APPLICATION OF MATH PRODUCTIVITY SOFTWARE IN A SYSTEM OF LINEAR EQUATIONS AND INEQUALITIES AND STUDENTS' GRAPHING SKILLS IN MATHEMATICS 8

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Abstract

This study investigated the impact of Mathematics Productivity Software (Software X and Software Y) on the graphing skills of Grade 8 students at Kapingkong National High School in the Philippines during the school year 2024-2025. The study employed a quasi-experimental design with three groups: a control group receiving conventional instruction and two experimental groups utilizing Software X (GeoGebra) and Software Y (Desmos), respectively. The findings revealed that while all groups exhibited comparable graphing skills at the beginning of the study, significant improvements were observed in both experimental groups after the intervention. Students using Software X demonstrated the most substantial gains in their graphing abilities, followed by students using Software Y. The control group showed progress, but it lagged behind the experimental groups. These results suggest that Mathematics Productivity Software can effectively enhance students' graphing skills, particularly Software X, which outperformed both Software Y and traditional instruction methods. The study highlights the potential of technology-based learning tools to improve student performance in mathematics and emphasizes the need for educators to explore and integrate such tools into their teaching practices.

Keywords: *mathematics productivity software, graphing skills, geogebra, desmos, quasi-experimental design*

Introduction

Teaching mathematics in today's diverse learning environment presents a significant challenge for educators. Learners come with varying interests, abilities, and experiences, so adapting instructional approaches to cater to their varied needs is essential. One critical aspect influencing effective mathematics instruction is the integration of technology. In an era where contemporary learners are immersed in technology, its incorporation into education becomes imperative to engage and empower students.

Technology offers numerous benefits in teaching and learning mathematics (Bright et al., 2022). It provides students with additional learning opportunities (Roberts, 2016), enhances engagement (White, 2015), and promotes exploratory learning (Bennet, 2019). In mathematics, students must comprehend abstract concepts and visualize, create, and understand the structure of mathematical forms. Technology can enhance these processes so that students see mathematics's relevance.

Learner misconceptions about the basic ideas underpinning graphing are another issue specific to the Philippines. It is also nice to note that currently, there are common difficulties among students identified in the learning process about the basic stages of graphing, such as choices of scales, labeling of axes, and reading the graphical presentation of data (Lannin et al., 2016). This lack of basic knowledge makes simple errors and incorrect interpretations when using mathematical software to graph. However, a research gap in the literature suggests how mathematical software may shape the learners' graphing competency. As presented in the current study, no prior research specifically examines the effects of mathematical software on students' developing and enhancing the skills of creating and interpreting graphs.

Graphical representations are useful in mathematics because figures are the basis of informative data analysis. However, technology plays a crucial role in learning (Baker & Inventado, 2014). Further, there is a lack of research attention on the substantial influence of mathematical software on developing students' graphing abilities. This gap also shows that mathematics education practice requires research to close the gap between theories in the field.

In the specific context of the Division of Sultan Kudarat, particularly at Kapingkong National High School, students' involvement in mathematics during the new normal has been weak, which has had a detrimental effect on their academic achievement. However, the impact of integrating technology, specifically productivity software, in teaching the subject has not been systematically studied. Mathematics Productivity Software has not yet been tested for its potential impact on students' mathematics academic performance within this setting.

Therefore, this study aims to address these gaps in research by investigating the effect of Mathematics Productivity Software (Software X and Software Y) concerning the graphing skills of Grade 8 students at Kapingkong National High School (KNHS), Kapingkong, Lambayong, Sultan Kudarat, during the school year 2024-2025. This research seeks to provide valuable insights into the role of technology in enhancing mathematics education, particularly in improving students' graphing skills, and its potential implications for academic achievement in mathematics.

Research Questions

The study investigated the effect of the Mathematics Productivity Software (Software X and Software Y) on the graphing skills of the

Grade 8 students in Mathematics at Kapingkong National High School, Kapingkong, Lambayong, Sultan Kudarat during the school year 2024-2025. It answered the following questions:

1. What is the level of the students' graphing skills of the control and experimental groups in their pretest?
2. What is the level of the students' graphing skills of the control and experimental groups in their posttest?
3. Is there a significant difference between the pretest results of the control and experimental groups in graphing skills?
4. Is there a significant difference between the posttest results of the control and experimental groups in graphing skills?
5. Is there a significant difference between the mean gain scores of the control and experimental groups?

