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Mathematics Lecturers' Attitude Towards GeoGebra Visualization in Teaching Coordinate Geometry at Colleges of Education in The North West, Nigeria

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Abstract
This study was aimed at finding the attitude of colleges of Education Mathematics towards integrating GeoGebra visualization in the teaching and learning of Coordinates Geometry Three objectives were set, three research questions were asked and three hypotheses were formulated to guide the study. Fifty-four (54) Mathematics Lecturers, 36 males and 18 females were sampled to be the subjects of the study. Teachers' Attitude Towards GeoGebra Questionnaires was adapted from Agyie and Benning and served as an instrument of the study. The reliability coefficient of the instrument has been established to be 0.89 through test and retest. The researchers conducted a one-hour workshop on the basics of GeoGebra. Immediately, after the workshop the lecturers were served with the questionnaires and the results were analyzed using SPSS version 26. The findings include: Colleges of Mathematics Lecturers are aware of GeoGebra soft wares, they also have a positive attitude towards the software and most importantly they use the soft wares in the teaching of Coordinates Geometry and Mathematics in general. Some of the recommendations given include: Colleges of Education Mathematics lecturers should update their knowledge on GeoGebra software and other software for the teaching and learning of mathematics through research and attending workshops and seminars. More so, the National Commission for Colleges of Education should introduce more courses into the NCE mathematics programme on the application of computers to mathematics.

Keywords: Colleges of Education, Mathematics Lecturers, Attitude, GeoGebra Visualization, Teaching, Learning

Introduction

The world is witnessing an increase in technological development in all aspects of life daily. Some of these developments include Artificial Intelligence (AI), Robotics, space science, drones, 3D painting, IOT, smart technologies and many more. Since these technologies are reshaping the world according to Musa et al. (2022), Mathematics teachers should embrace them to enhance teaching and learning of mathematics and also to visualize concepts. Technologies such as online teaching, data science, and interactive whiteboard computer software should be integrated into the classrooms. This will make teaching and learning relevant to the needs of the society. The teacher has been identified as the main determinant of integrating technology into mathematics classrooms (Agyie & Beining, 2015; Simanjutak & Sipayung, 2017; UNESCO, 2022). More so, the National Policy on Information and Communication Technology (2019) stated that:

(i) Teachers and trainers should use technology to support all learning across the curriculum functioning as coaches, mentors, advocates and managers of information.
(ii) All teachers and trainers should acquire the knowledge and skills to integrate technology into challenging and interdisciplinary curricula and address specific needs developmental levels and learning styles (P.X)

Computer software in the form of Dynamic Geometric Systems (DGS) and Computer Algebra Systems (CAS) are some of the means of infusing into mathematics classrooms. Computer software wares according to Tiwari et al. (2021) are said to be better than the traditional method because they enable teachers to give attention to specific mathematics courses, bring about dynamic movement, increase knowledge, develop skills, use sound and graphics

to enhance teaching and learning by contributing to problem-solving. Some of these soft wares are Geometer Sketchpad, Maple, Grapes and GeoGebra to mention a few

GeoGebra (from Geometry and Algebra) was developed in 2001 by Michael Hohenwarter. It combines the functions of DGS and CAS. It provides multiple representations. It offers Algebra, Geometry and spreadsheets all in one. The software is so versatile that is being used worldwide and translated into more than 45 languages. Fletcher (2019) reported that the use of GeoGebra aided learners successfully in discovering the properties of straight-line graphs with the majority of the learners understanding both concepts. Saidu (2019) established that GeoGebra software improves students' performance in coordinate geometry at the NCE level. Azucena et al. (2022) established that GeoGebra effectively and efficiently increases students' confidence in Algebra, enhances their learning and remediate students' least mastered skills and concepts. Owusu et al. (2023) found that GeoGebra allows University students to learn, understand and work with polar coordinates easier and faster; more interestingly, GeoGebra is gender-friendly software. Many students have reported that GeoGebra is effective in enhancing students' performance in Algebra, calculus, probability, coordinate geometry and many more. Coordinate Geometry is a branch of mathematics which enables one to solve geometrical questions algebraically. In other words, coordinate Geometry is a system which uses numbers (coordinates) to uniquely determine the position of a point in space. Coordinate geometry allows us to understand objects and points with algebraic expressions that wouldn't been understood otherwise; it is part of the mathematics curriculum in Nigerian secondary schools also a course MAT 122 at Colleges of Education in Nigeria. It is also a course in the University for Mathematics and Science students. Some of the areas of the application of coordinate geometry include: It is used to locate the position of aircraft within the space and also its proximity. The knowledge of coordinate Geometry also aids in the study of motion, centripetal force and how elections move on the magnetic field. In addition to these, it is also applied in cars and other devices with GPS systems that plot routes. More importantly, the knowledge of coordinate Geometry facilitates in the study of other subjects such as calculus, and graph theory.

