

# The Utilization of Desmos in Enhancing Mathematical Problem-Solving Skills among Secondary Students

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## ABSTRACT

This study examined the effect of utilizing Desmos on students' Mathematical problem-solving skills. A quasi-experimental approach was used with 50 Grade-8 students from Pasion National High School in Davao De Oro, Philippines. Two sections were assigned to two groups: the experimental group, which utilized Desmos, and the control group, which utilized direct interactive instruction. Pretests and posttests results showed significant improvement in both groups, with the experimental group who utilized Desmos demonstrating statistically greater gains. Quantitative data revealed that Desmos improved students' comprehension of Algebraic concepts such as graphing, factoring, linear functions and solving equations, and increased active participation during the problem-solving activity. The study recommends the integration of Desmos as an effective instructional tool in teaching Algebra and encourages its exploration across other branches of Mathematics such as Geometry, Trigonometry, and Calculus. Further qualitative and longitudinal research is suggested to gain deeper insights into student experiences and the long-term impact on Mathematical skills. Additionally, proper teacher training and support are advised to maximize the effective use of Desmos in classroom instruction.

**Keywords:** desmos, mathematics, problem-solving skills, graphing calculator, technology, interactive, moncast

## INTRODUCTION

### Rationale

Philippines in the 2022 Program for International Student Assessment (PISA) results stated that 16% of Filipino students achieved at least level two proficiency in Mathematics (Education GPS, OECD, 2025). It was reported that students scored only 355 points, indicating lower scores compared to the average score of 472 that is 69%. According to Servallos (2023) the Department of Education revealed that Philippines' poor performance in the 2022 PISA test suggested that Filipino students are lagging behind by approximately five to six years in terms of learning competencies compared to their peers in other participating countries. On the other hand, six Asian countries, such as Singapore (41%), Chinese Taipei (32%), Macao (29%), Hongkong (27%), Japan (23%), and South Korea (23%) had the largest shares of students who made it to the top. At this stage, students can model complex situations mathematically, can select, compare, and use appropriate problem-solving strategies (Education GPS, OECD, 2025).

Moreover, problem-solving can be considered as an important aspect of mathematics learning, as it not only develops students critical thinking and analytical skills but also deepens their understanding of mathematical ideas, making such a comparison is important for evaluating the effectiveness of the intervention (Klang et al., 2021). The success of good students' Mathematics performance depends on their ability to solve problems and understand when and how to apply their knowledge and skills (Chytrý et al., 2020). Teaching Mathematics using digital tool can enhance how mathematical concepts are presented to students, provide opportunities for an engaging learning process, facilitate differentiated instruction, and assessment (Cirneanu & Moldoveanu, 2024). However, the Philippines' education system is still dominated by

traditional teaching, which frequently overlooks the goal of mathematics learning to prepare students to deal with real-life situations, which affects the declining performance of students in their overall Mathematical ability, especially in problem-solving (Hidalgo & Callo, 2023). They often rely on paper and pen to find the right answer, but this method can take a lot of time. Writing things out step by step slows down the process, making it less efficient for solving problems. This approach is greatly helpful however, Szabo et al., (2020) cited that the traditional method does not support deep learning and flexible thinking. Students may perform well on similar problems, but they have a hard time on how to transfer knowledge to unfamiliar contexts, limiting their problem-solving agility. Likewise, Oribhabor (2020) this strategy may not always be the most effective and fastest way in enhancing students' Mathematical problem-solving skills.

Furthermore, the Department of Education, Davao De Oro (2024) reported that Davao De Oro has low 21<sup>st</sup> century skills proficiency in all subjects with Mean Percentage score within a range of 25-49. Among the 21<sup>st</sup> century skills, Davao De Oro scored 40.18% in Problem-Solving Skills, 36.29 in Critical Thinking, and 35.85% in Information Literacy. Moreover, Pasion National High School, one of the schools in Davao De Oro mirror this issue. According to the teachers, many students are struggling with Mathematics, particularly in developing problem-solving skills. Approximately 61% out of 90 enrolled Grade-8 are experiencing difficulties in this area. This foreground an essential need for interventions and innovative teaching strategies as problem-solving is a foundational skill that supports overall mathematical understanding.

