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ORIGINAL PAPER

Using the Desmos Graphing Calculator to Enhance Learning in Algebraic Fractions in Junior High Schools

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Abstract
Technology integration in mathematics instruction redefined the way we teach mathematical concepts, and the Desmos graphing calculator is a powerful ally in that evolution. It focused on the implications of using the Desmos graphing calculator in teaching Algebraic Functions to Grade 9 students in a public national high school. The subjects included 50 students using a quasi-experimental pretest-posttest design. Standardized questionnaires were used to obtain data on study habits and Algebra performance. Statistical methods used were frequencies, percentages, mean, standard deviation, and a paired t-test. The two groups were made up of students aged 14–15, with similar academic achievement levels and study practices. Results indicated a slight increase in Algebra posttest scores for the Control Group, but the Experimental Group was able to see a statistically significant improvement using the Desmos graphing calculator; even more so for those who reported using any other graphing calculators alone. The results indicate a meaningful difference between the groups' performance before and after the intervention. The study concludes that the Desmos graphing calculator has a positive impact on the Algebra achievement of Grade 9 students. Based on these findings, it is recommended that teachers receive training on integrating the Desmos graphing calculator to enhance the teaching and learning of Algebra.

Keywords:
Algebra
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Algebraic Fractions

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INTRODUCTION

Educational technology for teaching mathematics has evolved and become dynamic. The technology available to math teachers and students has steadily improved. Changes happen as graphing calculators become more common in math classes. The increase in technology literacy skills for teaching and learning has reduced boredom for teachers and students. This is because students may feel tired. Furthermore, instructional tools like a graphing calculator help students graph Algebraic Functions easily, making it more fun and enjoyable while learning Algebra.

In the Philippines, the Department of Education (DepEd) has mandated that public national high schools utilize instructional tools to help teachers and students learn the lessons with ease and enjoyment. Instructional tools are essential because they help teachers and students avoid overemphasizing recitation and rote learning, which can easily dominate a lesson. They enable students to have practical experiences, allowing them to develop skills and concepts and work in various ways. As observed by the researchers and, at the same time, a math teacher, many high school students make errors in graphing higher polynomial functions in the same way as graphing linear and

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quadratic ones. Students' prior knowledge of linear and quadratic functions influences graphing skills in polynomial functions of higher degrees.

The focus of this study is to examine the effects of the Desmos graphing calculator on students' problem-solving confidence in Algebra, since the use of graphing calculators plays a role in students' performance in mathematics, particularly Algebra. Students' performance in Algebra may be increased with the implementation of graphing calculators by able mathematics teachers. As students may use graphing calculators, the researchers should investigate them further, as they may alter students' problem-solving confidence in Algebra.

The Desmos calculator is one type of online graphing calculator. It is available for free download to mobile devices and can also be used in its online application. Students can access the graph, table, and critical information about the function of Desmos on a single screen. Desmos eliminates steps that obstruct the deep thinking needed to solve math problems by being more straightforward and intuitive in its approach to math. However, while online graphing calculators are increasingly omnipresent as technology progresses, it may still not be practical for schools to provide a mobile device for each student. But this creates a sense of isolation since not all students nationwide are exposed to the Desmos graphing calculator.

The Desmos Graphing Calculator is already a must-have app for mathematics teachers in DepEd as it helps them teach Algebra with interactivity, visualization, and access. This digital platform offers support areas for algebra, such as functions, transformations, and systems of equations, making it easier for students to comprehend the complex subject. Similarly, for teachers who need to deal with several students having zero baseline knowledge, Desmos offers an easy-to-use interface, which again saves time in making plots and explaining the most abstract concepts. Being a dynamic resource, it supports differentiated instruction for various types of students and promotes visual learning aligned with the K-to-12 curriculum. What makes Desmos an excellent tool for Algebra is its ability to have students see the equations and how changes in variables affect the graph. With instant feedback, this drives greater conceptual understanding and leads to inquiry into the world at large, critical thinking, and self-paced learning. Students learn through active discovery rather than rote memorization, increasing retention and problem-solving. The Desmos platform also works for remote or blended learning, making it perfect for education that sparks creativity and fights with an equity axe to close gaps. It empowers both teachers and students by transforming traditional approaches to teaching Algebra into engaging, technology-enhanced experiences that develop 21st-century mathematical competencies.

