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Implementation of Desmos as a Teaching Tool in Graphing Functions in the New Normal

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A B S T R A C T

Before the implementation of online learning, students graphed functions on paper using either a ballpen or pencil. However, online learning materials including online graphing calculators were being encouraged to be used since the modality had shifted into online learning. Desmos is one of the online learning materials that can be used in graphing functions. This study aimed to evaluate the effectiveness of the implementation of Desmos as a graphing tool for teachers and students together with the benefits of this software together with the perceptions towards it. The study was conducted with 23 Grade 11 students taking up Accountancy and Business Management during the classes of Statistics and Probability. The research design used was mixed consisting of comparative statistical techniques and narrative analysis. The interventions involving Desmos were done virtually through Google Meet. Their skills before and after the interventions involving Desmos were compared and based on the statistical aspect, there was a significant difference between the skills before and after the interventions with a t-statistical value of -3.78, which was lower than the critical value of -2.074. Besides, the students were able to collaborate in terms of tasks and reflect on what they had learned in Desmos, and they were able to see Desmos as an accessible, convenient, and effective graphing tool. Desmos should be widely used as a teaching tool in graphing functions so students will be able to appreciate technology with mathematics since people are now living in the era of technology.

KATA KUNCI

Desmos, Pembelajaran Daring, Kalkulator Grafik Daring, Alat Grafik, Menggambar Fungsi Grafik.

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A B S T R A K

Sebelum pembelajaran daring dilaksanakan, siswa menggambar grafik fungsi di atas kertas menggunakan bolpoin atau pensil. Namun, materi pembelajaran daring termasuk kalkulator grafik daring didorong untuk digunakan karena modalitasnya telah beralih ke pembelajaran daring. Desmos merupakan salah satu materi pembelajaran daring yang dapat digunakan pada fungsi grafik. Penelitian ini bertujuan untuk mengevaluasi efektivitas pelaksanaan Desmos sebagai alat bantu menggambar grafik bagi guru dan siswa beserta manfaat perangkat lunak ini beserta persepsi terhadapnya. Penelitian ini dilakukan terhadap 23 siswa Kelas 11 yang mengambil mata kuliah Akuntansi dan Manajemen Bisnis pada mata kuliah Statistika dan Probabilitas. Desain penelitian yang digunakan adalah gabungan antara teknik statistika komparatif dan analisis naratif. Intervensi yang melibatkan Desmos dilakukan secara virtual melalui Google Meet. Keterampilan siswa sebelum dan sesudah intervensi yang melibatkan Desmos dibandingkan dan berdasarkan aspek statistika, terdapat perbedaan yang signifikan antara keterampilan sebelum dan sesudah intervensi dengan nilai t-statistik sebesar -3,78 yang lebih rendah dari nilai kritis sebesar -2,074. Selain itu, para siswa dapat berkolaborasi dalam mengerjakan tugas dan merenungkan apa yang telah mereka pelajari di Desmos, dan mereka dapat melihat Desmos sebagai alat grafik yang mudah diakses, nyaman, dan efektif. Desmos harus digunakan secara luas sebagai alat pengajaran dalam grafik fungsi sehingga siswa akan dapat menghargai teknologi dengan matematika karena orang-orang sekarang hidup di era teknologi.

1. Introduction

Before the introduction of online learning, which was during the face-to-face setting, there were students who encountered difficulties in graphing functions using paper and pen. However, there is much software that can aid them in their mathematical skills, which include graphing [1]. There is much graphing software wherein people can input any function, which will allow them to see the graph based on the function they type [2], [3].

Graphing software was being made in order to assist the students in terms of their difficulties in graphing functions and analyzing graphs [4], [5]. These also enabled them to check if their graphs are correct or not

[6]. Since the pandemic outbreak has come, students had shifted into online learning where they were encouraged to use online learning materials such as online graphing calculators in doing mathematical exercises and tasks. Desmos is being used as a graphing software during the interventions of the study [7].

