



Improving Senior Five Students' Learning of Trigonometry Using Microsoft Excel in Schools of Rwamagana District, Rwanda

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Abstract: In Rwamagana District, Rwanda, students' performance in trigonometry is extremely poor, this is to a great extent attributed to the use of conventional teaching methods. The purpose of this study is to ascertain that Microsoft Excel is used as a learning tool to enhance students' understanding of the concept of trigonometry. The target population was all senior five students enrolled in mathematics related combinations from 32 schools of Rwamagana District, Rwanda. The study used a quasi-experimental design in which 32 students from two schools were selected purposively as a control group and 37 students from two schools were selected purposively as experimental group. The results showed that students who received instruction using Microsoft Excel performed noticeably better than those who received instruction using traditional methods. The post-test mean score for the experimental group was 31.23 ($SD = 3.42$), significantly higher than the control group's score of 24.78 ($SD = 5.15$). This difference was statistically significant ($p = 0.000$). Students who used Excel also performed more consistently and showed a deeper conceptual grasp of trigonometric functions. According to the study's findings, incorporating Microsoft Excel into trigonometry lessons improves students' academic performance. The study recommends mathematics teachers to use Excel as a regular teaching tool and support blended learning strategies.

Keywords: Mathematics, Trigonometry, Microsoft excel, Pre- Post-test, Self-efficacy

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1. Introduction

In the mathematical discipline of trigonometry, angles are measured and their relationships are examined (Adamek, Penkalski, & Valentine, 2005). It is crucial in many fields, including astronomy, physics, and engineering (Masha, Ali, & Abbas, 2023). Additionally, it helps students understand how trigonometric ideas are used in practical mathematical and scientific contexts. However, trigonometry's abstract ideas and complicated formulas

make it difficult for many senior secondary school students (Mokoena, 2021).

Numerous studies conducted in America, Europe and Asia have brought attention to the challenges that students face when learning trigonometry. For instance, a study conducted in Nepal found that students struggled with trigonometry due to misconceptions, challenges, and mistakes (Dhungana, Pant, & Dahal, 2023). Similarly, an American study discovered that students struggled to

comprehend trigonometric concepts (Perez & Nguyen, 2024). According to Australian research, solving word problems involving triangles and trigonometry was one of the most difficult subjects for students (Guo, 2022). Meanwhile, countries like Argentina, Uruguay, and Colombia have made progress in integrating ICT into mathematics education. However, their efforts are frequently hindered by a lack of technology infrastructure and insufficient teacher preparation (Hernández, Torres, Reche, & Costa, 2018).

Teaching trigonometry can be difficult, according to research from all over Africa. When it comes to solving trigonometric problems, Nigerian students struggle with transformation and process skills (Usman & Hussaini, 2017). According to South African research, trigonometry was seen as abstract, difficult, and boring, and students frequently struggled to grasp basic ideas (Odjer, 2017). According to Ghanaian research, students frequently make errors in their process skills and transitions (Mensah & Farouq, 2017). An initiative to improve ICT proficiency in trigonometry education was implemented in Tanzania (Lubuvu, 2024). The objectives of the policy and its actual application, however, were still not aligned, and there were few chances for experiential learning.

Numerous studies carried out in Rwanda have documented similar challenges. For instance, studies carried out in the Burera and Gicumbi districts revealed that pupils found it difficult to illustrate trigonometric functions like $f(x) = \tan x$ (Munyaruhengeri, Umugiraneza, Ndagijimana, & Hakizimana, 2022). Additionally, a study carried out in Kicukiro District found that students lacked knowledge of trigonometric equations, ratios, and word problem solving, and that their understanding of trigonometric concepts was inadequately expressed (Nizeyimana, Mutarutinya, Bimenyimana, & Habumuremyi, 2023). Additionally, a study conducted in the Rwamagana District found that, out of 40 difficult subjects, trigonometry was one of the hardest for secondary school math teachers to teach (Iyamuremye, Nsabayezu, Kwitonda, Habimana, & Mukiza, 2023). In the academic years 2021/2022, 2022/2023, and 2023/2024, trigonometry accounted for 25%, 25.4%, and 28% of the Senior Five national mathematics exams given by National Examination and School Inspection Authority (NESA), respectively. These numbers imply that a major contributing factor to students' generally poor math performance is trigonometry. The abstract nature of the subject, restricted access to technology, low student motivation, unfavorable peer pressure, bad study habits, and insufficient teaching materials were all cited as contributing factors to the challenge.

