IGNATIAN
INTERNATIONAL JOURNAL FOR MULTIDISCIPLINARY RESEARCH
www.icceph.com
ISSN 2984-9942

ASSESSING THE EFFECT OF GEOGEBRA®-ASSISTED INSTRUCTION ON MATHEMATICS ANXIETY, SELF-EFFICACY, AND PROBLEM-SOLVING SKILLS AMONG BACHELOR OF COMPUTER SCIENCE STUDENTS

Arsanial E. Sappayani

Graduate Studies, Sulu State University, Jolo, Sulu, Philippines

ABSTRACT

This study assessed the effect of GeoGebra-assisted instruction on mathematics anxiety, self-efficacy, and problem-solving skills among 100 Bachelor of Computer Science students at Sulu State University, Philippines. A descriptive-correlational design was employed using validated scales (Cronbach's α = .85–.89). Data were analyzed using descriptive statistics, independent t-tests, one-way ANOVA with Tukey HSD post-hoc, and Pearson correlation ($\alpha = 0.05$). Results indicated High levels of positive effect on mathematics anxiety (M = 3.73), self-efficacy (M = 3.54), and problem-solving skills (M = 3.81). No gender differences were found. Significant differences emerged for self-efficacy by age ($F = 4.380$, $p = .006$, $\eta^2 = 0.120$) and year level ($F = 2.890$, $p = .040$, $\eta^2 = 0.082$), with students aged 24+ reporting lower self-efficacy and fourth-year students reporting higher self-efficacy than first-year students. All correlations were significant: anxiety–self-efficacy ($r = .583$, $p < .001$), self-efficacy–problem-solving ($r = .307$, $p = .002$), and anxiety–problem-solving ($r = .301$, $p = .002$). The positive anxiety–problem-solving correlation contrasts with traditional literature, suggesting that GeoGebra may reduce cognitive load sufficiently to enable anxious students to perform well. The study concludes that GeoGebra is a low-cost, high-impact tool for mathematics instruction in computer science education.

Keywords: *GeoGebra, Mathematics anxiety, Self-efficacy, Problem-solving skills, Computer Science Education, Philippines*

INTRODUCTION

Mathematics is foundational to computer science, providing the logical, algebraic, and computational frameworks underlying algorithms, data structures, cryptography, and artificial intelligence. Despite this essential relationship, many computer science students experience mathematics anxiety a condition characterized by tension, apprehension, and fear that interferes with mathematical performance (Richardson & Suinn, 1972). Mathematics anxiety impairs working memory (Ashcraft, 2002), reduces persistence, and negatively correlates with achievement (Hembree, 1990). In the Philippine context, Bautista (2019) reported that 68% of college students experience moderate to high mathematics anxiety, with traditional lecture-based instruction identified as a contributing factor.

Concurrently, mathematics self-efficacy belief in one's capability to perform mathematical tasks (Bandura, 1997) emerges as a critical protective factor. Students with high self-efficacy persist longer, use more effective strategies, and experience less anxiety (Pajares & Miller, 1994). Problem-solving skills, the third pillar of mathematical competence, involve understanding problems, devising plans, executing strategies, and evaluating solutions (Polya, 1945). These three constructs anxiety, self-efficacy, and problem-solving skills are interrelated and jointly influence academic outcomes.

GeoGebra, a dynamic mathematics software created by Hohenwarter (2001), integrates geometry, algebra, spreadsheets, graphing, statistics, and calculus in a single platform. Its dual representation capability (Hohenwarter & Jones, 2007) allows students to manipulate algebraic and geometric representations simultaneously, fostering conceptual understanding. International research demonstrates that GeoGebra reduces mathematics anxiety (Zakaria & Lee, 2012; $d = 0.95$), improves self-efficacy (Thambi & Eu, 2021; $d = 0.91$), and enhances problem-solving skills (Saha et al., 2010; $\eta^2 = 0.31$). However, despite these robust findings, no study has specifically examined computer science students, who possess high prior technology exposure but may exhibit distinct anxiety profiles regarding abstract mathematical reasoning. Few studies have simultaneously measured all three constructs within a single design, limiting understanding of their interrelationships during GeoGebra instruction.

