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GeoGebra: Its Effects on Education Students' Attitudes, Motivation, and Performance in College Algebra

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Abstract

Mobile applications like GeoGebra are crucial for learning algebraic function graphing among college students. This application provides interactive visual aids that improve comprehension and memory of complex ideas relating to graphing of algebraic functions. It aimed to determine the effects of GeoGebra software in smartphones on education students' attitudes, motivation, and performance in College Algebra at a technological state university in Cebu City, Philippines. The participants were 80 students [40 students in the control group and 40 in the experimental group] who were chosen using purposive sampling. The quasi-experimental method used three questionnaires (Fennema-Sherman Mathematics Attitude Scales, Mathematics Motivation Questionnaire, and Students' Algebra Performance). The data were treated using frequency, mean, standard deviation, Pearson r, and paired t-test. The study revealed that students' attitudes and motivations toward algebra do not have significant relationships with their pretest and posttest performances in graphing algebraic functions. However, there is a substantial difference between the students' posttest means scores in Algebra of the control and experimental groups. The study concluded that students' attitudes toward algebra improved when using GeoGebra software to learn graphing of algebraic functions. The researcher recommends integrating GeoGebra software into Algebra's curriculum to enhance students' performance in graphing algebraic functions.

Keywords: Teaching Mathematics, GeoGebra, attitudes, motivation, performance

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INTRODUCTION

Graphing algebraic functions is a fundamental skill in mathematics, providing a visual representation of relationships between variables. When plotting a function, understanding its form is crucial for students enrolled in College Algebra, especially those using graphing papers. The result of the operation is a rough graph that reflects the characteristics of the function and seamlessly connects points. The clarity of the graph is improved by paying attention to details, such as naming axes and crucial spots. Understanding the function's behaviour is made more accessible by this visual depiction, which is essential for many mathematical and scientific applications. The graphing software is an example of technology that enhances human graphing by offering a fast and precise way to verify the created graph. Proficiency in graphing algebraic functions promotes a thorough knowledge of mathematical relationships and opens doors to more profound mathematical discoveries. It is also a helpful ability.

Because graphing provides a visual representation of mathematical relationships, it is essential to comprehending algebra. It offers understanding and clarity by turning abstract calculations into concrete pictures. Using graphs, students may see trends, pinpoint answers, and understand how functions behave. Understanding variables and their relationships is improved when algebraic statements are shown on a coordinate plane. Graphs encourage the practical application of algebraic principles by making real-world issues more straightforward to understand. They also make it possible to analyse trends, which helps with result prediction and the creation of mathematical models. Graphing is a valuable tool for breaking through algebra's complexity, bringing abstract ideas to life, and encouraging a more profound comprehension of mathematical relationships.

For students enrolled in College Algebra at one of the Philippine state universities, charting algebraic functions on conventional graphing paper presents several difficulties. The poor accuracy of the graphs is one of the main problems. The tiny grid squares could make it difficult to depict points precisely, resulting in an inaccurate representation of functions. Precise point alignment on the grid is a common source of difficulty for students, leading to deformed graphs that do not accurately depict the underlying mathematical connections. Coordinate determination mistakes can also arise from the manual paper graphing process. Tiny computation errors can potentially spread, impacting the entire graph and jeopardising the representation's correctness. This procedure takes time and requires great attention to detail, which can be daunting for students, especially those unfamiliar with algebraic principles.

Moreover, a significant drawback of graphing papers might be their limited space. The graph may be complicated for students to see and interpret if complex functions with several features do not fit on the paper. This constraint hinders their capacity to comprehend algebraic ideas fully and limits their ability to appreciate the subtleties of the functions they are learning. As an Algebra teacher for over thirty years, the researcher has observed that students enrolled in College Algebra struggle with graphing algebraic functions using papers, pencils, and rulers, which is tedious and time-consuming. The researcher would like to investigate whether the students' attitudes toward College Algebra will motivate them to learn more using the GeoGebra application. This would allow them to perform better in College Algebra, specifically in graphing algebraic functions.