This study's main focus is on the substantial challenges students face when drawing and analyzing trigonometric function graphs, specifically when it comes to determining the period, domain, range, and parity. The ongoing use of

antiquated teaching techniques like chalk and chalkboards, which have not produced positive outcomes, contributes to this problem even more. As a result, students struggle to comprehend trigonometry, which lowers their performance and decreases their interest in the subject. Furthermore, even though technology presents chances to enhance education, its effectiveness depends on elements like usability, accessibility, and fit for the needs of the local context, all of which the Rwamagana District's current ICT tools haven't always met.

This study intends to investigate whether incorporating Excel into classroom instruction can improve students' understanding of trigonometric graphs, increase their self-efficacy, and ultimately improve learning outcomes by concentrating on a few secondary schools in the Rwamagana District.

The following are research questions guided to conduct this research

1. What is the difference in the performance of senior five students in trigonometry before and after utilization of Microsoft Excel?
2. What self-efficacy beliefs do senior five students demonstrate while solving trigonometric problems during lessons using Microsoft Excel?
3. To what extent does the use of Microsoft Excel affects secondary school students' ability to visualize and interpret trigonometric graphs in secondary schools?

2. Literature Review

This section presents a comprehensive review of literature relevant to the use of Microsoft Excel in teaching and learning trigonometry. It is structured into two main sections: theoretical review and empirical review. The review explores existing knowledge, identifies research gaps, and establishes the foundation for the current study.

2.1 Definition of the Keywords

2.1.1 Trigonometry

Trigonometry is the study of the relationships between triangles' angles and sides, especially those that are right-angled. Because it focuses on measuring and computing triangle attributes, the term "trigonometry" is derived from the Greek words "trigon" (triangle) and "metric" (measure) (Basol, Tal, & Cangulu, 2019). The ratios of a right-angled triangle's sides to one of its angles are expressed by trigonometric functions, such as sine, cosine, and tangent. These functions are crucial for representing periodic events like waves and oscillations in a variety of disciplines, including physics, engineering, computer science, and economics.

2.1.2 Microsoft Excel

Microsoft Excel is a popular spreadsheet application made by Microsoft that is used for data organization, analysis, and visualization. Users can enter, edit, and analyze data, do calculations, and create visual displays like charts and graphs using its grid-based structure of rows and columns (Broman & H. Woo, Data Organization in Spreadsheets Karl, 2018). Excel is a useful tool in a variety of fields, including business, finance, science, and education, because of its extensive feature set.

2.2 Theoretical Review

For this study, two theories were selected: Constructivist Action, Process, Object, and Schema (APOS) theory and socio-historical Activity Theory (AT). In research on mathematics and ICT education, both of these theories are well-known (Tsafe, 2024). Each of these theories is covered separately:

2.2.1 APOS Theory

The APOS theory offers a comprehensive framework for comprehending the formation and learning of mathematical concepts. It highlights the abstractions and mental processes that students acquire while participating in educational activities to understand mathematical concepts (Yue , Huiru , Weina , & Chen , 2023). The fundamental tenet of APOS theory is that all mathematical ideas can be understood in terms of four mental structures: objects, processes, actions, and schemas. According to Longe and Aneshkumar (2023), these cognitive frameworks aid students in comprehending and internalizing mathematical concepts (Longe & Aneshkumar , 2023).

Piaget's constructivist theory is the foundation of APOS theory (Maria, Avenilde, & Asuman, 2019). Piaget thought that the process of reflective abstraction was connected to the development of mathematical understanding (Achmad , 2016). The process through which a student develops mathematical and logical frameworks as part of their cognitive development is known as reflective abstraction (Lulu , St. Budi , Kartono, & Scholastika , 2021).

2.2.2 Activity Theory (AT)

Developed by Engeström in 1987, Activity Theory (AT) expands on Vygotsky's cultural-historical psychology. It implies that children are not born with a blank slate; rather, social and cultural instruments constantly mold and impact their experiences. In addition, people use these tools to change and interact with their surroundings while also changing themselves as a result of using them (Vygotsky, 1978). His theory, which emphasizes the significance of

the historical development of ideas in addition to the active and creative involvement of the mind, is founded on the philosophies of Kant and Hegel (Alfredo , 2019).