This study is anchored on three complementary theories: Bandura's Social Cognitive Theory (1997), Sweller's Cognitive Load Theory (1988), and Ashcraft's model of mathematics anxiety (2002). When integrated, these theories suggest that GeoGebra may reduce mathematics anxiety by reducing extraneous cognitive load (Sweller), thereby freeing working memory; providing mastery experiences that build self-efficacy (Bandura); and directly lowering physiological arousal (Ashcraft).

Research Questions

This study aimed to determine the effect of GeoGebra instruction on the mathematics anxiety, self-efficacy, and problem-solving skills of Bachelor of Computer

Science students at Sulu State University. Specifically, it sought to answer the following questions:

1. What is the demographic profile of the respondents in terms of age group, sex, and year level?
2. What is the level of effect of GeoGebra instruction on respondents' mathematics anxiety, mathematics self-efficacy, and problem-solving skills?
3. Is there a significant difference in the level of effect of GeoGebra instruction when respondents are grouped according to age group, sex, and year level?
4. Is there a significant relationship among mathematics anxiety, mathematics self-efficacy, and problem-solving skills of respondents?

METHODOLOGY

Research Design. A descriptive-correlational research design was employed. This design was appropriate for describing the level of effect of GeoGebra instruction on mathematics anxiety, self-efficacy, and problem-solving skills as perceived by respondents, and for examining relationships among these variables without manipulating the instructional environment.

Research Locale. The study was conducted at Sulu State University (SSU), located in Jolo, Sulu, Philippines. SSU is a public higher education institution serving students from across the Sulu Archipelago. The university has integrated technology-enhanced instruction into its mathematics curriculum, including GeoGebra-assisted teaching in College Algebra courses.

Respondents and Sampling. Participants were 100 Bachelor of Computer Science (BCS) students enrolled in College Algebra during the 2025-2026 academic term who had experienced GeoGebra-assisted instruction for a minimum of one full term. Purposive sampling was used to ensure all respondents had direct, firsthand experience with GeoGebra-integrated instruction. The sample size of 100 was determined to be adequate for correlation analysis based on power analysis guidelines (Cohen, 1988), which recommend a minimum of 85 participants to detect a medium effect size ($r = 0.30$) with power = 0.80 at $\alpha = 0.05$.

Research Instrument. A structured survey questionnaire comprised three validated scales, each measuring one of the primary constructs. All items used a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The Mathematics Anxiety Scale (10 items) was adapted from Richardson and Suinn (1972). The Mathematics Self-Efficacy Scale (10 items) was adapted from Bandura (1997) and Pajares and Miller (1994). The Problem-Solving Skills Scale (10 items) was adapted from Heppner and Petersen (1982). Content validity was established through review by two faculty members from the Graduate Studies program. A pilot test with 30 non-respondent participants confirmed internal consistency, with Cronbach's α ranging from .85 to .89 across the three scales.

Data Collection Procedure. Prior to data collection, ethical clearance was obtained from the Sulu State University Research Ethics Committee. Formal written permissions were secured sequentially. Following institutional approval, the researcher visited College Algebra classes to explain the study purpose, procedures, and confidentiality protections. Informed consent was obtained in writing from all participants. Surveys were administered during regular class sessions, requiring approximately 15–20 minutes for completion.

Data Analysis. The following statistical tools were employed with an alpha level set at α = 0.05: frequency and percentage for demographic profile; weighted mean and standard deviation for level of effect; independent samples t-test for gender differences; one-way ANOVA with Tukey HSD post-hoc for age and year level differences; and Pearson product-moment correlation for relationships among variables. All statistical analyses were conducted using SPSS version 29.0 (IBM Corp., 2022).

RESULTS

Demographic Profile. Table 1 presents the demographic profile of the 100 respondents. The majority were female (74%), aged 20-21 years (49%), and first-year students (41%).