Methodology

Research Design

A quasi-experimental research design was used to measure the effect of the productivity software in focus on the academic performance of the Grade 8 learners in Mathematics.

It is similar to experimental research because in independent research, the variables are manipulated (Abraham & MacDonald, 2011)—the design aims to establish a causal relationship between an independent variable and a dependent variable. Quasi-experiments do not use random assignment, unlike true experimental designs. Instead of selecting participants at random, they are grouped based on pre-existing conditions. This quasi-experimental design is useful when true testing cannot be conducted for ethical or practical reasons (Thomas, 2020). This study used one (1) section as the control group and two (2) sections as the experimental groups that utilized the productivity software corresponding to each group.

Respondents

The respondents were the Grade 8 students at KNHS enrolled during the School Year 2024-2025, with thirty (30) students in the control group and sixty (60) students in the experimental groups, thirty (30) under Software X and thirty (30) under Software Y. This implies that all three (3) sections of Grade 8 students at Kapingkong National High School were the study respondents.

Choosing Grade 8 students for a study on the effect of Mathematics Productivity Software on their graphing skills is a strategic decision based on various factors: Grade 8 is a critical stage in students' cognitive development, where they exhibit increased cognitive abilities, abstract thinking, and problem-solving skills (Piaget, 2013). At this age, students can comprehend complex mathematical concepts and graphing techniques, making them suitable candidates for exploring the impact of Mathematics Productivity Software on graphing skills.

Moreover, Grade 8 students are generally technologically proficient, having grown up in a digital era (ISTE, 2016). They are likely to be familiar with various technology tools, making them more receptive to using Mathematics Productivity Software for graphing tasks.

Table 1. *Distribution of Respondents' Sample Size*

Section	Population	Sample
Courage	36	30
Humility	32	30
Industry	35	30
Total	N=103	n=90

Source: Enhanced Basic Education Information System (2024 - 2025)

Instrument

The researcher used Conventional Teaching for the control group. Mathematics Productivity Software, such as Software X and Software Y, was employed for the experimental group in the mathematics subject. The researcher also used a Classroom Assessment K to 12 Basic Education Program (Adopted from DepED, DO 8, s, 2015) assessment instrument focused solely on the student's achievements. The needed data for this study was gathered using a paper and pencil test modified by the researcher from the Mathematics 8 Learner's Materials based on Grade 8 learning competencies.

The researcher prepared a fifty-item test questionnaire as the main data-gathering instrument. This test questionnaire was based on a Table of Specifications (DepEd, 2017) to ensure the balance of the test items in terms of competencies. The test items used in the pre-test were rearranged in sequence before it was used in the post-test. Ramos (2014) supported the utilization of a modified post-test questionnaire, which was based on the same learning competencies and learning outcomes as the pre-test questionnaire. This approach is expected to yield more comprehensive results when comparing students' achievements.

The fifty (50) item test's pre-testing reliability was determined by administering the sample test to randomly selected Grade 9 students from Kapingkong National High School. The test items were refined by removing very easy and difficult questions through item analysis. Once the test items were modified, they were administered again to Grade 9 students to ensure their reliability.

The U—L Index Method, adapted from Conception's study (2007) and previously used by Juario (2015), was employed during the item analysis. The final validation results were evaluated using Kuder-Richardson Formula 20 to determine the instruments' acceptance

and ensure the tests' reliability. This resulted in KR-20 = 0.71, indicating a moderate to good level of internal consistency, which meant that the research instrument was reliable.

Procedure

The research began when the Dean of SKSU's Graduate School approved it. The researcher used all available resources to solve the study problem. A letter was submitted to the Superintendent of Schools in Sultan Kudarat asking permission for the researcher to conduct the study at Kapingkong National High School and utilize her official time throughout the data-gathering procedure.

A formal request was submitted to the Principal of Kapingkong National High School, seeking permission to conduct the study during face-to-face classes. The School Principal was asked to approve using the teacher's official time for teaching, distributing questionnaires, and administering the pretest and posttest to both the control and experimental groups.