Technological platforms like Desmos offer an innovative approach to bring Mathematics to life. Desmos allows students to manipulate variables, visualize changes in real-time, and explore Mathematical relationships dynamically. For example, by adjusting the base lengths and height of a trapezoid using sliders, students can discover why the formula works rather than just memorizing it. Through interactive explorations and student-centered problem-solving approaches, technology bridges the gap between seeing Math and truly understanding it. With the integration of online platforms such as Desmos, students now have access to more resources and can learn in different ways that suit them better. Moreover, students now have access to wider scope of resources and can engage with mathematical ideas in way that match individual learning approaches, making learning more effective.

## Research Objectives

In this study, the researchers intend to determine the effectiveness of utilizing Desmos as a strategy to improve secondary students' skills in Mathematics. Specifically, this study strives if utilizing Desmos in learning Math would enhance the problem-solving skills among Grade-8 students at Pasion National High School, related to Algebra particularly in linear functions, factoring, graphing, and simplifying or evaluating Algebraic equations.

## Theoretical Framework

The utilization of technology in Mathematics learning provides both learners and teachers with impulsive learning experiences that enhances students' problem-solving abilities. This study is grounded by Engeström's Activity Theory (1987), which explains how technological tools mediate learning, and is further supported by Vygotsky's Scaffolding Theory (1978), and the Technological Pedagogical Content Knowledge (TPACK) Framework of Mishra and Koehler, which highlight the role of guided learning and the efficient usage of online platforms in education.

The main concept of Engeström's theory discussed that knowledge is not required in isolation but through engagement with technological tools, teachers, and peers.

Correspondingly, Vygotsky's Scaffolding Theory complements Activity Theory by emphasizing the importance of guided learning. Vygotsky's Scaffolding Theory in 1978 noted that students learn best when they receive structured support from teachers, peers, or technology, which gradually decreases as they gain mastery.

Ultimately, the Technological Pedagogical Content Knowledge (TPACK) Framework of Mishra and Koehler (2006) pointed out the need for teachers to integrate technology effectively into their instructional strategies.

### Conceptual Framework

This study showed differentiation of the direct interactive instructional strategy and the utilization of Desmos. It aimed to find which strategy would be more effective in terms of enhancing mathematical problem-solving skills in secondary level, specifically in Grade-8 students. In the direct interactive instructional strategy, the teachers' approach used a traditional method where the teacher teaches the students in front of the class using chalk talk to discuss the concepts of the lessons. While in the other approach the teacher uses a Desmos on their discussion to visualized the concept of the lessons that aims to fully understand the topic and enhance the Mathematical problem-solving skills.

Figure 1 presented the instructional strategies namely (1) the direct interactive instructional strategy for the control group and, (2) the utilization of Desmos for the experimental group. These two instructional strategies serve as the independent variables that may affect the dependent variable, which is the academic performance in Mathematical problem-solving skills in pretest and posttest.

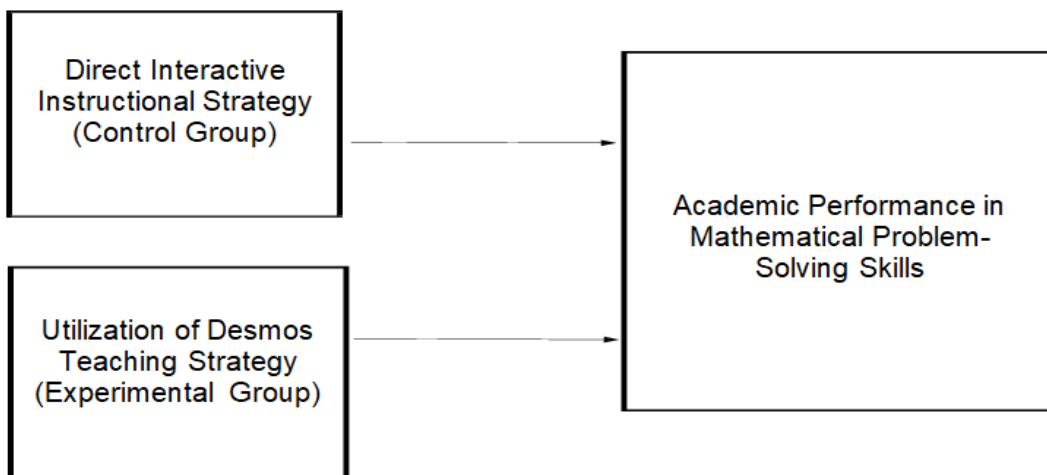


Figure 1. Schematic Diagram of The Utilization of Desmos in enhancing Mathematical Problem-Solving Skills among Secondary Students

### Statement of the Problem

This study was mainly concerned in finding the effectiveness of Desmos as an effective teaching strategy among secondary students rather than the direct interactive instruction. Particularly, this study aimed to address the questions as follows.