METHODOLOGY

This study employed the quasi-experimental method using a pretest/posttest design to gather data on the study habits and performance of the Grade 9 students in Algebra using the Desmos graphing calculator. Also, this study established the cause-and-effect relationships among the variables, such as study habits and Algebra performance in using the Desmos graphing calculator, particularly Algebraic Functions, using the Control-Experimental Group method. The researchers selected the research subjects in a classroom setting where they are also the mathematics teacher, teaching Algebra to Grade 9 students in a Philippine national high school. There were 50 Grade 9 students in the research locale who were chosen by arranging their final grade in Grade 8 mathematics last school year in descending order. Then, the researchers renumbered the list based on the ranked final grade in Grade 8 mathematics. Then, they separated the list using even and odd numbers. The researchers then tossed a coin to identify which two groups would be the Control Group and the Experimental Group. This study utilized two sets of questionnaires. The first set of questionnaires is a standardized study habit questionnaire for high school students by the National Institution for Youth

Education (https://bit.ly/3DpkiMR). The second set of questionnaires is the Algebra performance of students using the California Standardized Test in Algebra (https://bit.ly/3JkydHZ).

The standardized test for students' study habits has two parts. Part 1 gathers the respondents' profiles, including their age, gender, type of elementary school they graduated from, and their final math grade in Grade 8. Part 2 gathers the respondents' study habits toward mathematics. The section is categorized into three parts: a) Learning Skills, b) Learning Habits, and c) Importance of Learning. The first category has five items wherein the respondents will answer these items using the 4-point Likert scale: 4 points for Good at it [Strongly agree], 3 points for Somewhat good at it [Agree], 2 points for Not so good at it [Disagree], and 1 point for Not so good at it at all [Strongly Disagree]. The second category has ten items wherein the respondents will answer these items using the 4-point Likert scale: 4 points for Often [Strongly agree], 3 points for Sometimes [Agree], 2 points for Seldom [Disagree], and 1 point for Never [Strongly Disagree]. The third category has ten items wherein the respondents will answer these items using the 4-point Likert scale: 4 points for Very important [Strongly agree], 3 points for Somewhat important [Agree], 2 points for Less important [Disagree], and 1 point for Not important [Strongly Disagree].

The second instrument is a standardized test for Algebra Performance using the California Standards Test as part of the Standardized Testing and Reporting (STAR) Program under policies set by the State Board of Education. All questions in the said test are evaluated by committees of content experts that include teachers and administrators to ensure their appropriateness for measuring the academic content standards in Algebra. The test has four categories, namely: a) Number Properties, Operations, and Linear Equations [17 test questions], b) Graphing and Systems of Linear Equations [14 test questions], c) Quadratic and Polynomials [21 test questions], and d) Functions and Rational Expressions [13 test questions]. All in all, it has 65 test questions, each worth 1 point for a correct answer.

The following statistical tools were used in the study: To treat the gathered data from the profile of the subjects, frequency, simple percentage, mean, and standard deviation were used. To treat the students' study habits toward mathematics in terms of Learning Skills, Learning Habits, and Importance of Learning, weighted mean and standard deviation were used. To treat the students' performance in Algebra during the pretest and posttest administration, frequency, simple percentage, mean, and standard deviation were used. To test if there is a significant difference between the mean gain of the pretest and posttest scores of both groups, a paired t-test was used.

The researchers presented the procedures for exploring the study habits of Grade 9 students toward Algebra and evaluating the effectiveness of the Desmos graphing calculator in enhancing their performance. The study habits of the students will be assessed using a validated questionnaire, and their academic performance in Desmos integration was measured through a pre-test and a post-test.

The researchers wrote a transmittal letter to the school principal asking for approval to conduct the study on the identified research subjects. Once approved, the researchers asked the School's Record Section to provide the researchers with the students' final grades in Grade 8 mathematics for the 2021-2022 school year. These grades were used to classify the students as belonging to the Control Group or the Experimental Group. The researchers administered the students' study habits in mathematics and the pretest in Algebra to both the Control and Experimental Groups. Then, the researchers discussed the lessons of Algebraic Functions for a month. The Control Group only received the lessons in Algebraic Functions using traditional teaching methods, that is, with the use of chalk and green boards. In the Experimental Group, the subjects received lessons in Algebraic Functions using the Desmos graphing calculator. After a month of discussing algebraic functions, the researchers then readministered the posttest in Algebra.