The researcher then employs the three (3) different modes of teaching to specific sections of Grade 8. The conventional mode of teaching, with the use of K to 12 books in Mathematics, was utilized. In contrast, mathematics productivity software, such as Software X and Y, was used in the experimental groups. The control group was conducted in the classrooms of Grade 8, and the experimental groups were conducted at the school's ICT laboratories. Learners in experimental Group X used the computers with installed Productivity Software X, and learners in experimental Group Y were provided a laptop with readily installed Productivity Software Y.

The K to 12 Assessment Tool was used to assess the students' academic performance throughout the pretest and posttest or their performances in Mathematics, specifically in graphing (Adapted from DepED, DO 31, s, 2020).

Forms and data were collected, and the findings were analyzed and interpreted. The waterfall graphic illustrated the complexities of the data-gathering procedure.

Data Analysis

Once the study was completed, the collected data were organized, tabulated, analyzed, and interpreted. The following statistical tools were employed to address the research questions outlined in Chapter I. First, mean and standard deviation were used to determine the degree of assessment of the student's pretest and posttest academic achievement in mathematics.

Moreover, using Software X and Software Y, Analysis of Variance (ANOVA) was used to calculate the significant difference between the pretest and posttest results of the control and experimental groups regarding graphing skills and the significant difference between the mean gain scores of the control and experimental groups (Field, 2018).

Results and Discussion

This section presents, analyzes, and interprets the data collected during the study. The study examined the effect of Mathematics Productivity Software (Software X and Software Y) on the graphing skills of Grade 8 mathematics students. The results are presented in the following tables.

Graphing Skills

The level of graphing skills in the pre-test and post-test results are presented in Tables 2 and 3.

Table 2. *Level of Students' Graphing Skills Pre-test Scores*

Groups	N	Mean	SD	Description
Control Group	30	64.17	1.23	Did Not Meet Expectations
Experimental Group X	30	63.97	1.27	Did Not Meet Expectations
Experimental Group Y	30	64.03	1.90	Did Not Meet Expectations
Overall	N=90	64.06	1.47	Did Not Meet Expectations

Table 2 shows the pre-test scores of students' graphing skills across three groups: the control group, Group X, and Group Y.

The results indicate that before the intervention, the students in all groups exhibited similar levels of graphing skills, as reflected in the overall results (M=64.06, SD=1.47), which were all within a narrow range and classified under "Did Not Meet Expectations." The low standard deviations suggest relatively homogenous performance within the control group and Group X, while Group Y exhibited slightly more variability in their pre-test scores.

The consistent pre-test scores across all groups suggest that the students began the study with comparable baseline graphing skills. This uniformity establishes a reliable foundation for evaluating the effect of the Mathematics Productivity Software (Software X and Software Y) during the intervention. The results underscore the necessity for targeted instructional interventions to address deficiencies in graphing skills, as none of the groups met the expected competency level before the intervention.

Gusky (2018) emphasized that pre-tests, though seemingly counter-intuitive, often assess material the instructor has not yet introduced and that students are not expected to know. This approach offers valuable insight into baseline competencies, as reflected in the study, where students across all groups demonstrated low and comparable graphing skills before the intervention.

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Table 3. *Level of Students' Graphing Skills Post-test Scores*

Groups	N	Mean	SD	Description
Control Group	30	80.87	2.33	Satisfactory
Experimental Group X	30	88.50	2.16	Very Satisfactory
Experimental Group Y	30	86.83	1.78	Very Satisfactory
Overall	N=90	85.40	3.86	Very Satisfactory

Table 3 showcases the students' graphing skills post-test scores. Both experimental groups, X (M=88.50, SD=2.16) and Y (M=86.83, SD=1.78), were very satisfactory, while the control group (M=80.87, SD=2.33) remained at a satisfactory level.

Group X achieved the highest mean score, suggesting that Software X had a greater positive effect on students' graphing skills than both the control group and Group Y. Group Y also demonstrated a significant improvement, with results slightly lower than those of Group X. While the control group showed progress, it lagged behind the experimental groups, reflecting the added value of the Mathematics Productivity Software in enhancing graphing skills.