1. Is there significant difference in the pretest of control and experimental of Grade-8 students at Pasian National High School?
2. Is there a significant difference between the pretest and posttest scores of Grade-8 students using the direct interactive instructional strategy?
3. Is there a significant difference between the pretest and posttest scores of Grade-8 students utilizing Desmos?
4. Is there a significant difference between the posttest scores of Grade-8 students using the direct interactive instructional strategy and those utilizing Desmos?

### Null Hypothesis

To address the problems and provide unbiased answers, researchers formulated the following hypothesis:

1. There is no significant difference in the pretest scores of Grade-8 students between the control and experimental group at Pasian National High School.

2. There is no significant difference between the pretest and posttest scores of Grade-8 students at Pasian National High School when using the direct interactive instructional strategy.
3. There is no significant difference between the pretest and posttest scores of Grade-8 students at Pasian National High School with the utilization of Desmos.
4. There is no significant difference in the posttest scores of Grade-8 students between the direct interactive instructional strategy and the utilization of Desmos at Pasian National High School.

## METHODOLOGY

### Research Design

This chapter outlined the methodology, including the research design, research locale, subjects of the study, research instrument, research procedure, and statistical methods used for analyzing data. This quantitative research employed a quasi-experimental design. A quasi-experimental design allowed easier implementation in natural settings without needing to randomly select participants. This design was deemed appropriate as it allows the investigation of causal relationships within a natural classroom setting without random assignment of participants. The approach enabled the researchers to implement the intervention while minimizing disruption to regular instructional practices. This approach allowed researchers to study and evaluate the effects of a specific treatment while minimizing the influence of external variables (Singh, 2021).

### Research Locale

The study was conducted at Pasian National High School, a public secondary school located in Monkayo, Davao De Oro, Philippines. This first community is known for its thriving agricultural sector, particularly rice and banana farms. It is also home to the famous Mt. Diwata, a 1,000-meter-high range known for its gold ore deposits. Pasian National High School was established on January 1, 1999. It is about 12 kilometers from the town center. Currently, Pasian National High School has 26 teachers, three non-teaching staff, and an enrollment of around 600 students over the past three years since 2022. Figure 2 represents the vicinity map of Pasian. The school serves a diverse population of learners and reflects a typical urban educational setting in the region. The selection of this locale was based on accessibility and feasibility of implementing the intervention within an actual classroom environment.