Desmos is a graphing software where students can graph functions and introduced for a design project where students to practice graphing [8]. Since this era deals with online learning and many learners are encouraged to use the Internet, they can use Desmos online when graphing functions. Usually, graphing functions is one of the usual skills JHS students usually learn in Mathematics, however, due to restrictions implemented, teachers need to find ways to teach their students how to graph every function in the Cartesian plane [9]. Students are being taught how to graph functions since Grade 8 when they are being taught how to graph linear functions. While in Grade 9, they focus on quadratic, and in Grade 10, they focus on various functions. Nowadays, teachers are looking forward to more innovations in teaching graphs with the use of technologies and aim to influence each of the students in technological usage [10]. [11].

Desmos can enable the learners to develop their brainstorming skills, which can promote their creativity and enhance their critical thinking [12]. This also allows them to determine and understand the structure of every graph in the Cartesian plane. With Desmos, learners can be able to graph the functions digitally, solve problems easily involving graphs and interpret each of these [13]. They can also form various images and designs using graphs they construct in Desmos. Everyone can even draw figures using functions they have input using this software. This allows them to show their creativity with mathematical concepts. Teachers can use this software to implement numerous activities for the learners to get engaged in graphing functions through digital means [14].

The three main factors, which involve the mathematical skills of the learners with the utilization of technology. These indicate the following: (1) Mathematical Fidelity, (2) Amplifier/Organizer, and (3) Representations [2]. Teachers must carefully observe these when teaching math learners with the technological integration of Desmos. Teachers usually still play as facilitators in student learning whether face-to-face or online by triggering the students to ask questions and perform tasks and assess the skills needed. In terms of preparing assessments, teachers can even prepare digital worksheets where students will have to perform graphing and implement them during synchronous and asynchronous periods using this software.

With the help of Desmos, students no longer need paper and pen to sketch graphs as long as they have gadgets and the Internet [15]. Besides, students can be able to solve problems involving graphs with the help of this software and they can be able to improve their analysis of graphs [16]. Students can also gain feedback on every output, which can help them correct their errors in inputting data and be able to engage in reflective learning [17].

The action research aims to evaluate how effective the implementation of Desmos as a teaching strategy for SHS students. This also seeks to help them to appreciate the software in terms of utilization in teaching graphs. This targets to answer the following questions:

a) What are the teaching strategies done towards SHS students using Desmos?

b) What are the perceptions of SHS students towards Desmos as a teaching tool?

c) What is the significant difference in the performance levels in Mathematics of the respondents before and after using the Desmos in classes?

2. Research Method

The participants for this study consisted of students taking up Accountancy and Business Management at Mataas Na Paaralang Neptali A. Gonzales. They are currently in Grade 11. They were chosen through a purposive-convenience sampling technique. The number of participants was 23 and the researcher had requested permission from their class adviser. To observe ethical considerations, each of the names was not being mentioned in data gathering means.

The scores of the participants for the two Desmos tasks were graded according to the following: correctness of graph, computation, and analysis of graphs. In terms of the quiz, it consisted of 20 questions focusing on areas involving normal distribution. These can measure their understanding of the topics.

The researcher had implemented a series of interventions about Desmos during his classes in Statistics and Probability. The chosen topic to be discussed was normal distribution together with the areas of the regions. The researcher had conducted a series of interventions using Google Meet during class sessions with the participants since the topic to be discussed in the interventions was aligned with the curriculum of the subject he is teaching. The number of interventions was four.

During the first day of intervention (March 30, 2022), the researcher introduced Desmos to the participants and he discussed the properties of the normal distribution together with the graph itself. Then, he implemented the first task involving Desmos, which enabled the participants to analyze the differences between normal distributions with various means and

standard deviations. While on the day after (March 31, 2022), the researcher discussed computing for the area of the normal distribution and shading the regions using Desmos.

During the third and fourth days of intervention (April 6-7, 2022), the researcher discussed problems involving normal distribution and its area and how to solve problems using Desmos. He also implemented an activity wherein the participants will solve problems with the help of Desmos. He also disseminated another task, which focused on problem-solving involving normal distribution.

After a series of interventions, the researcher implemented a quiz, which focused on the topics tackled in Desmos and conducted an interview with selected respondents. The researcher encoded the scores of the respondents towards the tasks and quiz and transcribed interview answers dealing with the perceptions towards Desmos. He got the scores of the quiz of from the respondents before the implementation of Desmos. He also compared the scores of the quiz from the respondents before the Desmos with the scores of the quiz after the Desmos.