The lower standard deviations for the experimental groups (specifically Group Y) suggest a more homogenous improvement for students exposed to the software who realized more consistent enhancements and that the software's interventions worked for a larger number of students.

The results suggest that Mathematics Productivity Software (Software X and Software Y) improves students' graphing performance compared to instruction methods. The potential for Software X versus the other software may come from unique features or methodologies, which lead to an easy task in which developing graphing competencies is necessary. These results confirm that using technology-based learning tools in Mathematics education as an aid can result in high skill proficiency levels. Furthermore, the significant enhancement noted in the control group implies that targeted instructional efforts can still lead to advancements without the aid of the software, albeit the improvements may not be as significant as when technology-related applications are employed.

The results are consistent with Dahal et al. (2019), who stated that productivity software and programs help students pleasantly see abstract concepts. Schools promote autonomous learning, encouraging students to embrace different opinions and learn at their own pace. Such software can provide an interactive platform compatible with other operating systems, promoting accessibility and engagement in the learning process.

Analysis of Variance (ANOVA) for the Pre-test and Post-test

Tables 4 and 5 show the results of the Analysis of Variance (ANOVA) performed to compare the treatment group's (control, Group X, and Group Y) pre-test and post-test compared to their pre-test and post-test, indicating any significant differences and concluding how effective the Mathematics Productivity Software (Software X and Software Y) can be to students' graphing skills.

Table 4. *ANOVA for Pre-test Scores*

SV	SS	Df	MS	F	P-value	F-crit
Between Groups	0.622	2	0.3111	0.1380	0.8713ns	3.1013
Within Groups	196.1	87	2.2540			
Total	196.7222	89				

ns: Not Significant a = 0.05)

Table 4 shows the Analysis of Variance (ANOVA) results for the pre-test scores of students' graphing skills across the control group, Group X, and Group Y. The obtained F-value = 0.1380 was less than the critical F-value = 3.1013, with a p-value of 0.8713. The above test is done to determine whether or not the difference in the mean pre-test score between the groups is significant. Since the p-value is greater than the significance level (α=0.05), the group mean pre-test score difference is not significant statistically. The ANOVA test showed no significant difference between the pre-test scores of the three groups. The result indicates no significant difference in the graphing skills of the control group, Group X, and Group Y before the intervention. A low F−value further corroborates the low variability between the groups compared to the group variability.

No significant differences in pre-test scores indicate all groups were comparable base levels (Kim & Willson, 2010). The result means that differences between the two groups that you see in the post-test scores must be due to the effects of the intervention and not due to the groups having been disparate in students' graphing skills before the intervention (also known as selection bias). The results bolster the credibility of the research to evaluate the influence of Mathematics Productivity Software on students' graphing abilities.

Table 5. *ANOVA for Post-test Scores*

SV	SS	Df	MS	F	P-value	F crit
Between Groups	966.4667	2	483.23	109.1604	0.0000*	3.1012
Within Groups	385.1333	87	4.43			
Total	1351.6	89				

*: Significant a = 0.05

Table 5 contains the ANOVA results for students' graphing skills post-test scores across the control group, Group X, and Group Y. The

computed F-value = 109.1604 is more substantial than the Fcritical value = 3.1012. The difference between groups' post-test scores is statistically significant since the P-value = 0.0000 is lesser than the significance level (α=0.05). The ANOVA table shows significant differences between the post-test results of the control, group X, and Group Y cohorts. A high F-value shows heightened variance between the group means and relatively smaller variation between the groups, indicating a strong efficacy of the intervention.

Hence, the results indicate that Mathematics Productivity Software (Software X and Software Y) significantly improved students' graphing skills, as evidenced by the experimental groups' higher marks than the control group. Since the difference was statistically significant, it warrants going the extra mile to see which groups the difference shows and how effective the software is.

The large difference between the post-test scores demonstrates the effectiveness of integrating Mathematics Productivity Software in teaching graphing skills. The experiment groups were inclined to perform better, thus justifying the use of technology to boost educational outcomes. This outcome highlights the need to embrace innovative teaching tools to help cultivate skills in Mathematics, particularly regarding graphing concepts.

