



## Teaching Calculus Through GeoGebra and Microsoft Mathematics Software in Determining Students' Interest

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### Abstract

This study examines the teaching of calculus using GeoGebra and Microsoft mathematics software in determining students' interest. Two research questions and two null hypotheses were posed in carrying the study, and tested at 0.05 level of significance. Factorial design was used. Intact classes of one hundred and sixty (160) students of SSS3 mathematics were purposively used in Idah Education Zone areas of Kogi State as the sample. The classes were randomly assigned to experimental group 1 (Microsoft mathematics) and experimental group 2 (GeoGebra). Calculus Interest Scale (CIS) instrument was used for data collection. Using Cronbach alpha, 0.82 reliability index was obtained for CIS. The data collected were analyzed using descriptive statistics of mean and standard deviation to answer research questions and the null hypotheses were tested using Covariance Analysis (ANCOVA). The results of this study revealed that Microsoft mathematics software have significant mean ratings of students' interest in calculus. Based on the analysis, it was recommended that mathematics teachers utilize GeoGebra and Microsoft mathematics software in their classes to facilitate and sustain students' interest in calculus.

**Keywords:** GeoGebra, Microsoft mathematics software, interest and calculus

### Introductions

Integration of technology into mathematics instruction has become an essential strategy for enhancing students' engagement and learning experiences. Calculus, often regarded as an abstract and challenging branch of mathematics, requires innovative teaching approaches that can simplify complex concepts and sustain students' interest. This study, therefore, explores the use of GeoGebra and Microsoft Mathematics software in teaching calculus to determine their effectiveness in fostering students' interest in the subject. By leveraging the interactive and visual capabilities of these technological tools, the study aims to provide insights into how digital resources can transform the traditional mathematics classroom into a more engaging and student-centered learning environment. The teaching of calculus has often been regarded as problematic. Its pedagogical challenges are perhaps not surprising on the basis that it is an abstract concept in the history of mathematics. Ketelhut (2019) argues that many materials and methodological approaches used by teachers continue to be the same in the middle of the 21st century and this fact

will not prepare the students to engage properly in the contemporary world. According to Oliveira, Henriques and Gutiérrez-Fallas (2018) observed that it is important that teachers' professional development courses provide mathematics teachers with opportunities to incorporate information and communication technology (ICT) such as GeoGebra and Microsoft mathematics software in teaching and learning processes, especially on topics that are abstract in nature in order to capture and sustain students' interest. In the same view, Cejas-Léon and Navío-Gómez (2020) stated that contemporary teachers cannot be limited to learning only technical abilities on the operation of available digital tools as innovative strategy for teaching instead, they should get use to continuous application of software, thereby providing abilities to follow the changes in teaching, since ICT is important to meet up with the demands of 21<sup>st</sup> century, of which the use of software is not exceptional for constantly renewing the modern era where technology usage is a tradition of the generation for integrating the teaching and learning to catch up and satisfy students' interest. According to Mishra



(2019) planning and applying distinct instructional strategies using software require awareness on the part students' and teachers' roles towards the subject matter, and the technology. Realizing the relevance of technology of which GeoGebra and Microsoft mathematics software is inclusive as a necessary knowledge for mathematics teachers who work with technology demands figuring out ways to engage mathematics students in activities that sustains interest when integrating technology with mathematical concepts using pedagogical strategies (Oliveira, Henriques & Gutiérrez-Fallas (2018). In support of this view, Weinhandl, Lavicza, and Houghton (2020) emphasized that one of the alternatives to enrich the teachers' teaching proficiency consists of sharing knowledge and materials with their peers, and online software which enable students exchange ideals through interactions with software, especially in the face of the unique context of the year 2020 challenges characterized by social distancing due to the pandemic COVID-19, it is extremely important to apply technology such as GeoGebra and Microsoft mathematics software for pedagogical practices as a strategy.

Microsoft mathematics software is one of the free software for teachers made by Microsoft Corporation that can be applied in mathematics teaching and learning. According to Microsoft Corporation (2016), using Microsoft Mathematics can help students both in visualizing and understanding the mathematics concepts and problems solving. Microsoft Mathematics program is a free programming that has a representative processing framework and work dependently on scientific articulations. More specifically, the use of Microsoft mathematics software in classroom teaching can improve 'spatial mental picture skills', 'critical thinking ability' and 'understanding of associations among graphical, tabular, numerical and algebraic functions. Philip, Opoku, and Sampson (2016) stated that there is a better relationship between algebraic and graphical representations with Microsoft mathematics, and that students using Microsoft mathematics are more likely to achieve higher when used as a supplementary instructional strategy to capture students' attention in learning mathematics.