Mathematics teachers and students alike are seeing the advantages of digital tools and graphing software such as GeoGebra using smartphones. These substitutes overcome the drawbacks of conventional graphing paper by providing more accuracy, user-friendliness, and a deeper exploration of complicated functions. They also improve the entire algebraic learning process. With this in mind, the researcher conducted the study to determine whether the GeoGebra software effectively teaches students to graph Algebraic functions using the software installed on their smartphones.

This study is anchored on the following theories: Davis's Technology Acceptance Model (1989), Deci and Ryan's self-determination theory (1980), Dweck's Mindset Theory (2000), and Kolb's Experiential Learning Theory (1984). It is also supported by the Philippines' CHED Memoranda Order No. 4, Series of 2020, on Guidelines for Implementing Flexible Learning. Davis's Technology Acceptance Theory (TAM) (1989) suggests that students' attitudes and performance are influenced by their perceived usefulness and ease of use of technology (Chahal & Rani, 2022). Students who find algebraic software helpful and user-friendly are likelier to have positive attitudes and perform better in graphing algebraic functions (Hidayat et al., 2023).

Deci and Ryan's self-determination theory (2013) emphasises the importance of intrinsic motivation. Students who feel autonomy, competence, and relatedness when using algebraic software are likelier to have positive attitudes and perform well (Radiamoda et al., 2024; Irvine, 2020). Providing opportunities for students to make choices and take ownership of their learning can positively impact their engagement

(Capuno et al., 2019). Dweck's (2000) mindset theory theorises that students' beliefs about their ability to learn and succeed in algebra can influence their attitudes and performance (Muenks et al., 2020). A growth mindset, where students believe they can improve with effort and perseverance, may lead to more positive attitudes and better performance when using algebraic software (Brezavšček et al., 2020).

Kolb's Experiential Learning Theory (1984) conceptualises that learning through direct experience, facilitated by algebraic software, can positively influence attitudes and performance (Cabuquin & Abocejo, 2023; Yimer & Feza, 2019). Students who actively graph algebraic functions using the software may develop a deeper understanding and appreciation for the subject (Birgin & Topuz, 2021).

CHED Memoranda Order No. 4, Series of 2020 on Guidelines on Implementing Flexible Learning. Programs, courses, and learning interventions are designed and delivered to meet the specific requirements of learners in terms of location, pace, procedure, and learning outcomes. It involves digital and non-digital technology and covers face-to-face or in-person learning, out-of-classroom learning modes, or a combination of delivery modes (Ichikawa, 2023). It ensures the continuity of inclusive and accessible education when traditional modes of teaching are not feasible, as in the occurrence of national emergencies.

Algebraic language encourages the observation and study of patterns, problem-solving, and analytical abilities (Barana, 2021). However, some students may find algebra challenging due to its high degree of abstraction. Algebra-challenged students typically have fewer positive sentiments regarding the subject. According to the findings, students who used software to study algebra had far higher mean scores in algebraic thinking and attitudes about the subject than in the control group (Feng, 2023; Başkahya, 2021; Etcuban & Pantinople, 2018).

Although most universities and teachers rely on implementing various technological tools in the curriculum, accepting such tools among students still needs improvement. The study of Zogheib et al. (2015) attempts to test the integration of TAM and user satisfaction in the educational field. It investigates students' acceptance of technological tools in university math classes. The results show that students' behavioural intentions to adopt and use technology tools in a mathematics classroom are favourably impacted by user satisfaction, self-efficacy, subjective norms, perceived utility, perceived ease of use, and students' attitude constructions.