Despite the importance of coordinate Geometry, students perform poorly in the course and other mathematics courses at N.C.E levels. Mathematics is becoming more unpopular as very few students apply to read the course, and yet many leave the department without completing the course. One of the reasons advanced by researchers is that teachers are teaching in the era of ICT, the way they were taught. That is the chalk and talk method which makes students passive listeners. Since teachers are the key to implementing technology into the classroom, this study was conducted to find out the attitude of lecturers in the Colleges of Education towards integrating GeoGebra software into the teaching and learning of coordinate Geometry. Attitude refers to liking or disliking something. Attitude can be positive or negative if lecturers have a positive attitude towards GeoGebra, they will likely use it to teach their students. The students who are teacher trainees are likely going to use it when they become teachers. The course MAT 125- Application of Mathematics to Computer does not give room for teaching students (prospective teachers), how to use computer software in the teaching and learning of Mathematics. There is a need for more courses at the NCE level which will teach the students how to use computer software in teaching Mathematics.

Statement of the Problem

Students' enrolment into the NCE Mathematics programme at Federal College of Education, Zaria is declining year by year. Many students who are already in the Department leave without completing the programme for other courses in the name of "Change of Course". Those who remain as students of the Mathematics Department exhibit a lack of interest in the subject and consequently perform poorly in the examination, especially MAT 122-Coordinate Geometry. These problems can be traced to the traditional method of teaching "chalk and talk method" in the age of ICT, which has been proven to be ineffective. Many researchers have shown that GeoGebra software benefits students in learning Coordinate Geometry and Mathematics in general. So also, researchers have also established that the integration of GeoGebra into Mathematics classrooms lies in the hands of the teachers. Based on these, the researchers wish to investigate the attitude of Colleges of Education lecturers in integrating GeoGebra in the teaching and learning of Coordinate Geometry in Nigerian Colleges of Education.

Objectives of the Study

The objectives of this study include the following:

(i) to find out the level of awareness of College of Education lecturers in the N/W Zone of GeoGebra software

(ii) to investigate the attitude of COE lecturers in Northwest Zone towards the integration of GeoGebra in the teaching and learning of Coordinate Geometry.
(iii) to investigate if the lecturers are using GeoGebra as a pedagogical strategy.

Research Questions

The study is guided by these questions:

(i) What is the level of awareness of College of Education lecturers of GeoGebra software?
(ii) What is the attitude of Colleges of Education lecturers towards integrating GeoGebra software in the classroom?
(iii) To what extent do lecturers in the Colleges of Education in the North West use GeoGebra as an instruction strategy?

Hypotheses

The following hypotheses were formulated and tested at $\alpha = 0.05$.

H_{01}: Colleges of Education lecturers are not aware of GeoGebra software.

H_{02}: Colleges of Education lecturers in the North West have no positive attitude towards GeoGebra software.

H_{03}: Colleges of Education lecturers in the North West Zones do not use GeoGebra software as an instructional strategy.

Methodology

The study area is the seven states in the North West Zone, Nigeria, with twelve Colleges of Education of which seven are Federal Colleges of Education and 5 state Colleges of Education. The target population consists of all the Mathematics lecturers in the seven states. Three Colleges of Education; FCE Katsina, FCE Zaria and FCE Kano were purposely selected because they have the least security threat. The researchers visited the colleges and took permission in writing to conduct the research. A total of fifty-four (54) mathematics lecturers, 36 males and 18 females were used in the study. The researchers led the participating teachers in downloading GeoGebra software then after that, he demonstrated the teaching of Coordinates Geometry of the circle using the software. Areas covered include;

(i) Equation of a circle with the coordinates of the centre and a point on the circumference given
(ii) Equation of a circle with the coordinates of the end of points of a diameter given
(iii) Equation of a circle with any three points on the circumference given
(iv) Determining the coordinates of the centre and radius of a circle from a given equation'.