Once the data were collected, the researchers reviewed and checked the individual questionnaires for completeness of data entries. With the help of a Data Matrix file, she encoded each piece of data using the file. Afterward, data hygiene was conducted to ensure all entries were consistent, valid, and reliable. Statistical software was then used to tabulate and analyze the data.

Based on the results, data interpretation must be done with the support of related studies to strengthen the discussion. The researchers then drafted an intervention plan based on their findings. To ensure the confidentiality of collected data from the subjects, formal consent will be obtained from the school principal and the Grade 9 student subjects. These subjects will be guaranteed the confidentiality of the information gathered regarding their study habits towards mathematics and performance in Algebra. In this manner, the student's responses will be used only for research purposes.

The researchers ensure that the subjects' confidentiality is respected and maintained in the conduct of the study. The researchers advised the student subjects to fill out the consent form before they began answering the questionnaires. The concept of the consent form is that the researchers provided them with enough information regarding the study, which allows the subjects to be informed about the benefits of participating in the study. Also, this assures the subjects that only authorized personnel have access to all the information acquired and retrieved from them.

This research has ethical implications for advancing knowledge and truth by preventing data fabrication or falsification. To avoid such hazards, the subjects in this study are informed of all relevant details about the study's purpose, duration, and process. It is entirely up to you whether or not you choose to participate in this study. They will not be forced to participate in the study if they do not want to. If, for any reason, they wish, they may withdraw from the investigation. There will be no pressure on their part to continue with the study. There will be no negative consequences if they decline or withdraw from the study. Throughout the research procedures, the researchers complied with the ethical research considerations, and all responses were kept confidential, and identities were protected.

RESULTS & DISCUSSION

This section presents the gathered data regarding the effects of the Desmos graphing calculator software on smartphones on the performance of graphing algebraic functions among junior high school students.

Results

Level of Study Habits of the Subjects of Both Groups

Algebra is one of the most challenging lessons for Grade 9 students, as it affects their learning habits in high school. Algebra equations require not just a conceptual understanding but also regular practice and preparation. Watching how students study can give us valuable insights into what this means: problem-solving, focus management, and effective use of resources for classes. Students learn critical foundational elements at this stage that they will need for academic success in the future. Their learning habits—note-taking, homework completion, class participation, and self-study tell a tale of strengths and areas for improvement. Understanding the learning style of Grade 9 students will serve as an avenue to develop better approaches in teaching and in promoting efficient study habits for better academic performance in Algebra. The Grade 9 students' study habits were assessed based on their Learning Skills, Learning Habits, and Importance of Learning.

Learning Skills. Table 1 presents the results of the level of study habits of the Grade 9 students in terms of their learning skills. The Control Group of 25 Grade 9 students demonstrated generally positive study habits in terms of learning skills, with an aggregate mean of 2.92 ($\sigma = 0.68$), interpreted as "Agree." Among the indicators, the highest mean was in reading comprehension ($\overline{x} = 3.28$, $\sigma = 0.68$), interpreted as "Strongly Agree," showing that students recognize the importance of understanding texts in their studies. Memorizing followed closely ($\overline{x} = 3.00$), indicating that rote learning remains a common strategy. Skills such as understanding graphs and tables ($\overline{x} = 2.72$) and solving computational math problems ($\bar{x}$ = 2.64) scored slightly lower but still within the "Agree" range, suggesting room for improvement in analytical and problem-solving abilities. Making or experimenting with something ($\bar{x}$ = 2.96) also indicated a favorable but moderate engagement in hands-on activities.