3. Result and Discussion

3.1. Teaching Strategies did in Desmos

Using the narrative analysis, the researcher found out the teaching strategies were the following: demonstration method, virtual hands-on activity, collaborative learning, and reflective learning. As for demonstration method, it can be seen on Figure 1.

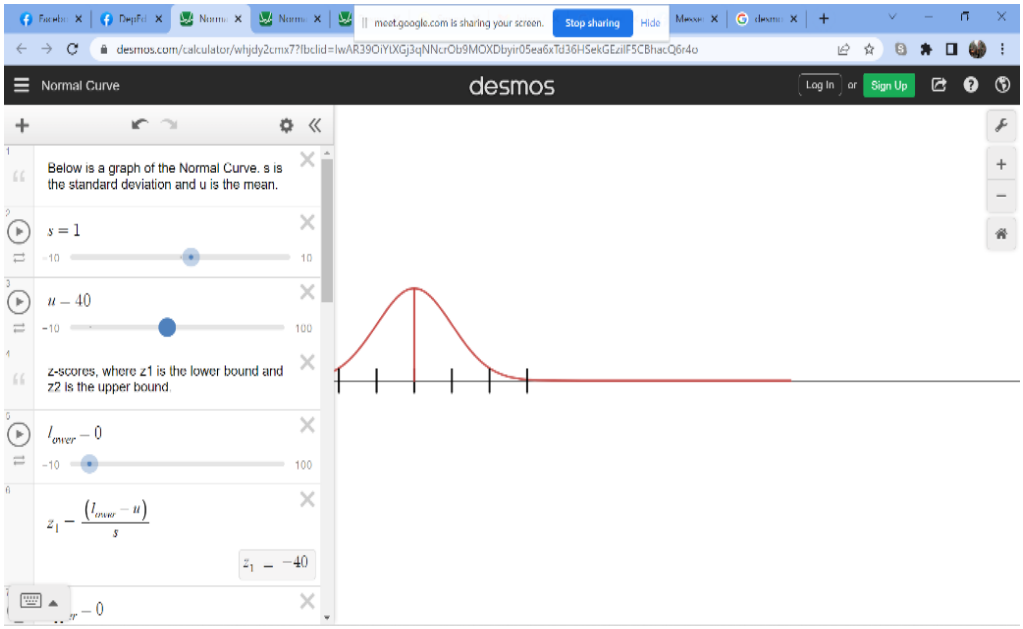

Figure 1. Demonstration Method in Teaching using Desmos

Using Google Meet, the researcher showed first how to graph the normal distribution using the Desmos calculator. He also showed how to transform the normal distribution by adjusting the mean and standard deviation. He had also emphasized that there was feedback from each input in Desmos. This was shown that the normal distribution could be translated by adjusting the mean. He also applied the concepts of statistics in teaching Desmos [17].

In the recitation phase, the researcher asked the respondents to use Desmos in finding the area of the normal distribution. He gave them ample time and asked them to post answers using Desmos in Facebook Messenger Group Chat in Statistics and Probability. The researcher sought to test the understanding of the respondents on graphing using Desmos. The respondent had shown the answer so the fellow respondents would be able to know how the graphing was done in. The answer can be seen on Figure 2.

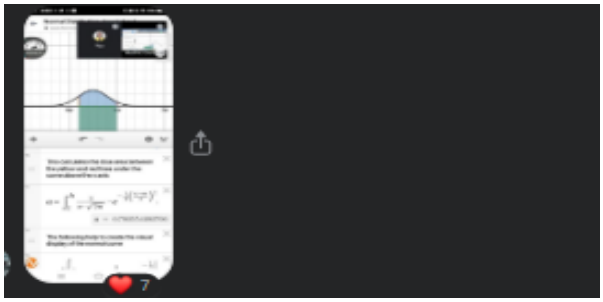

Figure 2. The Desmos Output done by One of the Respondents

The researcher implemented a collaborative task wherein the respondents would have to use Desmos while solving problems. Each member of the group was able to contribute their part in solving problems and graphing normal distributions with the help of Desmos. They were able to share their knowledge of

Statistics and Desmos in which can be seen on Figure 3.