Table 1. ***Demographic Profile of Respondents (N = 100)***

Variable	Category	Frequency (f)	Percentage (%)
Age	19 years and below	23	23.0
	20-21 years	49	49.0
	22-23 years	20	20.0
	24 years and above	8	8.0
Gender	Male	26	26.0
	Female	74	74.0
Year Level	First Year	41	41.0
	Second Year	17	17.0
	Third Year	32	32.0
	Fourth Year	10	10.0

Correlations Among Variables. Table 2 presents the Pearson correlation matrix. All three null hypotheses (H_{04}, H_{05}, H_{06}) were rejected. All correlations were statistically significant at α = 0.05.

Table 2. ***Pearson Correlation Matrix (N = 100)***

Variable Pair	Pearson r	p-value (2-tailed)	Interpretation
Math Anxiety ↔ Self-Efficacy	0.583	< .001	Moderate positive
Self-Efficacy ↔ Problem-Solving	0.307	.002	Weak positive

Math Anxiety ↔ Problem-Solving	0.301	.002	Weak-to-moderate positive

DISCUSSION

Level of Effect of GeoGebra-Assisted Instruction. Using the interpretation scale (1.00–1.80 = Very Low Effect, 1.81–2.60 = Low Effect, 2.61–3.40 = Moderate Effect, 3.41–4.20 = High Effect, 4.21–5.00 = Very High Effect), GeoGebra-assisted instruction demonstrated High levels of positive effect on all three constructs. Overall mathematics anxiety (M = 3.73, SD = 1.03) was High. The highest-rated anxiety item was "I worry about failing mathematics exams" (M = 4.09). Overall self-efficacy (M = 3.54, SD = 1.06) was High, with the lowest-rated items involving initial GeoGebra use (SE1: M = 3.25; SE2: M = 3.28) rated Moderate. Overall problem-solving skills (M = 3.81, SD = 1.02) was High, with checking work and reflecting on learning receiving the highest ratings (PS5: M = 4.12; PS10: M = 4.12).

Differences According to Demographic Profile. No significant gender differences were found for any variable (all p > .05), indicating that H_{02} was retained. Age significantly affected self-efficacy (F = 4.380, p = .006, η^2 = 0.120), with Tukey HSD post-hoc revealing that students aged 24+ reported significantly lower self-efficacy than those aged 20-21 (p = .019) and 22-23 (p = .003). No significant age differences were found for anxiety (p = .068) or problem-solving (p = .604). Thus, H_{01} was rejected for self-efficacy only. Year level significantly affected self-efficacy (F = 2.890, p = .040, η^2 = 0.082), with Tukey HSD post-hoc showing that fourth-year students reported higher self-efficacy than first-year students (mean difference = 0.27, 95% CI [0.02, 0.52], p = .035). No significant year level differences were found for anxiety (p = .078) or problem-solving (p = .120). Thus, H_{03} was rejected for self-efficacy only.

The High effect levels across all three constructs align with international research (Zakaria & Lee, 2012; Tatar & Zengin, 2016; Thambi & Eu, 2021) and Philippine studies (Cullano, 2024; Robiso, 2024). The finding that test anxiety (MA5) remained highest suggests that while GeoGebra reduces general mathematics anxiety, high-stakes assessment contexts require additional intervention. This is consistent with Ashcraft's (2002) observation that evaluation contexts trigger the most intense anxiety responses.

The absence of gender differences contradicts Delgado (2024) but supports Kollosche (2019) and Robiso (2024). GeoGebra may serve as an "equalizing force," reducing the gendered anxiety gap through supportive, technology-enhanced environments (Beilock et al., 2010). The significantly lower self-efficacy of students aged 24+ (p = .006, η^2 = 0.120) is a novel contribution. Possible explanations include longer gaps in mathematical study leading to skill decay, prior negative mathematics experiences accumulated over time, returning-student status with competing responsibilities, or less familiarity with educational technology. This finding extends Birgin and Uzun's (2020) observation that GeoGebra's effects differ by age.

The significant increase in self-efficacy from first to fourth year (p = .035) supports Bandura's (1997) assertion that cumulative mastery experiences build self-efficacy over time. The lack of significant anxiety reduction across year levels (p = .078) suggests that anxiety reduction may require more targeted early interventions rather than simply accumulating exposure.