Several studies (Wild & Neef, 2023; Li et al., 2021; Phoong, 2021) on mathematics education have analysed the connections between motivation and a range of student learning outcomes. Using the SDT lens, they discovered that encouraging autonomous motivation and meeting students' demands for competence is essential for assisting college students' academic achievement. According to their findings, teachers should include strategies that meet their students' fundamental psychological requirements and encourage self-motivation in mathematics. The theories, legal basis, literature, and studies mentioned are essential in studying students' attitudes, motivation, and performance in Algebra using GeoGebra software on smartphones.

This study examined the attitudes and motivations of education students regarding their use of GeoGebra in graphing algebraic functions within both the control and experimental groups. It also assessed the significance of the relationships between students' attitudes and motivations toward Algebra and their academic performance in graphing these functions. Additionally, it tested the significance of the differences in the mean scores of students' attitudes toward Algebra between both groups.

METHODS

The study employed the quasi-experimental design using the pretest-posttest method to gather data on the attitudes, motivation, and performances of Education first-year students enrolled in College Algebra. Furthermore, this study aims to establish the cause-and-effect relationships of variables (attitudes, motivation, and performance in graphing algebraic functions) using GeoGebra software in teaching college algebra, particularly graphing algebraic functions. This study was conducted in the College of Education of a technological state university in Cebu City, Philippines. The College offers undergraduate and graduate degree programs in mathematics, and its student population is 1,787. The Education first-year students comprise 343 students who have five College Algebra classes.

The researcher chose the study samples in a classroom where he is the mathematics teacher of the first-year students enrolled in College Algebra classes. In descending order, eighty first-year Education students majoring in Mathematics were chosen by arranging their Mathematics Final Grades in Grade 12 Mathematics. He renumbered the list based on their Final Grade in Grade 12 Mathematics to ensure the two groups were comparable. Then, they separated the list using even and odd numbers. Then, he tossed a coin to identify which groups were assigned to the control group and experimental group. The control group received the discussion of Graphing of Algebraic Functions using the traditional teaching method. In contrast, the experimental group received the discussion of graphing of algebraic functions with the aid of GeoGebra software and used the students' smartphones.

This study utilised three sets of questionnaires. The researcher used the Fennema-Sherman (1976) Mathematics Attitude Scales to assess the students' attitudes toward Algebra. The researcher utilised the Mathematics Motivation Questionnaire to gather the students' motivation towards Algebra. To determine the student's performance in Graphing Algebraic Functions, the researcher adopted an instrument from Cliff Notes.

The first questionnaire gathered the students' attitudes toward algebra, which was adopted from the Fennema-Sherman Mathematics Attitude Scales and consisted of 48 items. This part has four areas: a) Confidence in Learning [12 items], b) Attitudes Towards Success [12 items], c) Mathematics as a Male Domain [12 items], and d) Usefulness [12 items]. In this section, the respondents will answer using the 4-Likert scale: 4 points for Strongly Agree, 3 points for Agree, 2 points for Disagree, and 1 point for Strongly Disagree.

The second questionnaire gathers the motivation of students towards Algebra using a 15-item adapted Mathematics Motivation Questionnaire (MMQ) by Fiorella et al. (2021), consisting of four parts (Intrinsic value [3 items], Self-regulation [4 items], Self-efficacy [4 items], and Utility value [4 items]. The students are advised to rate the ítems using the 4-Likert scale: 4 points for Strongly Agree [Highly Motivated], 3 points for Agree [Moderately Motivated], 2 points for Disagree [Less Motivated], and 1 point for Strongly Disagree [Not Motivated].

The third questionnaire gathered students' algebra performance, particularly in graphing functions. It consists of a 35-item multiple choice test adopted from CliffNotes.com, grouped into seven categories, namely 1) Functions [5 items], 2) Conics [5 items], 3) Circles, 4) Parabola [5 items], 5) Ellipse [5 items], 6) Hyperbola [5 items], and 7) Systems of Equations [5 items]. In this questionnaire, the students were advised to encircle the correct answers [1 point for every correct answer]. The researcher instructed the students to answer the test within 1 hour.