This study's use of mathematics software aligns with findings by Nongharnpituk et al. The 2023 study obtained findings similar to those of Tan et al. Productivity software gave students the freedom to express creativity and self-discovery. These findings will solidify that embedding Software X and Software Y into mathematics instruction is a best practice for teaching math that engages students in developing and sustaining advanced reasoning skills.

Table 6. *Post-hoc Analysis using Tukey HSD of the Post-test Scores*

Pair	Dif	SE	Q	Lower CI	Upper CI	Critical Mean	p-value
C vs. X	7.6333	0.3841	19.8714	6.3380	8.9287	1.2954	0.0000*
C vs. X	5.9667	0.3841	15.5327	4.6713	7.2620	1.2954	0.0000*
X vs Y	1.6667	0.3841	4.3387	0.3713	2.9620	1.2954	0.0080*

: Significant a = 0.05

The post-hoc analysis results were demonstrated using Tukey's Honest Significant Difference (HSD) test on the post-test scores of students' graphing skills, as shown in Table 6. The comparison highlights the mean differences between the Control Group, Group X, and Group Y, allowing us to understand which group pairs exhibit meaningful differences.

Control Group vs. Group X: Mean difference 7.6333 p-value: 0.0000. The resulting data shows a statistically significant improvement in the graphing skills of students in Group X versus that of the control group. The confidence interval (CI) is between 6.338 and 8.9287, which also helps to explain the large difference. The result suggests that Software X effectively develops students' graphing skills well beyond what can be attained through instruction alone.

Likewise, the Control Group vs Group Y had a mean difference of 5.9667 and a p-value of 0.0000. This outcome indicates that students in =Group Y showed a substantial increase in the acquisition of graphing skills compared to the control group. The CI (4.6713–7.262) further confirms the significance of this difference. This result also indicates that Software Y effectively develops students' graphing skills.

The mean difference between Group X and Group Y is 1.6667 (0.0080). This result shows a statistically significant difference between the performance of both experimental groups and that Group X is better than Group Y. The CI also outlines the smaller but meaningful differences between the software tools. These results imply that, although both instruments successfully improve graphing skills, Software X may offer more instructional advantages or functions that result in better performance.

The post-hocalysis supports the efficacy of Mathematics Productivity Software tools in improving students' graphing ability. Software X performs better than the control group (not exposed to any software) a nd Group Y, suggesting that Software X is most effective. This shows an important implication that Mathematics Productivity Software can be incorporated into teaching with an emphasis on Software X. Furthermore, the findings highlight the need to choose particular tools and approaches that meet students' learning needs to realize their potential for skills development f.

The results corroborate the study of Maksimovic et al. (2018), which pointed out that digital tools such as GeoGebra can positively influence various aspects of students, including motivation, enthusiasm, and self-confidence. They concluded that these types of tools should become standard elements of standard classroom instruction. Such findings highlight the need for thoughtful decisions around instructional tools to fit students' unique learning needs and ensure the best outcomes for building skills.

Mean Gain Scores

In this study, the mean gain is used to assess the effectiveness of the Mathematics Productivity Software in enhancing students' graphing skills. By comparing the mean gain scores of the control and experimental groups, the researcher can determine the extent to which each intervention contributed to students' graphing development. Results are presented in Tables 7 to 9.

The study determined the mean gain for each group to analyze the difference in students' graphing skills between the control group, Group X, and Group Y. The mean gain was calculated as the post-test score minus the pre-test score (Table 7). The control group shows moderate gain in graphing skills with a n a mean gain of 16.7. The variance is 5.45, indicating a fair amount of variance in

students' performance. Group X had the highest mean gain, 24.5, and the highest variance, 6.40, which means the students in the X group improved more and with bigger difference results. Group Y also had a significant gain with a mean gain of 22.8 and a variance of 6.6, showing similar development dynamics. However, they have slightly lower gain in general compared to group X.