As a constructivist theory, APOS focuses more on the mental development of the individual within the system, whereas AT uses the tool-mediated transformation of an activity system as its unit of analysis. The fact that the individual and the Activity System that the two perspectives address are interdependent complex adaptive systems serves as both theories' motivating factor and common point of change, or learning, despite their divergent points of emphasis (Mosese, 2017). The difference between these two viewpoints arises from the identification of learning as either an activity-based process or a process of personal sense-making. These two viewpoints differ in that a sociocultural perspective defines learning as the degree to which an individual engages in social practices, whereas the other views learning as a process of individual sense making or as a process of participation in activity, meaning that students learn as their thought processes change (Rachel & Sarah , 2018).

2.3 Empirical Review

This section provides a review of the literature relevant to the study, aligned with the stated problem: Improving Senior Five Students' Learning of Trigonometry Using Microsoft excel in Schools of Rwamagana District, Rwanda.

For this purpose, this section was structured into four main subsections:

- The concept of trigonometry in mathematics;
- The application of Microsoft Excel in teaching and learning mathematics
- The role of Microsoft Excel in teaching and learning trigonometry.

2.3.1 The concept of trigonometry in mathematics

One of the topics covered in the mathematics curriculum is trigonometry, which presents many difficulties for students to learn (Tara & Abatar, 2021). Trigonometry itself and the various teaching strategies employed in classrooms have received little attention, despite the subject's importance in the mathematics curriculum and the difficulties students encounter with it (Annatoria , Sethembiso , & Deonarain ,2019). There has been little attention paid to trigonometry and the various approaches taken to teaching it in classrooms, despite the subject's importance in the mathematics curriculum and the difficulties students encounter when learning it (Erica , 2021). The intricacy resulting from the interdependence of its contexts might be a factor in the paucity of research on this subject. Furthermore, the lack of studies may also be explained by

the variety of ways the domain is represented (Nathaniel , 2023). Nathaniel (2023) suggests that the lack of research on trigonometric functions may be due to the fact that different school curricula present these functions in different ways.

2.3.2 The application of Microsoft Excel in teaching and learning mathematics

Ensuring that every student attains positive results is one of the main objectives of mathematics education. In the educational system, mathematics is regarded as one of the most difficult and troublesome subjects (Munyaruhengeri, Umugiraneza, Ndagijimana, & Hakizimana, 2022). However, considering that mathematical knowledge and abilities are crucial in daily life and that there are numerous mathematical applications in other subjects and sciences, it is also one of the most significant and fulfilling fields of science (Pranshi, 2021). These factors make mathematics a subject that merits careful consideration. Engaging with mathematical concepts is a challenge for many students. Students must actively engage with the concepts or objects being studied, whether they are concrete or abstract, in order for learning to occur (Catherine & Kathryn, 2022). Students who use Microsoft Excel are better able to understand mathematics as reasoning, exploring, discovering, solving problems, creating new information, and posing new questions rather than just as a collection of procedures (Marie & Darin, 2018).

2.3.3 The role of Microsoft Excel in teaching and learning trigonometry

Compared to other areas of mathematics education, there hasn't been as much research done on trigonometry instruction and learning, whether or not Microsoft Excel is used (Srdjan & Predrag , 2023). Furthermore, Annatoria (2023) observes that trigonometry and the different ways it has been taught in the classroom have received little attention (Annatoria , Sethembiso , & Deonarain, 2023).

Studies that used Microsoft Excel, albeit sparingly, to teach trigonometry have shown that it significantly improves student achievement (Martin , Aceng , Rosalina , & Padillah , 2019). Even though research indicates that using Microsoft Excel improves students' learning and performance, there is little evidence that the program may have an impact on students' capacity to connect various representations and contexts of trigonometry functions, despite the fact that this is a basic and essential skill for learning the subject (Tara & Abatar, 2021). Future research should look at how preservice teachers select the lessons to teach and how they practice teaching, as the lessons they choose to conduct during their teaching practicum have not been studied (Gila, 2021). Trigonometry was selected for this study as one of the most frequently studied subjects in Rwandan secondary schools.