GeoGebra software, combines dynamic geometry, algebra, calculus and spreadsheet characteristics (which other packages treat individually) into a single easy-to-use package; GeoGebra has a big global user and developer

community with customers. According to Ogwel (2009) the GeoGebra software elements that allow users to have more benefits compared to others, which follows: Menus: File; Edit; View; Options; Window; Help. Tools: Move; Points; Lines; Loc/Construction Polygons; Circles and Circular Arcs; Conics; Measures; Transformation Slider; Visibility; Toolbar Help. View: Graphic / Geometry View; Default View; and Drawing Pad for geometric objects. Algebra View: Gives algebraic object representation.

Interest of students is one of the inner variables influencing the teaching and learning of students in mathematics. Interest is always about desires or necessities, which is essential to create certain conditions for students to need and want to study at all times (Frenzel, Goetz & Pekrun, 2010). Interest is essential in terms of studying mathematics. It is also probable that someone with high interest will have elevated motivation. That is, the higher the interest to learn, the more positive students' interest toward mathematics will be. Students who are interested in their learning activities are likely to report high competence beliefs, high achievement levels and choose high school courses that are related to their interests (Watt, Shapka, Morris, Durik, Keating, & Eccles, 2012). Furthermore, the authors maintained that the great importance of students' interest for their learning processes is highly problematic and such that interest substantially declines during secondary school. This decline occurs particularly in mathematics (Watt, 2010). There are two categories of interest, namely situational interest and personal interest. Situation interest is an interest that is generated in the setting primarily by a set of circumstances or concrete objects such as GeoGebra and Microsoft mathematics software. Personal interest is a long-term interest in a subject or activity (Arthur, Oduro & Boadi, 2014). The advantages of having a situational interest are such that students will focus more on operations or learning activities to be able to learn and work on a long-term basis, use suitable teaching strategies, and enjoy what they do to accomplish challenges even in the face of gender differences.

Research consistently shows that gender differences influence students' interest and performance in mathematics. From an early age, females tend to show less interest in mathematics compared to males. Buckley and Sarah (2016) reported that male students in senior secondary classes performed better in science and mathematics than their



female counterparts, and Colleen and Sarah (2016) noted that gender differences in interest are greater than actual differences in achievement. As mathematical content becomes more complex, these variations contribute to a widening gender gap. Mehmet (2017) investigated the role of Microsoft Mathematics software in promoting students' interest, knowledge transfer, and understanding of complex function graphs. Using a sample of 20 students from seven college calculus classes, the study employed a survey design, interviews, and t-test analysis. Results revealed that Microsoft Mathematics significantly aided problem solving, though students' attitudes did not influence task performance. However, the small sample size limited the generalizability of the findings, highlighting a gap that the current study addresses by using intact classes and a larger, more representative sample. Similarly, Onaifoh and Ekwueme (2017) explored the use of GeoGebra software in teaching plane geometry in Delta State secondary schools through a quasi-experimental design. Their findings showed a significant improvement in students' achievement when GeoGebra was used compared to traditional methods, though no significant gender difference was observed. They recommended that schools provide adequate access to mathematics software like GeoGebra to enhance students' learning experiences.

In the teaching and learning of mathematics, calculus remains a vital component that equips students with essential skills for data interpretation, decision-making, and problem-solving in real-life contexts. Despite its importance, many senior secondary school students continue to show low interest and poor achievement in statistics, often due to abstract teaching methods and limited use of instructional technology. Emaikwu, Iji, and Abari (2015) explored the impact of Geogebra on the interest and achievement of senior high school students in statistics in Benue State's Makurdi Local Government Area. The study's aim was to determine GeoGebra's impact on the interest and achievement of students in statistics. The study population was all 2,412 senior high school (SS1) students in the 18 government co-educational secondary schools in Makurdi Benue State Local Government Area (BSTSB, 2010). The sample for this study was 242 out of 2,412 students using Multistage sampling technique. The study's design was a quasi-experimental design. Two tools, namely Statistics Achievement Test (SAT) and Statistics Interest Inventory (SII), have been created for

information collection. The reliability of Cronbach Alpha Coefficient of 0.71 was acquired. Five study issues were used, along with six hypotheses. To answer the study questions, the mean and standard deviation was used. Hypotheses were tested using Covariance Analysis (ANCOVA). Results of the study revealed that students taught statistics using the Geogebra teaching method achieved higher and also showed greater interest in learning statistics than those taught with conventional teaching approach. The study also discovered that both male and female students in experimental group achieved the same and also showed similar interest in calculus.