The researcher wrote a transmittal letter to the College Dean asking for approval to conduct the study on the identified research subjects. After the authorisation to conduct the study, the researcher requested the Registrar of the University to provide the researcher with the student's final grades in Grade 12 mathematics during senior high. These grades determined whether the students belonged to the control group or the experimental group. On the other hand, he administered the students' attitudinal test in algebra and their motivation towards the subject to both control and experimental groups. He then gave the pretest on the student's performance in algebra, particularly graphing of algebraic functions.

For two months, the researcher discussed the lessons in Graphing Algebraic Functions with students in the control group using traditional teaching methods, such as chalk and green boards. In the experimental group, the students received the lessons in Graphing Algebraic Functions using GeoGebra software on their smartphones. After two months of discussion, the researcher administered the posttest on the performance of both groups.

After gathering data, the researcher conducted hygiene procedures, ensuring all fields had entries in the Data Matrix file. He then transferred these data to Minitab software to compute the frequency, simple percentage, mean, standard deviations, Pearson r, and t-test. Based on the results, the researcher analysed and interpreted these to draw findings, conclusions, and recommendations. Formal consent was obtained from the College Dean and the students enrolled in College Algebra to ensure the confidentiality of collected data from the research subjects. The students in both groups are guaranteed the confidentiality of the information gathered regarding their attitudes, motivation, and performances in Algebra, particularly Graphs of Algebraic Functions.

Also, the researcher ensured that the students' confidentiality was respected and maintained during the study. He advised these students to fill out the consent form before they began answering the tests. The consent form's concept is that the researcher provided the students with enough information regarding the study to inform them about the benefits of participating. Also, this assures them that only authorised personnel have access to all the information acquired and retrieved from them.

This research has ethical implications for addressing and promoting the search for knowledge and truth by preventing data fabrication or falsification. To avoid such hazards, the students are informed of everything they need to know about the purpose of the study, its duration, and its processes. It is entirely up to them whether or not they will choose to participate in the study. They are not forced to participate in the study if they do not want to. If, for any reason, the students may withdraw from the study, there will be no pressure on their part to continue. There are no negative consequences if they decline or withdraw from the study. The researcher complied with ethical research considerations throughout the gathering procedures by protecting all sensitive information and identities.

RESULTS & DISCUSSION

Results

This section presents the gathered data regarding the effects of the GeoGebra software on smartphones on the performance of graphing of algebraic functions of education for first-year students enrolled in College Algebra.

Attitudes of the Subjects Towards Algebra

The college students' attitudes towards College Algebra were broken down into four areas: self-confidence, value, enjoyment, and motivation in learning College Algebra, specifically Graphing of Algebraic Functions. Table 1 shows the results.

Table 1. Students' Attitudes Towards Algebra

Indicators	Control Group (n = 40)			Experimental Group (n = 40)		
	$\bar{x}$	σ	Int	$\bar{x}$	σ	Int
A. Confidence in learning	3.42	0.21	SA	3.37	0.22	SA
B. Attitude towards success	3.37	0.18	SA	3.44	0.30	SA
C. Mathematics as a male domain	3.38	0.18	SA	3.38	0.19	SA
D. Usefulness	3.45	0.21	SA	3.44	0.23	SA
Aggregate Mean :	3.41	0.11	SA	3.41	0.15	SA

Legend:
1.00-1.74 Strongly disagree [SD]; 1.75-2.49 Disagree [D];
2.50-3.24 Agree [A]; 3.25-4.00 Strongly agree [SA]

Level of Motivation of the Subjects Towards Learning Algebra

The motivation level of college students toward College Algebra is classified into four aspects: intrinsic value, Self-regulation, Self-efficacy, and Utility value. Table 2 shows the results.