3. Methodology

3.1 Research Design and Study Setting

The study's blueprint is displayed in Figure 1, and a non-equivalent group with a pre-post-test and quasi-experimental design (Zeynab , et al., 2022) was selected. This kind of assessment aimed to ascertain whether a particular intervention had an impact on the result, or if a program or intervention had the desired causal effect on program participants (Creswell, 2014). Because they were not randomized, the two groups were not equivalent (Ines , 2016). The researcher compared the pretest and posttest results between the two groups to determine whether Microsoft Excel was more effective than traditional teaching methods in improving students' understanding of trigonometry. Senior Five students from four classes were divided into two groups with two classes each: the control group and the treatment group. The control group received trigonometry instruction using traditional methods, while the treatment group received instruction using Microsoft Excel.

The blue print

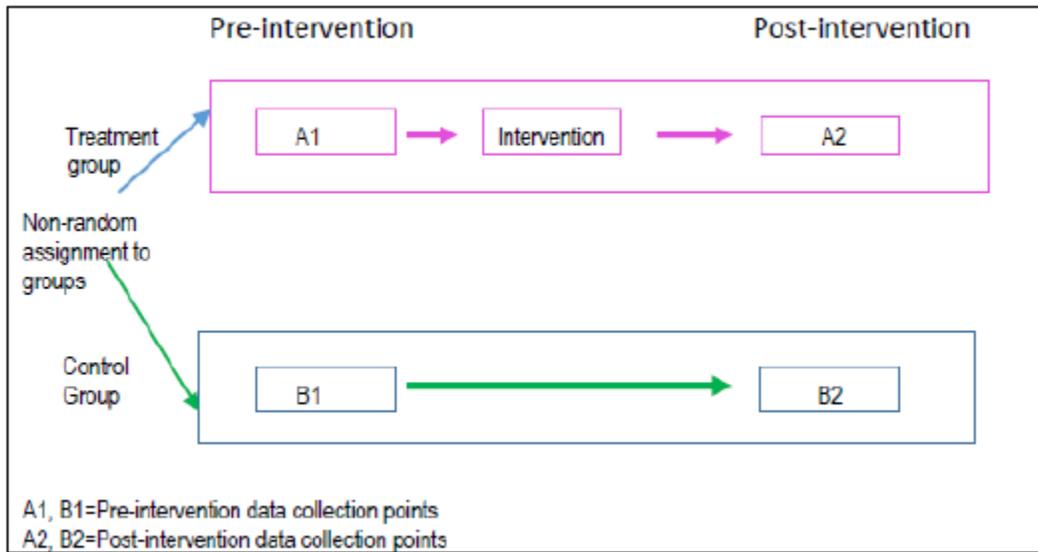


Figure 1: Blue-print of the quasi-experimental design (Adapted from: MLE, 2013)

3.2 Population, Sample and Sampling Procedures

The target population were 32 schools, which included 931 students enrolled in combinations related to mathematics.

69 Senior Five students from four classes in four-day schools in the Rwamagana District that offered combinations related to mathematics made up the sample size for this study. The study's participants were selected using purposive sampling where 37 students were in control group and 32 students were in experimental group.

Table 1: Sampled participants

GROUPS		SCHOOLS	Combination	Total	Percentage
Control Group	A		MEG	20	28.98550725
	B		MPG	17	24.63768116
	C		MCE	16	23.1884058
Experimental Group	D		MPC	16	23.1884058
Total				69	100

MEG: Mathematics, Economics and Geography

MPG: Mathematics, Physics and Geography

MPC: Mathematics, Physics and Computer Sciences

3.3 Data Analysis Procedures

The types of data collected such as questionnaires, observations, post-tests, and pre-tests, were taken into consideration when creating the analysis. Post-tests and pretests were analyzed using t-test while questionnaire and observational checklist were analyzed through the use of descriptive statistics.

3.4 Validity and Reliability Issues

After developing the test items, the researchers consulted an expert to guarantee the validity of the instrument. In order to confirm that the items assessed the intended

structures accurately, this step was crucial. For reliability, a pilot study was carried out. Two schools in the Nyamasheke District, which is educationally comparable to the Rwamagana District, participated in a pilot study that was not included in the main study's sample. There were 78 students in the pilot study overall, 40 in the control groups and 38 in the experimental groups. While the control group received instruction using conventional teaching techniques, the experimental groups received instruction primarily organized using Microsoft Excel software. Because their school had computers, the computer (experimental) group was selected. The Cronbach alpha formula was utilized to examine participant scores from the pilot trial, particularly for the

last section of the instrument. With a reliability coefficient of 0.816, the instrument's items were found to be highly reliable.