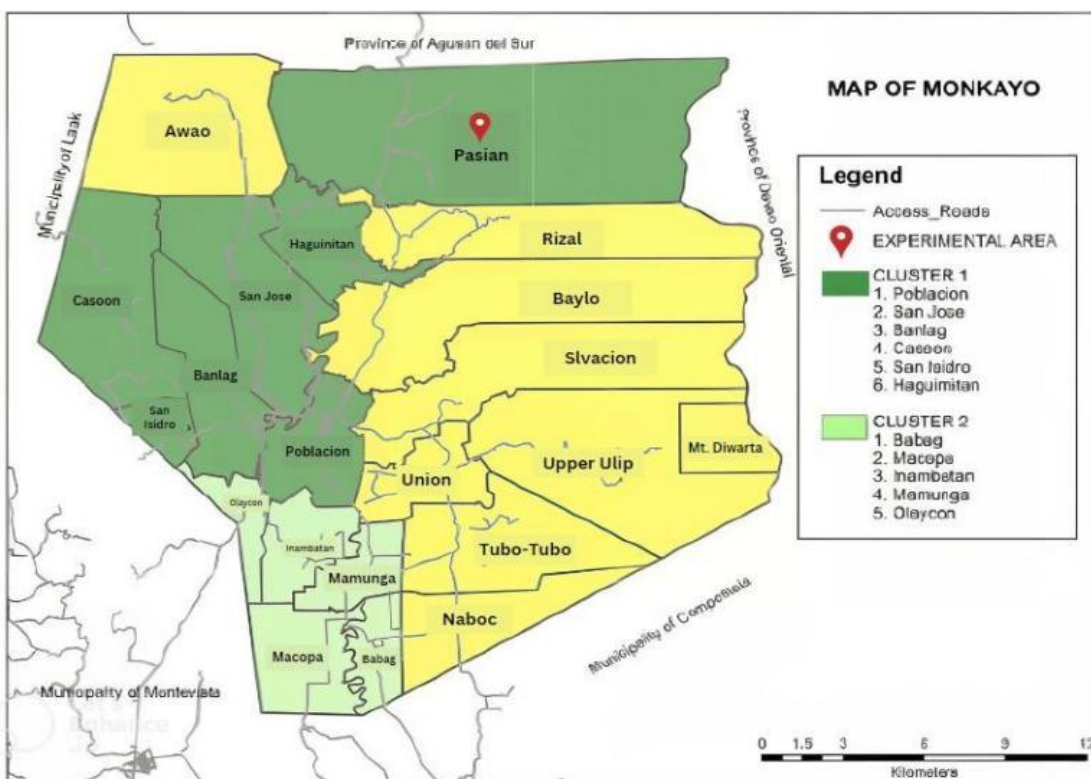


Figure 2. Vicinity Map of Pasian

## Respondents of the Study

Some of the researchers were alumni students in Pasian National High School and now pursuing a degree in Mathematics in Monkayo College of Arts, Sciences and Technology. Conveniently, the study was conducted in the locality under the two sections of Grade-8 with a total of 50 students at Pasian National High School under the academic year of 2024-2025.

One section was assigned as the control group ( $n=26$ ), while the other served as the experimental group ( $n=24$ ). The sample size, although relatively small, was determined based on the availability of respondents within the selected public school where the intervention could be practically conducted.

While the limited sample size may restrict the generalizability of the findings, it remains appropriate for a quasi-experimental study conducted in a natural educational setting. The use of intact classes ensured minimal disruption to school operations. Future research is encouraged to include a larger sample and multiple school to enhance external validity.

## Research Instrument

The pretest and posttest were researcher-made test patterns derived from basic mathematics textbooks, focusing on the exercises related to solving linear functions, graphing, factoring, simplifying and evaluating algebraic equations. The questions consisted of five (5) linear functions, three (3) graphing, four (4) solving algebraic equations and three (3) factoring questions for pretest and posttest. Both tests were in the form of Multiple-choice to have time constraints in handling numbers.

To ensure reliability, the instruments were subjected to test-retest procedures. Content validity was established through alignment with curriculum standards and expert review. The same test was administered as both pretest and posttest to ensure comparability of results.

## Research Procedure

The study followed a systematic intervention process to ensure consistency and replicability. Prior to implementation of the intervention, both groups were oriented regarding the purpose and procedures of the study to ensure ethical compliance and participant understanding.

It was conducted over a period of six (6) weeks. During the first week, the researchers administered the pretest to both the control and experimental groups to establish baseline equivalence in mathematical problem-solving skills. The second to fifth weeks were allotted for the implementation of the instructional intervention. During this period, both groups were taught the same algebraic topics, including linear functions, graphing, factoring, and solving algebraic equations. The control group received direct interactive instruction using traditional teaching methods such as lecture, board work, and guided practice. In contrast, the experimental group was instructed using Desmos, an interactive graphing tool that enabled students to visualize and explore mathematical concepts dynamically.

To control for teacher related variability, the same teacher handled both groups throughout the duration of the study. Lesson plans were carefully standardized to ensure that learning objectives, content coverage, instructional time, and assessment tasks were consistent across groups. The only variation between the two groups was the mode of instructional delivery.

In addition, to ensure implementation fidelity, the researchers closely monitored adherence to the prepared lesson plans, consistency in time allocation, and the proper integration of Desmos activities in the experimental group. During the sixth week, a posttest was administered to both groups under the same conditions as the pretest and posttest were then collected, analyzed, and compared to determine the effectiveness of the intervention.

## Statistical Treatment of Data

Statistical treatments of data were crucial in quasi-experimental study. This supports data analysis and aids in making proper conclusions. To address Problem number 1 regarding the competency levels of Grade-8

students from sections A and B in Algebra, based on their pretest and posttest scores, the weighted average mean and standard deviation were used to summarize students' performance. For the Problem number 2, number 3, and number 4, a t-test on the significance of the difference between two correlated means was used. Problem number 1 and 4, as well as the Null hypothesis 1 and 4, a t-test for independent samples was employed to assess the academic performance of the two sections. Also, Pearson Product-Moment Correlation (Pearson r) was used for reliability testing.