Table 7. *Mean Gain Scores of Students in Graphing Skills*

Groups	N	Sum	Mean Gain	Variance
Control Group	30	501	16.7	5.5
Group X	30	736	24.5	6.4
Group Y	30	684	22.8	6.6

The mean gain data reinforces the interventions' efficacy, as Groups X and Y made more gains in their graphing skills than the control group. Group X had the highest average increase, indicating that Software X had a greater effect on students' graphing abilities. Nevertheless, the other groups still significantly outperformed the control group, thus encouraging the beneficial impact of Mathematics Productivity Software on skill development. Both experimental groups also showed similar levels of improvement. Still, Group X displayed a slightly higher variance, suggesting that Software X had a more diverse impact on students. In contrast, Group Y was more stable in the mean gain metric, although with lower total improvement.

Overall, the results showed that Math Productivity Software integrated into classroom learning resulted in the most outstanding outcomes for students in graphing skills. Both Software X and Software Y were effective in helping students improve their skills, but Software X seems to be the more helpful tool. (more than traditional methods) in improving specific skills like graphing. This result is consistent with the findings of Halilovic et al. (2023), who showed that GeoGebra software is easy to use and works well for increasing the visuals of geometric content. The result supports the idea that educational technology can act as a catalyst to enhance students' visualization of and understanding of areas such as mathematics.

Table 8. *Analysis of Variance on the Mean Gain Score of Students*

SV	SS	Df	MS	F	P-value	F crit
Between Groups	1015.756	2	507.880	81.438	0.0000*	3.1012
Within Groups	542.567	87	6.240			
Total	1558.322	89				

: Significant a = 0.05

Table 8 displays ANOVA results for the mean gain scores of students in the control group, Group X, and Group Y. The p-value of 0.0000 is lower than the significance level of 0.05, suggesting significant differences exist among the groups regarding their mean gain scores. The ANOVA results show a significant difference in the mean gain scores between the groups. The high F-value of 81.438 suggests that the variability between the group means is much greater than the variability within the groups, indicating that the interventions of Mathematics Productivity Software substantially affected students' improvement in graphing skills.

It indicates that the differences in the means are likely the result of the intervention rather than chance. Mathematics Productivity Software helps students enhance their graphing skills, as the experimental groups outperformed the control group in the post-test.

Differences in mean gain scores are large, showing that the interventions delivered through Software X and Software Y similarly benefitted students in the graphing domain. The study's results confirm the importance of using these technological tools in the educational process to improve the skills developed in Mathematics. Overall, the study's results suggest that technology-based learning can be a powerful tool for enhancing teaching and learning in the classroom.

The results are from the studies of Kusumah et al. (2020) and Uwurukundo et al. Taylor et al. (2022) describe how using mathematics productivity software during certain geometry lessons improves students' capacity to visualize and examine content. This helps them understand geometry better and feel more positive toward it, which in turn helps them improve their performance.

Table 9. *Post-hoc Analysis using Tukey HSD on the Mean Gain Scores*

Pair	Difference	SE	Q	Lower CI	Upper CI	Critical Mean	p-value
C vs. X	7.8333	0.4559	17.1807	6.2958	9.3708	1.5375	0.0000*
C vs. Y	6.1000	0.4559	13.379	4.5625	7.6375	1.5375	0.0000*
X vs Y	1.7333	0.4559	3.8017	0.1958	3.2708	1.5375	0.0232*

: Significant a = 0.05

Table 9 shows the results of a post hoc analysis using Tukey's Honest Significant Difference (HSD) test on students' mean gain scores. This analysis compares the mean difference gains between the Control Group—Group X and Group Y—identifying statistically significant differences between specific group pairings.

The comparison between the Control Group and Group X revealed a mean difference of 7.8333, with a p-value of 0.0000. The result indicates a statistically significant improvement in the mean gain of students in Group X compared to those in the control group. The confidence interval (CI) ranges from 6.2958 to 9.3708, further validating the difference. The substantial improvement in the mean gain suggests that Software X had a considerable positive impact on students' graphing skills, outperforming the traditional teaching methods employed in the control group. The result highlights the effectiveness of Software X in enhancing graphing skills.

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Similarly, the comparison between the Control Group and Experimental Group Y showed a mean difference of 6.1, with a p-value of 0.0000, indicating a significant improvement in the mean gain of students in Group Y compared to the control group. The confidence interval spans from 4.5625 to 7.6375, reinforcing the validity of the difference observed. This result suggests that Software Y also positively affected students' graphing skills. Although the improvement was significant, it was slightly less pronounced than the effect observed in Group X, indicating that while both software tools were beneficial, Software X is more effective in improving graphing skills.