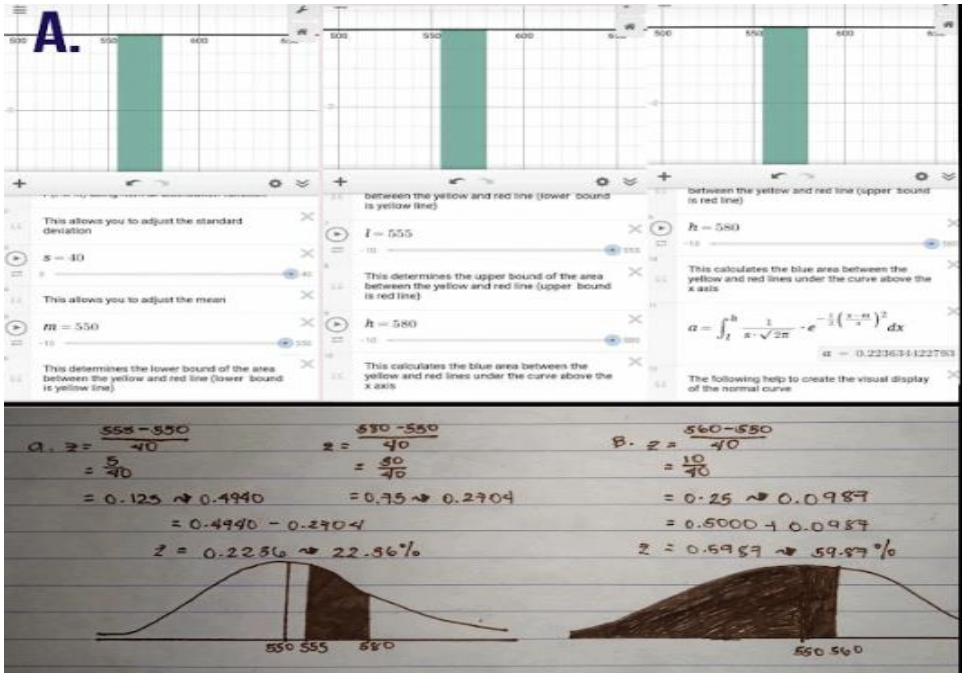

Figure 3. The Collaborative Output done by the Group of Respondents

In terms of quantitative analysis, the researcher enabled the students to perform graph analysis using Desmos. The students' performance a task involving graph analysis in groups. The task was evaluated according to the following criteria: correctness of input of data, explanation, and computation. This task was done in groups. Each of the criteria is being evaluated based on the rubric that shown on Table 1.

	E	S	A	Em	I
Correctness of input of data	5	4	3	2	1
Explanation	5	4	3	2	1
Computation	5	4	3	2	1

Table 1. Graph Analysis Rubric

Where E is excellent, S is substantial, A is average, Em is emerging and I is Insufficient. Here were their scores on this task that can be seen on Table 2.

Group	Correctness of input of data	Explanation	Computation
1	5.00	4.00	5.00
2	5.00	5.00	5.00
3	4.00	5.00	4.00
4	5.00	4.00	5.00
5	5.00	3.00	5.00
6	5.00	4.00	5.00
7	5.00	4.00	5.00
AVE	4.86	4.14	4.86

Table 2. Skills of the Students in Graph Analysis

According to Table 2, there were seven groups of students who had done this task. Group 3 was the only group that scored 4, which is substantial, in the correctness of input of data, while the rest of the groups were able to have a perfect score, which falls into an excellent description. In terms of explanation, Groups 2 and 3 were able to get a score of 5, which is excellent. Groups 1, 4, 6, and 7 were able to get a score of 4, which is substantial, while Group 5 was able to get an average score of 3. In terms of computation, only Group 3 received a substantial score of 4, while the rest of the groups received an excellent score of 5. Speaking of means, the students were able to receive an approximate average score of 4.86 in the correctness of input of data and computation, while they were able to score lower with an approximate average of 4.14. The overall mean of the three components was approximately 4.62.