In addition to p-values, effect sizes (Cohen's d) were computed to determine the magnitude of the differences, while 95% confidence intervals were used to assess the precision and reliability of the estimates. This combination of statistical technique provided a more comprehensive interpretation of the results.

## RESULTS AND DISCUSSION

The subjects of the experiment as presented were consisted of two sections. Table 4 presented the distribution of the students under the control group (Section A) and experimental group (Section B).

Table 4. Subjects of the Study

Section	No.	Percent
Grade-8 Section A (Control Group)	26	52%
Grade-8 Section B (Experimental Group)	24	48%
<b>Total</b>	50	100%

Table 4 showed a total of 50 as the subjects of the study, which is divided into two groups. The control group from Grade-8 Section A had 26 students while the experimental group from section B had 24 students. As to the distribution of the two groups, they were nearly equal at 52% and 48% respectively, which suggests a balanced comparison between the two groups.

### Test results of the Hypotheses

**Ho1: There is no significant difference in the pretest scores of Grade-8 students between the control and experimental groups at Pasian National High School.**

Table 5 represented the pretests scores of the control group (Section A) and experimental group (Section B) were analyzed before the intervention.

Table 5. Comparison of Pretest Scores

Group	Mean	SD	t-value	p-value	Finding	Interpretation
Grade-8 Section A (Control)	3.96	2.38	1.155	0.254	Accept Ho	Not Significant
Grade-8 Section B (Experimental)	3.25	1.94				

Table 5 showed the pretest scores between the control group (Section A) and experimental group (Section B). The control group got a slightly higher average score of 3.96, while the experimental group got 3.25. However, the t- value of 1.155 and p-value of 0.254 shows that the difference is not statistically significant. This means that we fail to reject the null hypothesis, suggesting that there was no significant difference in the pretest of the groups before the intervention. This also means that both groups had the same level of knowledge, considered very suitable for the experiment.

**Ho2: There is no significant difference between the pretest and posttest scores of Grade-8 students at Pasian National High School when using the direct interactive instructional strategy.**

Table 6 presented the findings of the t-test of the significant difference between two correlated means of the students in Grade-8 Section A, the control group. The results of their pretest and posttest were compared to check if there was significant difference before and after they were taught using traditional strategy.

Table 6. The Control Group Results Before and After the Experiment

Test	Mean	SD	t-value	p-value	Finding	Interpretation
Pretest	3.96	2.38	3.333	0.003	Reject Ho	Significant
Posttest	4.98	1.92				

Table 6 showed the findings of the control group prior to and after the treatment. The average score increased from 3.96 in the pretest to 4.98 in the posttest, indicating an improvement in the performance. The t-value of 3.333 and the p-value of 0.003 showed that this increase is statistically significant. As to that, the null hypothesis is rejected, implying that the control group’s performance is notably enhanced, despite not being subjected to the intervention.

**Ho3: There is no significant difference between the pretest and posttest scores of Grade-8 students at Pasian National High School with the utilization of Desmos.**

Table 7 presented the results of the t-test on the significance difference between two correlated means of the students in Grade-8 Section B, the experimental group. Likewise, the findings of their pretest and posttest were compared to check if there was significant difference before and after utilizing Desmos as instructional strategy.

Table 7. The Experimental Group Results Before and After Experiment

Test	Mean	SD	t-value	p-value	Finding	Interpretation
Pretest	3.25	1.94	13.387	0.001	Reject Ho	Significant
Posttest	6.21	1.38				

Table 7 showed the average scores of the experimental group before and after utilizing Desmos as the instructional strategy to improve their problem- solving skills in Mathematics, particularly in algebra. Their average went up from 3.25 in the pretest to 6.21 in the posttest, indicating a clear improvement. The high t-value of 13.387 and the value of 0.001 confirmed that this difference is statistically significant. Therefore, the null hypothesis is rejected, suggesting that utilizing Desmos had a positive effect on the students’ performance of the experimental group.

**Ho4: There is no significant difference in the posttest scores of Grade-8 students between the direct interactive instructional strategy and the utilization of Desmos at Pasian National High School.**

The posttest scores of both the control and experimental group were analyzed thoroughly after the interventions were done. The control group was employed with direct interactive instructional strategy. Table 8 presented the comparison of the scores of the posttest.