Teaching calculus conventionally has become merely list of procedures to follow and results only in practicing usual way of solving algebraic systems as such students get frustrated easily over the system required in calculus due to their expectation of a lengthy algebraic solution to problems which is common in calculus. Mathematics teachers only focus more on the procedures rather than understanding of the underlying concepts of calculus. Some researchers blamed and attributed poor interest in calculus to be the traditional approach which fails to help students understand the basic concepts of calculus, contrary studies reported that curriculum on calculus should be improved by focusing on the conceptual understanding of calculus. Therefore, the need for carefully applying software that supports visualization and visual thinking for improving interest in calculus become pertinent through some software packages like GeoGebra and Microsoft mathematics software. These software has been variously reported to be effective on statistics by some researchers; nevertheless, can GeoGebra and Microsoft mathematics software be effective for better understanding of calculus?

### Research Questions

1. What are the mean interest ratings scores of students taught calculus using GeoGebra software and those taught using Microsoft mathematics software?
2. What are the differences in the mean interest ratings scores of male and female students taught calculus using GeoGebra software and those taught using Microsoft mathematics software?

### Hypotheses

**H0<sub>1</sub>:** There is no significant difference in the mean interest ratings of senior secondary school

students taught calculus using Microsoft mathematics software and those taught using GeoGebra software

**H02:** The mean interest ratings scores of male and female students in calculus do not differ significantly using Microsoft mathematics software and those taught using GeoGebra software

### Methodology

The design for this study is the design of factorial studies. Factorial designs are a quasi-experimental method in which various factors (autonomous variables controlled by the researcher) are manipulated or permitted to differ and provide two major benefits to researcher. First, they enable researcher to concurrently examine the primary impacts of two or more autonomous factors. GeoGebra software ( $x_1$ ) and Microsoft mathematics software ( $x_2$ ), while gender as the moderating variable at two levels: Male ( $y_1$ ) and Female ( $y_2$ ). This research was carried out in Idah Education Zone area of Kogi State. This study is important in this area due to persistent poor performance of students from WAEC chief examiner's report 2023, and 2024. The population is 700 SSS3 mathematics students (425 male and 275 female) for the 2023/2024 academic session. Purposive sampling was used to sample two intact classes of 160 SSS3 mathematics students were used. This was done because many schools have little or no workable and good number of computers. GeoGebra Group and Microsoft mathematics Groups were assigned by using simple random sampling (tossing of coins). Mathematics teachers teaching SSS3 students in the schools were trained by the researcher for four days before the study began. After the training, calculus interest scale (CIS) pre-CIS was administered. The purpose of the training was to enable the mathematics of the schools that taught the students understand GeoGebra and Microsoft mathematics software tutorial. At the end of the fourth week after the treatment, post-CIS were administered at the same time. Calculus Interest Scale (CIS) is the instrument for data collection. The researcher developed the Calculus Interest Scale for the study. The Calculus Interest Scale (CIS) contained two (2) parts A and B. Section A contain students demographic information that react to the instrument. B contained data on the interest of students in learning calculus using mathematics software. The CIS is made up of 30 items. The items were structured response type which was

used to measure the rate of students' interest in using mathematics software to learn calculus. The instrument is a 4 points scale of Strongly Agree (SA) - 4 points; Agree (A) - 3 points; Disagree (D) - 2 points; and strongly Disagree (SD) - 1 point. The CIS is a modified likert-type scale developed by the researchers. A total of 30 item statements (18 positively cued and 12 negatively cued) were developed. Students expressed rate of agreement or disagreement with each of the interest items statement by a tick ( $\checkmark$ ) in the appropriate column. The instrument is a 4 points scale of Strongly Agree (SA) - 4 points; Agree (A) - 3 points; Disagree (D) - 2 points; and strongly Disagree (SD) - 1 point. To determine the construct validity of the CIS instrument, factor analysis was carried out as follows; the modified CIS of forty-five (45) items on students' interest in using GeoGebra and Microsoft mathematics software were subjected to factorial validation for construct validity using factor analysis. From the result of the factor analysis, items with loading of 0.35 and above were accepted as valid (Factorially pure, FP, 30 items), but items with factor loadings of less than 0.35 (Factorially impure, FI, 11 items), and items which loaded up to 0.35 in more than one factors (Factorially complex, FC 4, items) were rejected based on Meredith (1969) recommendation that a loading of 0.35 should be accepted as the minimum factor loading for accepting any item. Thirty copies of the instrument were administered to SSS3 students in Ankpa local Government in order to establish the reliability of the CIS tool. The data collected was subjected to analysis and a reliability coefficient of 0.82 was obtained using Cronbach Alpha. The data collected was analyzed using descriptive statistics of mean and standard deviation to answer the research questions, while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05% level of significance. If  $F_{\text{calculated}} > F_{\text{critical}}$   $F_{\text{calculated}} > F_{\text{critical}}$   $F_{\text{calculated}} > F_{\text{critical}}$ : Reject  $H_0 \rightarrow$  There is a significant difference among the group means.  $F_{\text{calculated}} \leq F_{\text{critical}}$   $F_{\text{calculated}} \leq F_{\text{critical}}$   $F_{\text{calculated}} \leq F_{\text{critical}}$ : Fail to reject  $H_0 \rightarrow$  There is no significant difference among the group means.