Table 2. Students' Motivation Towards Algebra

Indicators	Control Group (n = 40)			Experimental Group (n = 40)		
	$\bar{x}$	σ	Int	$\bar{x}$	σ	Int
A. Intrinsic value	3.36	0.34	HM	3.32	0.46	HM
B. Self-regulation	2.84	0.27	MM	3.42	0.28	HM
C. Self-efficacy	3.46	0.22	HM	3.48	0.26	HM
D. Utility value	3.43	0.24	HM	3.31	0.27	HM
Aggregate Mean :	3.27	0.15	HM	3.38	0.17	HM

Legend:
1.00-1.74 Not motivated [NM]; 1.75-2.49 Less motivated [LM];
2.50-3.24 Moderately motivated [MM]; 3.25-4.00 Strongly motivated [HM]

Performance of Both Groups in Graphing of Algebraic Functions During Pretest and Posttest

Table 3 presents the results of both groups' pretest and posttest in graphing algebraic functions.

Table 3. Pretest and Posttest Performances of Both Groups in Graphing of Algebraic Functions

Raw Scores	Verbal Description	Control Group (n = 40)				Experimental Group (n = 40)			
		Pretest		Posttest		Pretest		Posttest	
		f	%	f	%	f	%	f	%
29 – 35	Excellent	10	40.00	8	32.00	6	24.00	11	44.00
22 – 28	Very Good	5	20.00	13	52.00	18	72.00	14	56.00
15 – 21	Good	10	40.00	4	16.00	1	4.00	0	0.00
8 – 14	Fair	0	0.00	0	0.00	0	0.00	0	0.00
0 – 7	Poor	0	0.00	0	0.00	0	0.00	0	0.00
	Mean :		25.52		26.16		25.40		28.04
	StDev :		4.67		3.83		2.89		2.32

Test of Significance of the Relationship

The study hypothesised that the students' attitudes towards Algebra significantly correlate with their performance in graphing algebraic functions during the pretest and posttest. Table 4 shows the results.

Table 4. Relationship Between Students' Attitudes Towards Algebra and its Academic Performance in Graphing of Algebraic Functions (alpha = 0.05; df = 78)

Variables	Pearson r	Strength	p-value	Significance	Result
Students' attitudes towards Algebra and					
Pretest performance in graphing of algebraic functions	0.103	Weak positive linear correlation	0.626	Not significant	Ho accepted
Posttest performance in graphing of algebraic functions	-0.001	Weak negative linear correlation	0.995	Not significant	Ho accepted

Also, it was hypothesised that the student's motivation towards Algebra had significant relationships with their performances in graphing algebraic functions during the pretest and posttest. Table 5 shows the results.

Table 5. Relationship Between Students' Motivation Towards Algebra and its Academic Performance in Graphing of Algebraic Functions (alpha = 0.05; df = 78)

Variables	Pearson r	Strength	p-value	Significance	Result
Students' motivation towards Algebra and					
Pretest performance in graphing of algebraic functions	-0.049	Weak negative linear correlation	0.817	Not significant	Ho accepted
Posttest performance in graphing of algebraic functions	-0.075	Weak negative linear correlation	0.720	Not significant	Ho accepted

Test of Significance of the Difference

The study hypothesised a significant difference in the mean scores of students' attitudes toward Algebra in the control and experimental groups. Table 6 shows the results.

Table 6. Difference of Mean Scores of Students' Attitudes Towards Algebra of Both Groups (alpha = 0.05)

Group	Mean	StDev	t-value	p-value	Significance	Result
Control	3.41	0.10	-0.02	0.982	Not significant	Ho accepted
Experimental	3.41	0.15				

Also, it was hypothesised that there is a significant difference in the post-test mean scores of the control and experimental groups. Table 7 shows the results.