Table 1. Level of study habits of the subjects as to learning skills

Indicators	Control Group (n = 25)			Experimental Group (n = 25)		
	$\bar{x}$	σ	Int	$\bar{x}$	σ	Int
1. Memorizing	3.00	0.58	A	3.20	0.65	A
2. Solving computational math problems	2.64	0.70	A	2.72	0.74	A
3. Reading comprehension	3.28	0.68	SA	3.20	0.76	A
4. Understanding what graphs and tables indicate	2.72	0.61	A	2.80	0.82	A
5. Making or experimenting with something	2.96	0.84	A	2.88	0.78	A
Aggregate :	**2.92**	**0.68**	**A**	**2.96**	**0.75**	**A**

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

The Experimental Group of 25 Grade 9 students at Don Andres Soriano National High School, who were taught Algebra using the traditional method with the aid of the Desmos graphing calculator, showed generally favorable study habits in learning skills. The aggregate mean was 2.96 (σ = 0.75), interpreted as "Agree," indicating a consistent but not exceptional level of skill engagement. Memorizing ($\bar{x}$ = 3.20, σ = 0.65) ranked highest, suggesting students relied significantly on recall in their learning process. Reading comprehension ($\bar{x}$ = 3.20, σ = 0.76) was equally high, highlighting strong abilities in understanding written information, although slightly lower than the Control Group. Understanding graphs and tables ($\bar{x}$ = 2.80, σ = 0.82) reflected a moderate but promising analytical skill, likely influenced by exposure to Desmos visualizations. Making or experimenting with something ($\bar{x}$ = 2.88) and solving computational math problems ($\bar{x}$ = 2.72) showed balanced yet improvable performance.

Learning Habits. Table 2 presents the results of the level of study habits of the Grade 9 students in terms of their learning habits. The data on the study habits of the Grade 9 students in the Control Group reveal an overall aggregate mean of 2.78 (σ = 0.70), interpreted as *Agree*, indicating generally positive learning habits. Students showed strong engagement in active participation in group work ($\bar{x}$ = 3.48, *Strongly Agree*), reflecting their focus and collaborative skills. However, certain distracting behaviors, such as taking naps ($\bar{x}$ = 1.88, *Disagree*), using cellphones during class ($\bar{x}$ = 1.80, *Disagree*), and spacing out ($\bar{x}$ = 1.84, *Disagree*), indicate occasional lapses in attention.

Moreover, the information on Grade 9 from the Experimental Group is characterized by a generally favorable behavior of learning, with an average value of 2.77 (Agree). This suggests that, on the whole, students do have productive study behaviours, with some variations in specific indicators. Students scored highest in focusing on what the teacher is saying ($\bar{x}$ = 3.52, Strongly Agree) and proactive participation in group work ($\bar{x}$ = 3.40, Strongly Agree).

These results suggest strong engagement during class discussions and collaborative activities, which are critical for effective learning. Preparation and review habits also scored relatively high, with students agreeing that they prepare for classes beforehand and review their lessons ($\bar{x}$ = 3.12, Agree), and that they study proactively at home without being prompted ($\bar{x}$ = 3.00, Agree). Homework completion ($\bar{x}$ = 3.20) is also positive but only rated as "Agree," indicating some room for improvement. On the less favorable side, indicators reflecting inattentive or disruptive behaviors, such as taking naps during class ($\bar{x}$ = 1.92, Disagree) and looking at cellphones ($\bar{x}$ = 1.72, Strongly Disagree), show that these negative habits are generally uncommon but still present in some students.

Table 2. Level of study habits of the subjects as to learning habits

Indicators	Control Group (n = 25)			Experimental Group (n = 25)		
	$\bar{x}$	**σ**	**Int**	**$\bar{x}$**	**σ**	**Int**
1. I take notes properly during class	3.40	0.50	A	3.24	0.78	A
2. I take naps during class	1.88	0.97	D	1.92	1.04	D
3. I look at my cellphone or send text messages during class	1.80	1.00	D	1.72	0.89	SD
4. I read books other than the textbook	2.80	0.58	A	2.72	0.98	A
5. I space out during class	1.84	0.90	D	1.84	1.11	D
6. I focus well on what the teacher is saying	3.28	0.46	SA	3.52	0.77	SA
7. I proactively participate in group work	3.48	0.59	SA	3.40	0.58	SA
8. I finish homework on time	3.28	0.61	SA	3.20	0.76	A
9. I prepare for classes beforehand and review what I learned	2.92	0.57	A	3.12	0.73	A
10. I proactively study without being told at home	3.08	0.86	A	3.00	0.87	A
Aggregate :	**2.78**	**0.70**	**A**	**2.77**	**0.85**	**A**

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

Importance of Learning. Table 3 presents the results of the level of study habits of the Grade 9 students in terms of the importance of learning.