Cronbach's Alpha	N of Items
.816	18

Figure 1. The reliability of the questionnaire

4. Results and Discussions

This section presents the analysis and interpretation of data collected from the 69 students in four (4) sampled schools, categorized into two groups: Experimental and control. The analysis is structured around the research objectives and questions, using both quantitative and qualitative data.

4.1 Demographical Presentation of the Respondents

The demographic details of the study participants from the four secondary schools in the Rwamagana District that were chosen are shown in this section. Understanding these attributes offers crucial background for analyzing the research results, specifically concerning the efficiency of Microsoft Excel in enhancing students' trigonometry education.

4.1.1 Gender Distribution of the Respondents

A total of 69 respondents were selected from four secondary schools of Rwamagana District.

Table 1: Gender of respondent

GROUPS		SCHOOLS	Male	Female
Control Group		A	9	11
		B	8	9
Experimental Group		C	5	11
		D	6	10
Total			28	41
Percentage (%)			40.57971014	59.42029

Table 2 illustrates the percentage of gender based participants in the study. The study used 28 (40.58%) male and 42 (59.42%) female.

4.1.2 Academic Background of the Respondents

Table 2: Academic background of respondents (Mathematics combinations)

GROUPS	SCHOOLS	Combination	Total	Percentage
Control Group	A	MEG	20	28.98550725
	B	MPG	17	24.63768116
	C	MCE	16	23.1884058
Experimental Group	D	MPC	16	23.1884058
Total			69	100

The respondents are presented in the table 3 according to the percentage of the respondents who attended the study and it includes 20 (28.98%) of MEG, 17 (24.63%) of MPG and 46.37% (83) of MCE.

4.1.3 Results of the Performance in the Achievement tests

To determine whether there was a statistically significant difference between the experimental group's and the

control group's test scores, Tables 4 and 5 provide both descriptive and inferential statistics tables.

Table 4: Groups mean achievement scores in the post-test of both the control and experimental groups

	Post-test	N	Mean	Std. Deviation	Std. Error Mean
Post-test	Control	37	24.7838	5.14854	.84642
	Experimental	32	31.2344	3.42426	.60533

As shown in the table 4, the mean score for the experimental group was 31.23 (SD=3.42), significantly higher than the mean score for the control group, which was 24.78 (SD=5.15), this implies that students in the experimental group outperformed those in the control group on the test, supporting the idea that using Microsoft Excel improved their comprehension of trigonometric functions (Lupahla, 2020). Furthermore, the experimental

group's lower standard deviation indicates more consistent student performance, while the control group's higher score variability denotes inconsistent learning consequences. According to Cardona and Ana (2024), these results corroborate previous studies that show how technology-assisted learning resources can enhance student comprehension and reduce performance gaps.

Table 5: t-test analyses of the students' achievement in the test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Interval Difference Lower	Confidence of the Upper
Post-test	Equal variances assumed	4.773	.032	-6.025	67	.000	-6.45059	1.07061	-8.58753	-4.31365
	Equal variances not assumed			-6.199	63.080	.000	-6.45059	1.04060	-8.53001	-4.37118

The statistical significance of the variation in post-test scores is further supported by the results of the independent samples t-test. The findings show that the observed difference between the two groups is unlikely to be the result of chance, with a p-value of 0.000. This is consistent with research showing how digital tools promote active learning and improve mathematical performance, such as spreadsheet applications (Elizabeth & Guillermo, 2022). Additionally, the significant variation between groups, as shown by Levene's test (F = 4.773, p = 0.032), raises the possibility that Excel's structured method of graphing trigonometric functions helped to minimize learning discrepancies by promoting a more consistent learning environment.

Multiple studies support the conclusions of this research, highlighting the positive impact of technology on mathematics instruction. The digital tools such as Excel facilitate dynamic visualization of mathematical concepts, fostering a deeper understanding (Mary, et al., 2023). Likewise, Spreadsheet technology enhances analytical skills by allowing students to manipulate data and observe immediate changes in mathematical graphs. The interactive exploration of trigonometric function transformations may have played a role in the improved performance of the experimental group (Jack & Philip, 2019).