Table 7. Difference of the Posttest Mean Scores of Both Groups (alpha = 0.05)

Group	Mean	StDev	t-value	p-value	Significance	Result
Control	26.16	3.83	-2.25	0.034	Significant	Ho rejected
Experimental	28.04	2.32				

Discussions

Attitudes of the Subjects Towards Algebra

Table 1 shows that in the control group, the indicator of usefulness got the highest mean of 3.45 (Strongly agree) with a standard deviation of 0.21. Meanwhile, the indicator of attitude toward success got the lowest mean of 3.37 (Strongly agree) and a standard deviation of 0.18. The data imply that as technology advances, the data provide valuable insights into students' learning patterns and outcomes. These allow teachers to tailor algebraic instruction to individual needs, enhancing comprehension and engagement. As students witness the tangible benefits of algebra, their perception of its relevance and utility is likely to improve. Thus, these data are crucial in learning algebra that positively influences how college students perceive the practical value of algebra in their academic and future endeavours.

Also, Table 1 shows that the indicators of Usefulness and Attitude toward success in the experimental group got the highest mean of 3.44 (Strongly agree) with standard deviations of 0.23 and 0.30, respectively. The indicator of confidence in learning got the lowest mean of 3.37 (Strongly agree) with a standard deviation of 0.22. The data imply that the usefulness of algebra for college students must be balanced. Teachers can identify students' challenges in mastering algebraic concepts, allowing for targeted interventions. Tailored learning experiences ensure that students receive the support they need, promoting better understanding and application of algebra in real-world scenarios. Also, these enable continuous feedback, aiding both students and teachers in monitoring progress and adapting instructional approaches to foster a more effective and relevant learning experience.

Level of Motivation of the Subjects Towards Learning Algebra

Table 2 shows that in the control group, the indicator of Self-efficacy got the highest mean of 3.46 (Highly motivated) with a standard deviation of 0.22. In contrast, the indicator of Self-regulation towards success got the lowest mean of 2.84 (Moderately motivated) with a standard deviation of 0.27. The data imply that through continuous assessment and feedback, students enrolled in algebra will gain insights into their progress and areas needed for improvement. Personalised interventions will address specific challenges, empowering students to overcome hurdles and build confidence in their algebraic abilities.

Also, Table 2 shows that in the experimental group, the indicator of Self-efficacy got the highest mean of 3.48 (Highly motivated) with a standard deviation of 0.26. Meanwhile, the indicator on utility value got the lowest mean of 3.31 (Highly motivated) with a standard deviation of 0.27. The data holds immense implications for motivating college students toward algebra by enhancing self-efficacy. With these, students enrolled in algebra receive personalised feedback, pinpointing strengths and weaknesses in their algebraic skills. As students witness their progress, confidence grows, fostering a positive self-efficacy mindset towards the lessons in algebra.

Performance of Both Groups in Graphing of Algebraic Functions During Pretest and Posttest

Table 3 shows that in the control group, the students scored higher in the performance examination involving graphing of algebraic functions, with raw scores between 22 and 28 (Very Good) in their posttest examination. The students in the control group got a mean score during the pretest of 25.52 with a standard deviation of 4.67 and a mean score during the posttest of 26.16 with a standard deviation of 3.83.

Also, Table 3 reveals that in the experimental group, the students scored higher, with raw scores of 22 to 28 (Very Good) during the pretest examination. The students in the experimental group had a mean score during the pretest of 25.40 with a standard deviation of 2.89 and a mean score during the posttest of 28.04 with a standard deviation of 2.32.

These data imply that students' high results on the Graphing of Algebraic Functions pretest and posttest have numerous significant consequences. A solid fundamental grasp of the topic among students may be shown by their consistently good performance, which might result from either their innate skill in this area or their earlier training being beneficial. Also, this result could imply that the teaching strategies employed between assessments were sufficient to keep students' proficiency levels high but may need to be more demanding to improve their abilities. Teachers should consider using more complex or varied teaching tactics beyond students' capabilities to maximise learning. This method might aid in locating underlying flaws and fostering a greater comprehension of mathematical ideas.

Test of Significance of the Relationship

Table 4 reveals the students' attitudes toward Algebra in their pretest and posttest performances in graphing algebraic functions. The computed p-values are significantly higher than their critical values of 0.05; thus, the null hypotheses were accepted that the students' attitudes toward Algebra have no significant relationships with their pretest and posttest performances in graphing algebraic functions.