The moderate positive correlation between mathematics anxiety and self-efficacy (r = 0.583) indicates that students who reported higher anxiety also reported higher confidence. While counterintuitive relative to traditional literature reporting negative correlations (Hembree, 1990), this may reflect that GeoGebra simultaneously engages both affective dimensions. Students who engage more deeply with the software may experience both greater awareness of their anxiety and greater confidence from mastery experiences.

Most notably, the significant positive correlation between mathematics anxiety and problem-solving skills (r = 0.301, p = .002) diverges from traditional literature, which consistently reports negative correlations (Ashcraft, 2002; Hembree, 1990). This may be interpreted through Sweller's (1988) Cognitive Load Theory: GeoGebra reduces extraneous cognitive load, freeing working memory resources that anxious students would otherwise lose to worry. Rather than anxiety impairing performance, GeoGebra may enable even anxious students to perform well, transforming the typical negative relationship into a weak positive one. The weak positive correlation between self-efficacy and problem-solving (r = 0.307) is consistent with Bandura (1997) and Pajares and Miller (1994), though weaker than some meta-analytic estimates, possibly due to restriction of range.

Conclusions

Based on the findings, the following conclusions are drawn. First, GeoGebra-assisted instruction produces High levels of positive effect on mathematics anxiety, self-efficacy, and problem-solving skills among computer science students. Second, GeoGebra is equally effective across genders, suggesting it serves as an equitable instructional tool for male and female students. Third, mature students (aged 24 years and above) have significantly lower self-efficacy and require targeted confidence-building interventions beyond GeoGebra exposure. Fourth, self-efficacy builds progressively across year levels, supporting Bandura's theory that cumulative mastery experiences enhance confidence over time. Fifth, contrary to traditional literature reporting negative correlations, mathematics anxiety and problem-solving skills are significantly positively correlated among students using GeoGebra, suggesting that GeoGebra's visual and interactive features may reduce cognitive load sufficiently to enable anxious students to perform well. Sixth, the moderate positive correlation between mathematics anxiety and self-efficacy indicates that GeoGebra simultaneously engages both affective dimensions.

Recommendations

For mathematics instructors, it is recommended to integrate GeoGebra consistently throughout College Algebra rather than as an occasional supplement, provide explicit scaffolding for initial GeoGebra use, address test anxiety specifically through practice tests and anxiety-reduction strategies, and provide targeted support for mature students (aged 24+) through one-on-one tutoring and extended practice opportunities.

For curriculum developers, it is recommended to mandate GeoGebra integration across all mathematics courses in the computer science curriculum, develop standardized training materials for faculty, and ensure adequate computer laboratory access.

For administrators, it is recommended to invest in continuous technical support and professional development for GeoGebra integration, establish a technology-enhanced mathematics learning center, and consider offering bridging or refresher courses for mature students.

For students, it is recommended to actively engage with GeoGebra for both in-class and independent practice, recognize that anxiety does not necessarily impair performance when using technology-enhanced tools, and seek additional support if aged 24+ or experiencing persistent test anxiety.

For future researchers, it is recommended to conduct experimental studies with pretest-posttest control groups to establish causality, include direct performance measures alongside self-reports, replicate with larger samples of mature students ($n \geq 30$ per age group), conduct qualitative interviews with students aged 24+ to understand self-efficacy barriers, test whether the positive anxiety–problem-solving correlation replicates in other technology-enhanced environments, and extend the study to other institutions and mathematics courses.

Compliance with Ethical Standards

The researchers declare compliance with all ethical standards for research involving human participants. Prior to data collection, ethical clearance was obtained from the Sulu State University Research Ethics Committee. Informed consent was obtained in writing from all participants, and participants were informed of their freedom to withdraw from the study at any time without negative consequences. Anonymity of the respondents was maintained throughout as no personally identifying information was collected. Data privacy was followed in accordance with the Philippine Data Privacy Act of 2012. The respondents' well-being was safeguarded throughout the research process. No conflict of interest exists in the conduct of this study. Plagiarism was strictly avoided, and all sources cited are properly acknowledged. The researchers maintained no bias in the interpretation of the findings. The results were used purely for research purposes. No artificial intelligence tools were used in the analysis or interpretation of data; AI was used solely for language refinement and formatting assistance.