4.1.4 Frequency Distribution of the Students' Self-Efficacy Beliefs in Learning Trigonometry

Table 6: Frequency distribution of Students' self-efficacy beliefs in learning trigonometry

	N	Mean	Std. Deviation	Remarks
I enjoyed learning trigonometry using Microsoft Excel	30	4.63	.556	Strongly Agree
I found trigonometry to be more interesting when I learned it using Excel.	30	4.00	1.050	Agree
Using Excel in trigonometry made the lessons more interactive and interesting	30	4.23	.817	Agree
Excel has increased my motivation to learn trigonometry.	30	4.17	.950	Agree
Beyond trigonometry, I would like to utilize Excel for other mathematics topics.	30	3.63	1.474	Agree
Learning trigonometric graphs felt more applicable to real-world situations due to Excel.	30	3.80	1.031	Agree
Using Excel to solve trigonometric issues gave me a sense of success.	30	3.77	1.073	Agree
My understanding of trigonometric functions has improved by using Excel.	30	4.10	.923	Agree
After utilizing Excel, my confidence in my trigonometric abilities has increased.	30	4.07	.691	Agree
Due to Excel, I can see trigonometric graphs more readily.	30	4.50	.630	Strongly Agree
I think Excel made complex trigonometric ideas easier to understand.	30	3.77	1.006	Agree
Solving trigonometric problems on my own was considerably simpler by using Excel.	30	4.17	.913	Agree
I feel more at ease using Excel to read and analyze trigonometric graphs.	30	3.63	.928	Agree
Compared to more conventional approaches, Excel helped me remember more trigonometric facts.	30	4.07	.740	Agree
Excel helped me practice trigonometric computations.	30	4.43	.679	Agree
Using Excel makes it easier for me to locate and address my trigonometric errors.	30	4.43	.679	Agree
Plotting trigonometric graphs in Excel enhanced my general mathematical abilities.	30	4.37	.718	Agree
I am able to do trigonometric exercises more precisely due to Excel.	30	4.17	.747	Agree
Overall mean		4.11		Agree

The results indicate that students generally agreed that using Microsoft Excel enhanced their learning experience, as reflected in the overall mean score of 4.11. The highest-rated statement was "I enjoyed learning trigonometry using Microsoft Excel" ($M = 4.63$, $SD = 0.556$), followed by "Due to Excel, I can see trigonometric graphs more readily" ($M = 4.50$, $SD = 0.630$). These findings align with previous studies that have highlighted the effectiveness of technology-enhanced learning environments in improving

students' engagement and interest in mathematics (Caitríona, Eabhna, & Ciarán, 2023).

Several students agreed that Excel made trigonometry lessons more interactive ($M = 4.23$, $SD = 0.817$), increased their motivation to learn ($M = 4.17$, $SD = 0.950$), and helped them practice computations ($M = 4.43$, $SD = 0.679$). These findings are consistent with research which found that integrating digital tools into mathematics

instruction can foster active learning and promote a deeper conceptual understanding (Andrada & Cristian, 2024).

Furthermore, students reported that using Excel increased their confidence in their trigonometric abilities ($M = 4.07$, $SD = 0.691$). This observation is supported by the research which argued that technology-based learning tools help reduce students' anxiety and build confidence in solving mathematical problems (Zara, 2024). The use of Excel provided a structured approach to visualizing and

analyzing trigonometric functions, which likely contributed to students' improved self-efficacy.

The findings also reveal that students found Excel beneficial for identifying and addressing their errors ($M = 4.43$, $SD = 0.679$), as well as for improving their general mathematical abilities ($M = 4.37$, $SD = 0.718$). Technology-assisted learning tools such as Excel can enhance students' ability to recognize patterns, make corrections, and refine their mathematical thinking (Chunming, 2020).

4.1.5 Observational Analysis of Students' Interaction with Microsoft Excel

Table 7: Frequency distribution of the observation checklist of Students' Interaction with Microsoft Excel