Table 3. Level of study habits of the subjects as to the importance of learning

Indicators	Control Group (n = 25)			Experimental Group (n = 25)		
	$\bar{x}$	**σ**	**Int**	**$\bar{x}$**	**σ**	**Int**
1. To follow the teachers' instructions and study hard	3.80	0..41	SA	3.68	0.56	SA
2. To find what you are good at and develop the skill	3.60	0.71	SA	3.28	0.84	SA
3. To focus on extracurricular activities	3.48	0.77	SA	3.32	0.75	SA
4. To respect teachers	3.68	0.75	SA	3.84	0.55	SA
5. To be a class leader	2.71	0.91	A	2.72	0.89	A
6. To have critical thinking and good judgment	3.36	0.81	SA	3.04	1.02	A
7. To keep acquiring new knowledge	3.56	0.77	SA	3.28	0.84	SA
8. To study hard now for my future	3.60	0.71	SA	3.68	0.69	SA
9. To apply what I learned to the real world	3.56	0.71	SA	3.72	0.46	SA
10. To study proactively	3.36	0.86	SA	3.64	0.49	SA
Aggregate Mean :	**3.47**	**0.78**	**SA**	**3.42**	**0.71**	**SA**

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

Results from Grade 9 students who were responding to the Control Group reflected an appreciation of the importance of learning, indicated by an aggregate mean score of 3.47 (SD = 0.78), in the Strongly Agree range. The strongest indicator was "to follow the teachers' instructions and study hard" ($\bar{x}$ = 3.80, SD = 0.41). These were followed by "to respect teachers" ($\bar{x}$ = 3.68) and "to study hard now for my future" ($\bar{x}$ = 3.60), hence a great sense of both discipline and motivation towards the future. The administrator-created indicator "to be a class leader" ($\bar{x}$ = 2.71, SD = 0.91) was the lowest rated, indicating aspiring leaders are less competitive than personal growers.

The Experimental Group of Grade 9 students showed a strong recognition of the importance of learning, as indicated by an aggregate mean of 3.42 (SD = 0.71), interpreted as Strongly Agree. The highest-rated indicator was "to respect teachers" ($\bar{x}$ = 3.84, SD = 0.55), reflecting a high regard for authority and discipline in the learning environment. This was followed by "to apply what I had learned to the real world" ($\bar{x}$ = 3.72), and then "to follow the teachers' instructions, and study hard" ($\bar{x}$ = 3.68), which identified their appreciation for practical application of learning processes as well as adherence to teacher-oriented guidance. Additionally, both "be a class leader" ($\bar{x}$ = 2.72, SD = 0.89) and "critical thinking and good judgment" ($\bar{x}$ = 3.04, SD = 1.02) were rated lower, suggesting that, bizarrely enough, leadership roles as well as higher-order thinking skills may not be a top priority in some scenarios.

Summary Table. Table 4 presents a summary of the study habits of the Grade 9 students.

Table 4. Summary table on the level of study habits of the subjects

Indicators	Control Group (n = 25)			Experimental Group (n = 25)		
	$\bar{x}$	σ	Int	$\bar{x}$	σ	Int
A. Learning Skills	2.92	0.68	A	2.96	0.75	A
B. Learning Habits	2.78	0.70	A	2.77	0.85	A
C. Importance in Learning	3.47	0.78	SA	3.42	0.71	SA
Aggregate Mean :	**3.06**	**0.72**	**A**	**3.05**	**0.77**	**A**

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

Among Grade 9, the Control Group showed a general overall Agree interpretation of study habits ($\bar{x}$ = 3.06, SD = 0.72). "Importance in Learning" was ranked the highest in all three categories ($\bar{x}$ = 3.47, SD = 0.78, Strongly Agree), which indicated that students understood well the value of being educated. The lowest scores were in "Learning Skills" ($\bar{x}$ = 2.92) and "Learning Habits" ($\bar{x}$ = 2.78), revealing a lack of knowledge of how to learn new material best and through repetition, respectively.

Finally, the Grade 9 Experimental Group indicated an Agree rating for their study habits, with a total mean score of 3.05 (SD = 0.77) "Importance in Learning" had the highest mean (($\bar{x}$ = 3.42, SD = 0.71, Strongly Agree) indicating that respondents recognize the benefit of education However, the ratings for "Learning Skills" ($\bar{x}$ = 2.96) and "Learning Habits" ($\bar{x}$ = 2.77) were lower indicating a basic level of high utility skills but a moderate proficiency in effectively learning and partaking in existing habits respectively.