After demonstrating and discussing the above concepts on the screen, the lecturers were made to complete the research instrument titled 'Teacher Attitude Towards GeoGebra Questionnaire' which was adapted from Agyie and Benning (2015). The questionnaire has two sections: A and B. Section A contains lecturers' personal information while section B has six sub-headings with five questions each totalling 30 items. The questionnaire was pilot-tested at Kaduna State College of Education Gidan Waya and its reliability coefficient is 0.89 using the test-retest method. Data collected were analyzed using SPSS version 26.

Results

Among the personal variables of the teachers selected for analysis along with their opinions on the use of GeoGebra for teaching and learning mathematics in the Colleges were location, highest educational attainment, field of specialization, sex and years of experience on the job. Table 1 shows the descriptive categorization of the teachers by their selected socio-demographic characteristics.

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Table 1: Distribution of Mathematics Teachers by the selected Socio-Demographic Characteristics (n=54)

Variables	Variable options	Frequency	Percent
Location	FCE Zaria	21	38.9
	FCE Katsina	20	37.0
	FCE Kano	13	24.1
Qualification	First degree	16	29.6
	Masters	33	61.1
	Ph D	5	9.3
Specialization	Mathematics Education	17	31.5
	Functional analysis	2	3.7
	Mathematics	21	38.9
	Applied Mathematics	1	1.9
	Space Dynamics	2	3.7
	Science Education	4	7.4
	Pure Mathematics	3	5.6
	Modelling	1	1.9
	Fluid Dynamic	1	1.9
	Statistics	2	3.7
Gender	Male	36	66.7
	Female	18	33.3
Years of experience	1-10years	19	35.2
	11-20years	23	42.6
	Above 20years	12	22.2

(Source: Filed survey, 2024)

A total of 54 mathematics teachers selected from three Federal colleges of Education were involved in the study. Of the total, 38.9% were based in the Federal College of Education, Zaria, 37.0% were selected from the Federal College of Education Katsina and 24.1% were based in the Federal College of Education Kano. Qualification-wise, 31.5% were with a First degree as their highest qualification. Those with Master's degrees were 61.1% and 9.3% were with Doctorate degrees. In terms of specialization, 31.5% of the teachers were in Mathematics Education, 3.7% were specialists in Functional analysis, 38.9% were in general mathematics, and 1.9% were specialists in Applied Mathematics. Others in the categories were 3.7 in Space Dynamics, 7.4% in Science Education, 5.6% in Pure Mathematics, 1.9% each as specialists in Modelling and Fluid Dynamics and 3.7% as specialists in Statistics. The males among the teachers were 66.7% while 33.3% were female among the teachers involved in the study. For years of experience, 35.2% had between 1 and 10 years of experience on the job while 42.6% had between 11 and 20 years of experience on the job. Only 22.2% of the teachers had more than 20 years of experience on the job. These years of experience are expected to provide the teachers enough information to respond to questions on the use of GeoGebra visualization in the teaching and learning of coordinate geometry in the colleges of Education.

Awareness of Lecturers on GeoGebra Software teaching and learning in the classroom

To find out the level of awareness of College of Education lecturers on GeoGebra software in the selected Colleges of Education, the opinions of the lecturers on awareness of the software are summarized in Table 2. Based on the midpoint average of 3.00 on the five-point scale, the decision on agreement is based on a mean score above 3.00 while a lower mean would imply disagreement with the suggestion.