	N	Mean	Std. Deviation	Remarks
The extent of involvement in graphing activities				
The student actively engages in exercises centered on graphing trigonometric functions using Excel.	5	4.20	.447	Often
The student participates in the conversation on graphing and deciphering the trigonometric functions' shapes.	5	4.20	.447	Often
The student queries or looks for clarification on graphing methods and graph interpretation.	5	4.20	.447	Often
Throughout the class, the student maintains attention on assignments utilizing Excel and graphing.	5	4.60	.894	Always
Understanding of Graphical Representations				
The student correctly deciphers Excel-created trigonometric function graphs.	5	4.20	1.304	Often
The student recognizes the graphs' salient characteristics, including phase changes, amplitude, and period.	5	4.60	.894	Always
The student is able to describe how the graphical representation and the algebraic equation relate to one another.	5	4.60	.894	Always
Students can experiment with various graphical aspects by using Excel functions (such as changing graph settings or axes).	5	4.20	1.304	Often
Engagement with Excel for Visualizing Graphs				
The student successfully creates and edits graphs of trigonometric functions using Excel.	5	4.20	1.304	Often
To improve their comprehension of graph characteristics, students practice using Excel's graphing capabilities.	5	4.60	.894	Always
By playing with color, line styles, and chart elements, the student exhibits creativity in visualizing the graphs.	5	4.00	1.581	Often
The student shows interest in the results of adjusting the Excel graphing tool's parameters.	5	4.20	.447	Often
Ability to Interpret Graphs				
Student uses Excel effectively to create and modify graphs of trigonometric functions	5	4.00	1.581	Often
Student experiments with Excel's graphing tools to enhance their understanding of graph properties.	5	4.00	1.581	Often
Student demonstrates creativity in visualizing the graphs, such as experimenting with color, line styles, or chart features.	5	4.00	1.581	Often

Student demonstrates curiosity about the effects of changing parameters in the Excel graphing tool.	5	4.00	1.581	Often
Attitude Toward Graphing				
The student has a favorable attitude toward graphing trigonometric functions in Excel.	5	4.60	.894	Always
The student actively explores Excel tools and asks for help when necessary.	5	4.60	.894	Always
The student actively participates in peer conversions about Excel and interpretation.	5	4.60	.894	Always
When faced with difficulties in Excel graphing assignments, the student demonstrates perseverance and concentration.	5	4.60	.894	Always
Overall mean		4.31		Often

The observational analysis presented in Table 7 highlights students' interaction with Microsoft Excel during the graphing of trigonometric functions. The findings indicate that students are highly involved with Excel, as evidenced by mean scores ranging from 4.00 to 4.60 across various aspects of graphing, with an overall mean of 4.31, suggesting frequent involvement. These results align with research by Mary , et al. (2023), which emphasizes the role of dynamic graphing tools like Excel in fostering student engagement and conceptual understanding in mathematics.

Students demonstrated a strong ability to maintain focus on graphing tasks (mean = 4.60, always), suggesting that Excel's interactive features contribute to sustained attention. This is consistent with the findings of Cirneanu and Moldoveanu (2024), who argue that digital tools in mathematics classrooms enhance student concentration by providing real-time visualization and immediate feedback. Additionally, the high mean score (4.60, always) for students' ability to connect graphical representations with algebraic equations supports research by Koyunkaya (2016), which found that technology-assisted learning improves students' ability to bridge abstract mathematical concepts with their visual representations.

Creativity and curiosity in graphing activities were also evident, as students frequently experimented with Excel's graph settings, colors, and line styles (mean = 4.00 to 4.20, often). This aligns with research by Hidajat, et al. (2023), which highlights how digital tools encourage exploration and creative problem-solving in mathematical tasks. Moreover, the students' positive attitude towards using Excel (mean = 4.60, always) echoes the findings of Boadu and Boateng (2024), who noted that technology integration in mathematics enhances students' motivation and willingness to engage in learning activities.

5. Conclusion and Recommendations

5.1 Conclusion

The use of Microsoft Excls encouraged the students to explore the effects of certain inputs on the trigonometry. In this way students became creatively and actively involved in solving trigonometry tasks by plotting and transforming graphs, determining properties of trigonometry, and connecting various representations of trigonometry. This encouraged peer to peer interaction and students were seen to participate more in the classroom.

The aim of the study was to investigate the effectiveness of the use of Microsoft excel in the teaching and learning of trigonometry functions. The results of the investigation indicate that the use of Microsoft Excel enhances students' understanding of trigonometric graphs, improves their performance, fosters confidence and motivation, and facilitates active participation in the learning process.

5.2 Recommendations

Based on the study findings, the following recommendations are proposed:

1. Schools and teachers should adopt Microsoft Excel as a regular instructional tool in teaching trigonometric graphs.
2. Teachers should integrate Microsoft excel as a medium for encouraging student-centered learning approaches and inquiry-based tasks.
3. Teachers should use a blended approach, combining Excel with traditional teaching methods, to accommodate diverse learning styles and ensure better comprehension and retention.

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