## Results

**Table 1: The mean interest ratings for students taught by GeoGebra software and Microsoft math software**

Software	N	Pre-CIS		Post-CIS		Mean gain
		$\bar{x}$	SD	$\bar{x}$	SD	
GeoGebra Software	75	51.43	18.96	68.43	11.09	27.00
MS Maths Software	85	54.65	16.52	57.63	12.89	40.99

Result in Table 1 shows that the group taught calculus using GeoGebra software got a pre-CIS interest mean ratings scores of 51.43 with a standard deviation of 18.96 and a post-CIS interest mean ratings scores of 68.43 with a standard deviation of 11.09. The difference between the pre-CIS and post-CIS interest mean scores for the group taught using GeoGebra software was 27.00. It shown that the Group that was taught calculus using Microsoft mathematics software had a pre-CIS mean score interest ratings of 54.65,

with a standard deviation 16.52 and post-CIS means scores interest ratings of 57.63 with standard deviation of 12.89. The difference between the pre-CIS and post-CIS interest mean scores for the group taught using Microsoft mathematics software was 40.99. The research result demonstrates that the post-CIS interest mean scores for each class were higher than the pre-CIS interest mean scores for the class instructed using Microsoft mathematics technology with a higher interest mean benefit.

## Hypothesis one

$H_{01}$ : There is no significant difference in the mean interest ratings of senior secondary school students taught calculus using Microsoft mathematics software and those taught using GeoGebra software.

**Table 3: Analysis of Covariance (ANCOVA) of the Significant Difference in the Mean Interest Scores of Senior Secondary School Students Taught Calculus using Microsoft Mathematics Software and those taught using GeoGebra Software.**

Source	Type II Sum of Squares	df	Mean Square	F	Sig.	Dec.
Corrected Model	8818.376 <sup>a</sup>	4	2204.594	19.378	0.00	
Intercept	77196.999	1	77196.999	678.535	0.00	
PretestInterest	.895	1	.895	.008	0.92	
Group	3200.992	1	3200.992	28.136	0.00	S
Gender	4168.406	1	4168.406	36.639	0.00	S
Group * Gender	472.123	1	472.123	4.150	0.04	S
Error	17634.368	155	113.770			
Total	3787515.000	160				
Corrected Total	26452.744	159				

$\alpha = 0.05$ , S = Significant

The result in Table 3 above indicates that an F-ratio of 28.13 with related likelihood value of 0.00 was obtained with regard to the important distinction in the average interest ratings of senior school students who were taught calculus using Microsoft mathematics tools and those taught using GeoGebra technology. Since the related probability value of 0.00 was less than 0.05 set as meaning point, the zero theory ( $H_{01}$ ) which indicated that there is no important distinction in the average interest ratings of senior school students taught calculus using Microsoft

mathematics tools and those taught using GeoGebra software is therefore rejected. Consequently, the inference taken is that there is a substantial distinction in the mean interest ratings of senior school students taught calculus using Microsoft mathematics software and those taught using GeoGebra software with those taught using Microsoft mathematics technology with greater mean interest ratings.