The research has fascinating pedagogical implications demonstrating no significant association between students' attitudes toward mathematics and their performance on pretest and posttest exams involving graphing algebraic functions. This discrepancy suggests that students' general attitudes about mathematics may not directly correlate with their proficiency in particular mathematical abilities. This might imply that cognitive knowledge or instructional strategies more significantly impact some fundamental skills, like graphing, than attitudes do. As a result, teachers should think about emphasising direct skill development rather than just trying to change students' attitudes, realising that favourable attitudes do not always equate to improved performance in specific domains.

Also, Table 5 reveals the students' motivation towards Algebra in their pretest and posttest performances in graphing algebraic functions. The computed p-values are significantly higher than their critical values of 0.05; thus, the null hypotheses were accepted that the student's motivation towards Algebra has no significant relationship with their pretest and posttest performances in graphing algebraic functions.

There are essential pedagogical ramifications to the research showing no correlation between students' desire for mathematics and how well they graph algebraic functions on pretest and posttest evaluations. This lack of link shows that mastery of particular mathematical abilities, like graphing, may be primarily driven by something other than an intrinsic passion for the topic. It suggests that other elements like cognitive capacities, teaching strategies, or even the physical classroom setting—might be more critical in determining how well students succeed on technical tasks. Therefore, to successfully increase and assist students' learning in algebra, teachers need to look at a wider variety of effects than only motivation.

Test of Significance of the Difference

Table 6 shows no significant difference between the students' attitudes towards Algebra of the control and experimental groups. The study got a t-value of -0.02 with a p-value of 0.982, significantly higher than its critical value of 0.05. This leads to the acceptance of the null hypothesis.

The lack of statistically significant variations in the views of the control and experimental groups regarding algebra indicates that the intervention under investigation did not affect students' opinions of the subject. This result points to a possible area for redesign by suggesting that the intervention, whether pedagogical or resource-based, might need to be more successful in changing attitudes. Moreover, it emphasises how strong pre-existing views are, implying that they could be firmly rooted in variables outside the purview of the intervention. Teachers have to think about investigating different approaches or extra factors that can better affect and enhance students' attitudes about algebra.

Also, it was hypothesised that there is a significant difference in the post-test mean scores of the control and experimental groups. Table 7 shows a significant difference between the students' posttest means scores in Algebra of the control and experimental groups. The study got a t-value of -2.25 with a p-value of 0.034, significantly less than its critical value of 0.05. This leads to the rejection of the null hypothesis.

The experimental group's intervention was successful based on the substantial change in posttest mean scores between the control and experimental groups. The improvement in scores shows the potential advantages of the new teaching strategies, materials, or curriculum given to the experimental group. It emphasises how crucial cutting-edge teaching techniques are to raising student learning results. School administrators and teachers must consider implementing comparable initiatives on a larger scale. Further examination can also assist in pinpointing the precise components of the intervention that had the most influence, guiding the creation of curricula and future teaching methods in College Algebra.

CONCLUSION

This study examined the influence of GeoGebra software on education students' attitudes and the program's impacts on smartphones. It concludes that students' attitudes toward algebra improved using GeoGebra, indicating that the software's interactive and user-friendly features made algebra more approachable and exciting. This shift in perspective is essential since a positive attitude toward a subject frequently boosts classroom participation and overall learning experiences. Also, the study concludes that students who used the GeoGebra software had a noticeable boost in motivation. This increase is likely linked to the app's instant feedback and visual learning tools, which help make challenging algebraic ideas easier to understand. This decreases frustration and increases effort and perseverance in learning. Regarding performance, the results showed that students who used the program significantly outperformed those in the control group on the post-test. This enhancement demonstrates how successful GeoGebra is in increasing the efficacy and enjoyment of learning, reiterating the link between the use of technologically advanced learning resources and algebraic academic success.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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