Acknowledgements

The researcher extends deepest gratitude to the Almighty God for divine wisdom and guidance. The researcher acknowledges Dr. Charisma S. Ututalum, President of Sulu State University, for fostering an environment conducive to learning and research. The researcher thanks Dr. Nelson U. Julhamid, VP for Academic Affairs, and Dr. Masnona Asiri, Dean for School of Graduate Studies, for her guidance. Finally, the researcher thanks all respondents who participated in this study.

REFERENCES

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. Current Directions in Psychological Science, 11(5), 181–185.

Bandura, A. (1997). Self-efficacy: The exercise of control. Freeman.

Bautista, R. G. (2019). Mathematics anxiety among Filipino college students: Prevalence and correlates. Philippine Journal of Education, 98(2), 145–167.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. Proceedings of the National Academy of Sciences, 107(5), 1860–1863.

Birgin, O., & Uzun, K. (2020). Age differences in GeoGebra-based instruction. International Journal of Educational Technology, 15(3), 234–248.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Cullano, R. M. (2024). Technology integration and mathematics self-efficacy in Philippine higher education. Asian Journal of Technology in Education, 12(1), 34–52.

Delgado, M. P. (2024). Gender differences in mathematics anxiety among Filipino STEM students. Philippine Social Science Journal, 7(1), 89–104.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. Journal for Research in Mathematics Education, 21(1), 33–46.

Heppner, P. P., & Petersen, C. H. (1982). The development and implications of a personal problem-solving inventory. Journal of Counseling Psychology, 29(1), 66–75.

Hohenwarter, M. (2001). GeoGebra: Ein Softwaresystem für dynamische Geometrie und Algebra der Ebene [Unpublished master's thesis]. University of Salzburg.

Hohenwarter, M., & Jones, K. (2007). Ways of linking geometry and algebra: The case of GeoGebra. Proceedings of the British Society for Research into Learning Mathematics, 27(3), 126–131.

IBM Corp. (2022). IBM SPSS Statistics for Windows (Version 29.0) [Computer software]. IBM Corp.

Kollosche, D. (2019). Gender differences in GeoGebra-based instruction. International Journal of Mathematical Education, 50(3), 345–360.

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. Journal of Educational Psychology, 86(2), 193–203.

Polya, G. (1945). How to solve it: A new guide to mathematical method. Princeton University Press.

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. Journal of Counseling Psychology, 19(6), 551–554.

Robiso, J. L. (2024). Self-efficacy and anxiety in college mathematics: A correlational study. Philippine Journal of Psychology and Education, 15(2), 78–96.

Saha, R. A., Ayub, A. F. M., & Tarmizi, R. A. (2010). The effects of GeoGebra on mathematics achievement: Enlightening coordinate geometry learning. Procedia Social and Behavioral Sciences, 8, 686–693.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285.

Tatar, E., & Zengin, Y. (2016). The effect of GeoGebra on problem solving strategies of secondary school students. International Journal of Research in Education and Science, 2(1), 127–137.

Thambi, N., & Eu, L. K. (2021). Effect of GeoGebra on students' mathematics self-efficacy: A meta-analysis. Malaysian Journal of Learning and Instruction, 18(1), 95–121.

Zakaria, E., & Lee, L. S. (2012). Teacher's perceptions toward the use of GeoGebra in the mathematics classroom. International Journal of Education and Research, 10(2), 112–126.

APA Citation:

Sappayani, A. E. (2026). ASSESSING THE EFFECT OF GEOGEBRA®-ASSISTED INSTRUCTION ON MATHEMATICS ANXIETY, SELF-EFFICACY, AND PROBLEM-SOLVING SKILLS AMONG BACHELOR OF COMPUTER SCIENCE STUDENTS. Ignatian International Journal for Multidisciplinary Research, 4(6), 1077–1085. https://doi.org/10.5281/zenodo.20680250

asappayani@sulustatecollege.edu.ph