Performance of Both Groups in Algebra During Pretest and Posttest

Table 5 presents the results of the pretest and posttest performances of the Control Group in Algebra.

Table 5. Pretest and posttest performances of the control group in Algebra

Raw Scores	Verbal Description	Pretest Frequency	Pretest Percentage	Posttest Frequency	Posttest Percentage
52 - 65	Excellent	0	0.00	0	0.00
39 - 51	Very Good	0	0.00	0	0.00
26 - 38	Good	1	4.00	17	68.00
13 - 25	Fair	20	80.00	7	28.00
0 - 12	Poor	4	16.00	1	4.00
	Mean :	**15.76**		**28.24**	
	StDev :	**4.21**		**8.75**	

Table 5 shows that the Control Group's performance in Algebra showed notable improvement after undergoing traditional teaching methods. In the pretest, the majority of students (80%) were in the "Fair" category (13–25), while 16% were in the "Poor" category (0–12). Only one student (4%) achieved a "Good" rating (26–38), and no students reached the "Very Good" or "Excellent" levels. The first question answer is given on a scale of 1 to 20; therefore, the mean score of 15.76 (SD = 4.21) indicates limited primary knowledge on this issue. There was a significant improvement in performance after posttest measures. Sixty-eight percent (n = 27) rated "Good"; for only 4% (n = 1), the rating was poor. While no students in this study achieved the Very Good or Excellent categories, there was an average gain in knowledge of 28.24 (SD = 8.75).

Table 6. Pretest and posttest performances of the experimental group in Algebra

Raw Scores	Verbal Description	Pretest Frequency	Pretest Percentage	Posttest Frequency	Posttest Percentage
52 - 65	Excellent	0	0.00	20	80.00
39 - 51	Very Good	0	0.00	5	20.00
26 - 38	Good	0	0.00	0	0.00
13 - 25	Fair	18	72.00	0	0.00
0 - 12	Poor	7	28.00	0	0.00
	Mean :	**14.56**		**54,36**	
	StDev :	**3.61**		**3.23**	

In Table 6, pre- and posttest scores for Algebra data within this study support a marked change in proficiency with traditional classroom methods. In the pretest, 72% of students were considered "Fair" and 28% "Poor" in the lower performance categories. There were no students in the upper score ranges (Good, Very Good, Excellent), which indicated some early difficulty with Algebra concepts. But the posttest results are striking. Top results included an "Excellent" rating between scores 52-65 for 80% of students, while the other 20% scored "Very Good" from scores 39-51. In total, students in the three levels scored below the "Very Good" percent, so it shows a distinct improvement across the board. We also observed that the mean score increased significantly from 14.56 in the pretest to 54.36 in the posttest, combined with a decrease in standard deviation from 3.61 to 3.23, revealing more accurate responses among students.

Test of Significance of the Difference

Also, the study hypothesized that there is a significant difference between the mean gains of the pretest and posttest scores of both groups. Results from the pretest and posttest scores yielded a statistically significant difference in the Algebra performance of Grade 9 students under the Control Group. The data, with $t = -7.16$, $p=0.000$, indicate that the pretest and posttest (the "dependent measures") are statistically different. The p-value is less than the conventional significance level of 0.05. Hence, reject the null hypothesis, i.e., that there is no difference between Algebra scores before and after the intervention.

Furthermore, the results indicate a very significant difference in the Algebra performance of Grade 9 students in the Experimental Group when pretest and posttest scores were analyzed. Given that the calculated t-value is -42.43 with $p = 0.0000$, there is a statistically significant difference between pretest and posttest scores at an alpha level of.05. This means that the null hypothesis (H0) of no significant difference in Algebra performance before and after the intervention is rejected. This high value of t indicates a significant improvement in students' algebraic skills after the treatment, which employed innovative methods and instruments.

Discussion

Level of Study Habits of the Subjects of Both Groups

Learning Skills. The results in **Table 1** reflect a solid foundation in study habits, with strengths in comprehension and memorization, yet requiring further enhancement in higher-order thinking skills. A recent study has shown that junior high school students might have more effective third-order cognitive and metacognitive skills in comparison to higher-order cognition skills. Abid et al. (2023) found that deeper strategies tend to be less apparent; however, good reading and study routines were characteristic of achievement by secondary students. Olop et al. (2024) described how students are predisposed to surface-level strategies, neglecting analytical or evaluative forms. Similarly, Ewell et al. (2023) found that relying on passive study behaviors inhibits the transfer of problem-solving skills.