3.2. Perceptions towards Desmos

According to the responses with some of the participants done through a written interview, where reflective learning was applied. The interview focused on the multiple areas. The following areas are helpfulness of Desmos in graphing and computing, learnings earned in Desmos, and effectiveness of Desmos as a teaching tool.

In terms of helpfulness of Desmos as a graphing tool and calculator, the students had indicated that Desmos can help them graph various functions whether algebraically or statistically. Aside from it, the students had implied that they are being guided with the formulas and formats in graphing functions. One of the respondents had mentioned "Desmos can help me graph functions more proficiently and computationally since I only need to input the data to be computed on the website with the formulas taught by our statistics teacher." Aside from it, they also had indicated that Desmos had enabled them to graph in a convenient

manner since it enables the students and teachers to use technology in graphing functions instead of paper and pen. One of the respondents had mentioned: "Desmos help me in graphing functions easier and faster. Since we are just going to type in what numbers we need to graph, I can say that it's very convenient for us students."

In terms of learnings earned in Desmos, the students were able to learn how to input data (i.e., functions and its parts) for computations and graphing various functions, including normal distribution. Besides, they were also able to learn how to shift graphs vertically or horizontally and determine the maximum or minimum values of the graphs. They were also able to know the shortcuts in graphing functions using this calculator.

One of the respondents had mentioned "From using Desmos, I learned the fastest way to graph any given value. I also use it sometimes to check my manual computation. I realize that one wrong value can affect all so we must be careful not to mess up." Aside from it, they also acknowledged that they were able to see the corrections in their graphs. One of the respondents had mentioned "I learned how to graph a problem automatically and how one variable can affect the whole graph; it can also be used as a checker or guide for us students to know if we have graphed the problem correctly."

In terms of the effectiveness of Desmos, the respondents had agreed that Desmos is an effective tool. One of the respondents had added "Yes, it is confusing at first, but if you understand the functions of the buttons and procedures, you'll accurately show the graph to the students with no flaws. It is also a free website and app so students or teachers can easily access it and explore any mathematical problems that need to be solved, such as functions." This means that Desmos can be accessible and convenient for both teachers and students in terms of utilization as a teaching and learning tool. She also emphasized that the functions and instructions must be carefully observed in order to graph functions perfectly and accurately.

3.3. Skills Before and After the Intervention of Desmos

The comparative analysis of the skills involving Desmos can be seen on Table 3.

	S1	S2
Mean	10.5600000	13.96
Variance	9.26000000	24.95
Observations	23.00000000	23.00
Hypothesized Mean Difference	0	
Df	22.00000000	
t Stat	-3.79000000	
P(T<=t) one-tail	0.00050452	
t Critical one-tail	1.72000000	
P(T<=t) two-tail	0.00100904	
t Critical two-tail	2.07400000	

Table 3. Comparative Analysis of the Skills involving Desmos

Where S1 is skill before Desmos intervention and S2 is skill after Desmos intervention. In Table 3, the overall mean of the scores of the students before the intervention of Desmos in graphing was approximately 10.57. Since the total number of items is 20, the raw percentage of the students based on the skills before the Desmos intervention was approximately 52.83%. After the implementation of Desmos interventions, the overall mean of the scores of the students after the intervention of Desmos in graphing was approximately 13.96, which led them to have an approximate raw percentage of 69.78%. Based on the t-test, the t critical value was ± 2.074 for the two-tailed hypothesis and the significant level was 0.05. The computed t-statistic for this data was approximately -3.79 and it was lower than the approximate t-value of 2.074. With this comparison, there was a significant difference between the skills before and after the implementation of Desmos because the t-statistic fell under the rejection region.

4. Conclusion

Based on the teaching strategies, the researcher and participants were able to perform collaborative learning in various tasks, reflect based on the lessons learned in the Desmos interventions, analyze graphs and demonstrate on how to graph using this software even everything was done in an online setting. In terms of perceptions, the respondents were able to graph functions with the use of this software. Besides, they had even mentioned that this software made their lives convenient, and it was also accessible. They also had indicated that they were able to understand the graphing lessons more. Based on the skills, the participants had improved not just their graphing skills but also their mathematical skills based on their pre-test and post-test scores.

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