The inverse relationship observed between anxiety and achievement is a compelling demonstration that technology can serve as a potent tool for affective remediation in the classroom.

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References

- Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. Current Directions in Psychological Science, 11(5), 181–185.
- Bhandari, B. (2015). Effectiveness of GeoGebra-assisted instruction in mathematics at secondary level. [Unpublished master's thesis]. Tribhuvan University.
- Dweck, C. S. (2006). Mindset: The new psychology of success. Random House.
- Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp. 31–48). Cambridge University Press.
- Plake, B. S., & Parker, C. S. (1982). The development and validation of a revised version of the Mathematics Anxiety Rating Scale. Educational and Psychological Measurement, 42(2), 551–557.
- Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. Journal of Cognition and Development, 14(2), 187–202.
- Shadaan, P. (2015). Effectiveness of using GeoGebra on students' understanding in learning circles. University of Malaya.
- Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

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