Table 8. Comparison of Posttest Scores Between the Control Group and Experimental Group

Group	Mean	SD	t-value	p-value	Finding	Interpretation
Grade-8 Section A (Control)	4.61	1.87	3.457	0.001	Reject Ho	Significant
Grade-8 Section B (Experimental)	6.21	1.38				

Table 8 showed the difference of posttest average scores of two groups, Section A as the control group and Section B as experimental group. The experimental group, which used Desmos during the intervention, got the higher average score of 6.21, on the other hand, the control group had an average of 4.61, the t-value of 3.457 and the p-value of 0.001. The hypothesis is rejected and therefore there was significant difference between the scores of the students during the posttests under the control group and the experimental group. It implies that although both instructional strategies had enhanced the students’ skills in problem-solving. The students utilized Desmos during the lessons performed a lot better compared with the students with direct interactive instructional strategy.

The findings revealed that both instructional approaches contributed to improvements in students' mathematical problem-solving skills. However, the experimental group demonstrated significantly greater gains compared to the control group. Beyond statistical significance, the computed effect sizes indicated that the Desmos intervention had a meaningful educational impact. The inclusion of confidence interval further strengthened the reliability of the findings, suggesting that the observed differences were not due to chance alone. The results highlight the potential of technology-enhanced instruction in fostering deeper understanding and engagement in mathematics learning.

To complement the results of the significance tests, effect sizes using Cohen's *d* were calculated to determine the magnitude of differences between groups and test conditions. The results are summarized in Table 9.

Table 9. Summary of Effect Sizes (Cohen's *d*) for Key Comparisons

Comparison	Mean 1	Mean 2	Pooled SD	Cohen's <i>d</i>	Interpretation
Pretest (Control vs. Experimental)	3.96	3.25	2.17	0.33	Small
Control Group (Pre vs Post)	3.96	4.98	2.16	0.47	Medium
Experimental Group (Pre vs Post)	3.25	6.21	1.68	1.76	Very Large
Posttest (Control vs Experimental)	4.61	6.21	1.64	0.98	Large

The effect size results confirmed that utilizing Desmos had a strong and meaningful impact, exceeding the improvements observed in the traditional instructional approach.

## CONCLUSION

This study explored the effectiveness of utilizing Desmos as a teaching strategy in enhancing students' performance in Algebra. Both controlled group and experimental group showed similar skill level in Algebra, particularly in graphing, factoring, evaluating and simplifying algebraic equations prior to the implementation of the intervention. Moreover, both instructional strategies namely: the direct interactive instructional and the utilization of Desmos as a teaching strategy, showed clear improvements on students' competency levels after the intervention. It implies that both strategies are effective in enhancing the mathematics students' competency. However, the utilization of Desmos as teaching strategy led to a greater improvement as the comparison of the two strategies resulted in a significant difference.

After examining the data gathered and the summary of the results, it can be concluded that the utilization of Desmos showed positive and better results than the direct interactive instructional strategy. Therefore, the utilization of Desmos proves to be a more effective teaching strategy that significantly enhances students' capability to engage with and understand Mathematical problems more effectively.

## RECOMMENDATIONS

The following recommendations are hereby presented after the conclusions were established:

1. Based on the results, utilizing Desmos is an effective instructional strategy, particularly for the lessons in algebra such as linear functions, graphing, factoring, evaluating and simplifying Algebraic equations. Teachers can try to integrate Desmos as another method to help students understand these topics better.
2. Since Desmos includes features that relate to other areas of Mathematics, it might be good to explore how it can be used in subjects like Geometry, Trigonometry, and Calculus. Further exploration could help determine its broader applicability.
3. Further qualitative study might be helpful to explore students' insights and experiences while using Desmos. Looking into their views may give a better understanding of how the tool supports learning.
4. Longitudinal study may help assess the long-term impact of using Desmos on students' Mathematical skills, and may help determine whether the improvement in problem-solving abilities stays effective in the long term.
5. Teachers could benefit from training or support on how to use Desmos more effectively in class. Learning more about its features may help make teaching more engaging and easier for students to understand.

6. Future studies are encouraged to involve a larger sample size and include participants from multiple schools to enhance the external validity and generalizability of the findings. Expanding the scope of respondents across different educational settings may provide a more comprehensive understanding of the effectiveness of Desmos as an instructional tool in diverse learning contexts.

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