The results suggest that Desmos integration may have enhanced visualization and comprehension, but further strategies are needed to strengthen problem-solving and experimental learning skills. Dani and Ashok (2025) explored how secondary students' learning of geometrical transformations benefited from Desmos integrated within the 5E instructional model. Results showed enhanced ability to analyze transformations and validate solutions via visualization, with clear gains in conceptual understanding. Still, the study noted that proper pedagogy beyond the tool itself is necessary to cultivate students' experimental and problem-solving abilities. The study concluded that when paired with structured, inquiry-based teaching, Desmos can significantly elevate comprehension, but teachers must scaffold thinking beyond visual aids.

Learning Habits. Results in **Table 2** imply that the Control Group has strong habits from refresher courses, but may be able to increase academic achievement by reducing distractions and increasing self-directed study. They have learning patterns that indicate they can be depended upon but lack concentration for long periods, which is due to targeted support and independent study skills.

Cheng et al. (2025) found that much self-regulated learning (SRL) takes place. Students of higher functioning read more and re-read, and the lower-performing students devoted significantly more time to mental mapping. This study highlights the need for both scaffolding tools and teacher professional development programs that promote SRL in secondary education.

The study of Wu and Zhong (2022) examines the Relationship Between Intrinsic motivation, grit, need for cognition, growth mindset, and academic achievement. It identifies four unobserved characteristics among students that significantly predict academic attainment in different subjects. The findings suggested the importance of non-cognitive factors that affect academic success.

The Experimental Group demonstrates sound study habits with strong classroom engagement and proactive learning behaviors, though maintaining focus and minimizing distractions remains an area to monitor. Bulado et al. (2025) found that a positive classroom environment and strong study habits significantly enhance junior high school students' academic engagement, leading to higher grades, better retention, and increased graduation rates. Shi and Yang (2025) reported that cognitive ability and self-control, moderated by structured learning plans, improve focus and reduce distractions. Similarly, Zhao et al. (2024) observed that self-management positively relates to achievement, with self-efficacy mediating this effect. Their findings suggest that fostering study habits, self-control, and self-efficacy, alongside supportive environments, can strengthen students' academic performance, sustain engagement, and minimize distractions both in and out of the classroom.

Importance of Learning. The findings in **Table 3** imply that the Control Group values study habits centered on discipline, knowledge acquisition, and application, with slightly less emphasis on leadership and critical thinking skills. This indicates a positive but improvement-oriented academic mindset. Mutya et al. (2023) found that Filipino junior-high students using self-learning modules scored higher in effortful study habits and the application of concepts. This research suggests that junior-high students come to school with a constrained yet strong academic mindset that emphasizes discipline and application, while also indicating some need for growth-oriented development in areas such as leadership or critical thinking.

The results indicate that the Experimental Group maintains strong, discipline-based study habits with a focus on respect, application, and consistent effort. However, leadership and critical thinking remain areas for development. Zhang et al. (2020) found that school closures disrupted students' routines, yet those with structured study habits, teacher communication, and goal-setting managed learning effectively and experienced reduced stress. Maintaining regular study routines and receiving teacher support helped sustain learning, emphasizing self-discipline and consistency, although opportunities for leadership and higher-order thinking declined during emergency remote instruction.

In general, the results indicate that students take learning very seriously, but both their skills and habits require further development to succeed in school fully. Also, the results suggest that students are aware of the importance of studying, but they should improve their study habits and practices to improve their academic performance.

Performance of Both Groups in Algebra During Pretest and Posttest

Based on the data in **Table 5**, conventional teaching methods significantly heightened the students' mastery of Algebra. While it generally seems that change is present, the lack of an increased number of proficient and advanced categories still indicates that while basic skills may have been reinforced, higher-level abilities might require further methods or tools beyond traditional instruction to help push students into Very Good and Excellent proficiency levels. To elevate student achievement to higher levels, enhanced teaching strategies or supplementary instructional tools such as technology integration, collaborative learning, or real-world applications might be necessary. This highlights the need to complement traditional methods to foster deeper understanding and higher-order thinking in Algebra.