**Table 2: Mean and standard deviation of male and female students interest ratings in calculus.**

Variable	N	Pre-CIS		Post-CIS		Mean gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Male	85	58.75	17.83	60.53	11.64	30.74
Female	75	66.77	15.37	67.41	11.70	35.60

Result in Table 2 demonstrates that the male students got a mean pre-CIS interest mean scores ratings of 58.75 with a standard deviation of 17.83 and a mean post-CIS interest ratings of 68.53 with a standard deviation of 11.64. For male students’ interest ratings mean scores, the distinction between the preliminary and final average mean interest ratings scores is 30.74. The average rate for the students who learned calculus was 66.77, with a normal 15.37 deviation and a mean rate of 67.41 with a 11.70 deviation. The average mean interest ratings distinction for female students between pre-CIS and post-CIS preference is 35.60. Result demonstrates greater interest in calculus among male students than female students.

**Hypothesis two**

**H<sub>02</sub>: The mean interest ratings of male and female students in calculus do not differs significantly using Microsoft mathematics software and those taught using GeoGebra software**

Findings from Table 3 shows that an F-ratio of 36.63 with the related probability value of 0.00 was obtained in relation to the significant difference in male and female calculus mean interest ratings. Since the related probability value of 0.00 is less than 0.05 set as meaning level, it is dismissed the zero theory (H<sub>02</sub>), which indicated that the mean interest ratings of male and female students in calculus do not differ significantly using Microsoft mathematics software and those taught using GeoGebra software.

**Discussion of Findings**

The findings of this study revealed that, there is a significant difference in the mean interest ratings of senior secondary school students taught calculus using Microsoft mathematics software and those taught using GeoGebra software with students taught using Microsoft mathematics software having a higher interest ratings mean gain. □ Microsoft Mathematics provides a step-by-step problem-solving feature that guides learners through the processes of solving

calculus problems. This immediate feedback mechanism may have enhanced students’ understanding and confidence, thereby increasing their interest. In contrast, GeoGebra, while powerful for visualization and exploration, often requires a higher level of conceptual abstraction, which may have limited its motivational impact on some learners. The design of Microsoft Mathematics emphasizes procedural fluency and computational support—features that may appeal more directly to students accustomed to traditional classroom practices. GeoGebra, being more exploratory and conceptually driven, requires a constructivist learning mindset that may not be fully developed among secondary school students, especially those used to formula-based problem-solving approaches. This finding aligns with existing research emphasizing the role of technology-based learning tools in enhancing students’ interest and motivation in mathematics. Oyelekan and Olorundare (2016) found that students exposed to Microsoft Mathematics Software demonstrated improved motivation and interest because of its structured guidance and immediate feedback system. Bada and Ojedokun (2020) reported that digital tools providing real-time problem-solving support, such as Microsoft Mathematics, tend to sustain students’ attention and curiosity better than open-ended visual tools. Conversely, Agyei and Voogt (2011) and Idowu & Adodo (2019) found that while GeoGebra effectively enhances conceptual understanding and visualization, its exploratory nature may not immediately translate into increased affective engagement, especially among students with limited prior exposure to dynamic geometry environments. This means that teaching calculus using Microsoft mathematics software improves the interest of students more compared to GeoGebra software.

The results also indicated that there is an important distinction in male and female calculus means score interest ratings. The result indicating a significant difference in the mean interest ratings of male and female students in calculus suggests that



gender plays an influential role in shaping students' attitudes and emotional engagement toward learning mathematics. Female students are generally reported to experience higher levels of mathematics anxiety, which can suppress curiosity and intrinsic motivation toward the subject. This emotional barrier may reduce their interest levels compared to males, who often display greater persistence in problem-solving despite challenges. The finding is concurrent with the finding of Onaifoh and Ekwueme (2017) conducted an innovative study of plane geometry teaching strategies using Geogebra software at Delta State secondary schools. Using GeoGebra software, the study investigated the effect of innovative strategy in teaching and learning geometry of mathematics planes.

### Conclusion

The findings of this study clearly indicate that the use of mathematics software enhances students' interest in learning calculus. The integration of digital tools such as Microsoft Mathematics and GeoGebra creates an interactive and engaging learning environment that simplifies complex concepts, provides immediate feedback, and promotes active participation. These features help to reduce students' anxiety toward calculus and stimulate curiosity, motivation, and positive attitudes toward the subject. Therefore, mathematics software serves as an effective pedagogical tool for improving students' interest and engagement in calculus learning.

### Recommendations

Based on this study's findings, it was recommended that since Microsoft mathematics software as teaching strategies is effective in improving students' interest in learning calculus, mathematics teachers should adopt this teaching strategies, in order to improve the academic interest of students in mathematics, Since it makes students to be involved in carefully structured activities where learning is needed. It will help the mathematics teachers in providing learning environment that will sustain students' interest in calculus irrespective of gender differences.

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