The comparison between Group X and Group Y showed a mean difference of 1.7333, with a p-value of 0.0232. The result indicates a statistically significant difference between the two experimental groups, with Experimental Group X demonstrating a greater mean gain. The confidence interval, ranging from 0.1958 to 3.2708, further supports this finding. While both software tools significantly improved students' graphing skills, Software X appears to have had a slightly greater impact than Software Y. This suggests that while both tools were effective, there may be certain features or instructional strategies within Software X that contributed to its superior performance, highlighting the potential for further refinement and optimization in the use of educational technology.

The post-hoc analysis confirms earlier results showing that Software X and Software Y significantly enhanced students' graphing proficiency. However, the data show that Software X has a higher effect on the mean gain score of the students than Software Y, and some features or pedagogical approaches need to be more effective than their counterparts in improving students' graphing skills. The result highlights the need to judiciously select and assess the effectiveness of educational technology tools to enhance learning in Mathematics. However, due to the large variations in experimental groups, it demonstrates the capability of software-based learning aids to further student development.

This finding confirms the work done by Carretero, Vuorikari, and Punie (2017), highlighting that the quality of teacher development and its impact tends to be higher when educational software is effectively integrated into the teaching process. This alignment indicates that such tools enhance teaching effectiveness and motivate students to engage in active learning and achieve better academic results. Moreover, it also complements educational software-based learning's student's independence in utilizing technology to improve their knowledge.

Conclusions

The following conclusions are derived from the results of the study:

The pre-test results show that the students in the control group, Group X, and Group Y exhibited similar initial skill sets in graphing, validated by the tendency of their mean scores. There is no significant difference in the pre-test scores among the three groups, confirming that all three groups began with similar levels of graphing abilities before the intervention.

The post-test scores indicated that the Mathematics Productivity Software improves students' graphing abilities. There is a statistically significant difference among the control group, Group X, and Group Y. These findings emphasize the considerable impact of the Mathematics Productivity Software on enhancing students' graphing skills. The greater variability between group means, compared to within-group variability, highlights the effectiveness of the intervention, with the experimental groups significantly outperforming the control group. The post-hoc analysis utilizing Tukey's HSD test affirmed the effectiveness of both Mathematics Productivity Software tools in improving students' graphing skills. Experimental Group X outperformed both the control group and Experimental Group Y, showing significant mean differences.

Software X substantially impacted students' graphing skills, although both tools demonstrated effectiveness. The variance values indicate that the improvements in Experimental Group X were more varied, while Experimental Group Y exhibited more consistent results, albeit with slightly lower overall improvement.

The ANOVA results on the mean gain score confirmed that Mathematics Productivity Software X and Software Y interventions significantly improved students' graphing skills. Both software tools demonstrated positive effects, with Group X showing the greatest improvement in mean gain scores, substantially greater than the control group and Group Y. The results highlight the superior effectiveness of Software X, with a more pronounced impact than Software Y, although both interventions proved beneficial.

In consideration of the aforementioned findings and conclusions, the following recommendations are put forth:

The lack of statistically significant differences among the groups before the intervention suggests that future studies can ensure similar baseline assessments across groups. Additional data can be collected to monitor initial proficiency levels in different skills, ensuring that interventions effectively address all gaps in student knowledge.

 Future educational programs might focus on implementing and enhancing technology-based tools. Educators might consider blending traditional teaching methods with software tools to optimize student engagement and skill development.

Mathematics educators can consider using Software X and Software Y in separate learning environments where they can be directly compared. This would allow them to derive additional insights into which elements of the respective software approaches had the most influence on knowledge attainment.

Since both software tools demonstrated significantly enhanced graphing capabilities, educators may contemplate utilizing Software X and Software Y together. They might consider a blended approach to technology integration, which is regarded as beneficial since it offers diverse learning experiences and outcomes for different individuals.

Future studies can explore how these software tools can be adapted to different learning styles and learner abilities. Software features could be modified to ensure consistent results across a broader range of students.

Since the use of software proved to be effective, it may also be tested in other year levels to determine its broader applicability and effectiveness across different grade levels.

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