The comparison shown in **Table 6** clearly illustrates how much traditional teaching methods have left a lasting impact on the Algebra skills of Grade 9 students. The data unequivocally demonstrates that the intervention has led to improvements in students' conceptual understanding and procedural fluency in Algebra. This supports the idea that targeted and explicit instruction helps students grasp concepts more effectively than simply building on previous ideas. These findings suggest that the method can be an effective way of boosting student academic achievement, and it does so regularly and predictably. This means that, in general, we can be quite justified in using traditional pedagogy to build a few years' worth of Algebraic foundations before finding opportunities to blend the best of both competence-based and mastery-based approaches in readiness for Grade 9.

Test of Significance of the Difference

The results confirm that the type of strategies used has some contribution to an improvement in academic achievement in Algebra. This suggests that the students did learn to some extent, which is consistent with the claim that specific instructional interventions can enhance Algebra performance. Future research could examine which elements of the instruction were most beneficial or how to maintain and increase these gains in follow-up lessons. These data show that the control group did make a significant improvement in their Algebra skills. Oribhabor (2020) used a quasi-experimental pretest–posttest design to examine activity-based teaching in mathematics, finding significantly higher posttest scores compared to traditional lecture methods. Similarly, Karjanto and Acelajado (2022) reported that a flipped classroom approach produced statistically significant cognitive gains across all algebra topics among first-year college students, improving both performance and attitudes toward mathematics. Kandukoori et al. (2024) compared digital tools with traditional instruction, revealing that students using technology achieved substantially higher posttest scores. Collectively, these findings highlight the effectiveness of active learning strategies and technology integration in enhancing algebra instruction and improving student achievement in mathematics.

The data show that the intervention significantly enhanced students' understanding and knowledge of Algebra content, with higher average posttest scores compared to pretest scores. This significant effect shows that the experimental intervention effectively raised Algebra grades. The results of the study further reinforce the teaching strategy as a possible factor for improvement in learning and performance of Grade 9 students if implemented in the Algebra House. The study results suggest that continuing (or expanding on) these approaches for providing a more thorough understanding and practice in the domain of Algebra will ultimately aid in addressing longer-term academic advancements in mathematics.

Hernandez Godoy Jr. (2021), although not directly related to Desmos, notes that the use of technology parallels graphing calculator applications like Desmos, which embed interactivity in their vision for student engagement and pedagogical understanding. Also, the study by Smolinsky et al. (2020) examined computer-based testing as an alternative to the traditional paper-and-pencil format. The study underscored the benefits of computer-based testing, such as instant feedback and digital tool usage — features that are found in graphing calculators used by Desmos. However, it is an appraisal focused on GeoGebra, which aims to evaluate the effectiveness of interactive tools in teaching subjects. Therefore, the results of the study for Algebra suggest that a methodological approach based on modeling, visualization, and programming, when implemented in teaching using Desmos, could have significant potential to enhance performance (Ziatdinov & Valles Jr., 2022).

CONCLUSION

The study concluded that the use of the Desmos graphing calculator has a significant positive effect on the Algebra performance of Grade 9 students. Research showed substantial gains in essential Algebra understanding, including graphing linear and quadratic functions, interpreting equations, and the connection between variables. Desmos catalyzed sense-making, partly by delivering an experience that was more physical than a paper task. In addition, this allowed students to test, see, and update their solutions in the tool, accelerating active learning, critical thinking, and problem-solving capabilities.

The study also found that students were more engaged and confident when working with Algebra problems; thus, they argued that technology integration contributes to the eagerness and appeal of mathematics. These benefits were evident regardless of student performance, suggesting that Desmos can be beneficial for students who are struggling as well as advanced. Irrespective of the concerns, using Desmos persuades some teachers to reconsider this simple addition to their instruction that has positive results for student scores in Algebra. The researchers recommend that mathematics teachers should receive adequate training to maximize the platform's features in the use of instructional technologies such as the Desmos graphing calculator. In line with this, the researchers recommend that mathematics teachers should have training in the use of the Desmos graphing calculator to improve their teaching practice. Along with this, they suggested that the lesson plan be improved, integrating it into the regular curriculum to sustain and extend learning gains.

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