Table 2: Opinions of Mathematics Lecturers on Awareness GeoGebra for Teaching and Learning

Sn	Awareness of GeoGebra	SA	A	U	D	SD	Mean	Std. Dev.
1	I am familiar with GeoGebra software	19(35.2)	20(37.0)	1(1.9)	13(24.1)	1(1.9)	3.80	1.219
2	I have used GeoGebra to teach my students or conduct research	13(24.1)	20(37.0)	4(7.4)	17(31.5)		3.54	1.177
3	The tools in GeoGebra are familiar to me	14(25.9)	21(38.9)	5(9.3)	12(22.2)	2(3.7)	3.61	1.204
4	I have seen teachers/lecturers using GeoGebra in their lesson	10(18.5)	23(42.6)	3(5.6)	17(31.5)	1(1.9)	3.44	1.176
5	I have downloaded GeoGebra software	10(18.5)	15(27.8)	6(11.1)	21(38.9)	2(3.7)	3.19	1.245

(Benchmark = 3.00)

The expressed opinions of the lecturers in Table 2 revealed that they were aware of the use of GeoGebra Software for teaching and learning in the classroom among the selected Colleges of Education. In the table, 35.2% and 37.0% of the lecturers strongly agreed and agreed respectively with the suggestion that they were familiar with GeoGebra software. But those who have been opportune to use it were slightly lower as 24.8% and 37.0% were the ones who strongly agreed and agreed to have used the software. Most (25.9% and 38.9%) agreed that they were familiar with the tools in the software while 18.5% and 42.6% of the lecturers strongly agreed and agreed respectively that they have seen teachers/lecturers using the software in their lessons. Most of the lecturers did not agree that they have downloaded the software for teaching and learning utilization in the classroom as indicated by 38.9% and 3.7% who disagreed and strongly disagreed along with 11.1% of the lecturers who did not express their view on the suggestion. A clear indication that most lecturers were aware of the software but may not have been using it for teaching and learning in the selected Colleges of Education involved in the study.

Attitude of Colleges of Education lecturers towards integration of GeoGebra in teaching and learning in the classroom

To examine the attitude of Colleges of Education lecturers in Northwest Zone towards the integration of GeoGebra in the teaching and learning of Coordinate Geometry, their expressed opinions were scored and summarized as indicated in Table 3.

Table 3: Opinions of Mathematics Lecturers on Attitude towards GeoGebra for Teaching and Learning

Sn	Attitude towards integration of GeoGebra in teaching/learning	SA	A	U	D	SD	Mean	Std. Dev.
1	I like using GeoGebra software	12(22.2)	16(29.6)	13(24.1)	9(16.7)	4(7.4)	3.43	1.222
2	I feel comfortable in using GeoGebra for exploration	7(13.0)	23(42.6)	10(18.5)	12(22.2)	2(3.7)	3.39	1.089
3	I need a lot of time to think before I can use GeoGebra to teach coordinate geometry	8(14.8)	26(48.1)	7(13.0)	10(18.5)	3(5.6)	3.48	1.128
4	I will continue to learn and use GeoGebra	13(24.1)	27(50.0)	10(18.5)	2(3.7)	2(3.7)	3.87	0.953
5	GeoGebra makes coordinate geometry easy to teach and learn	12(22.2)	24(44.4)	11(20.4)	5(9.3)	2(3.7)	3.72	1.036

(Benchmark = 3.00)

Table 3 revealed that the lecturers had a positive attitude towards the integration of the

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GeoGebra software in the teaching and learning among the selected Colleges of Education involved in the study. Though opinion was divided on whether they like using the software or not 13.0% and 42.6% of the lecturers strongly agreed and agreed that they felt comfortable using software for exploration at the same time, 14.8% and 48.1% of them strongly agreed and agreed respectively that they require time to think before they can use the software for teaching coordinate geometry. But 24.1% and 50.0% of the respondents strongly agreed and agreed respectively that they will continue to learn and use the software while 22.2% and 44.4% strongly agreed and agreed respectively that the software makes coordinate geometry easy to teach and learn. The indications here are that the lecturers have a very positive attitude towards the use of the software for teaching and learning in the selected Colleges of Education.

Use of GeoGebra as an instruction strategy by lecturers in the Colleges of Education

To determine the extent to which the software is used as instructional materials in the Colleges, their opinions were rated along with means and standard deviations as summarized in Table 4.

Table 4: Opinions of Mathematics lecturers on pedagogy use of GeoGebra for teaching and learning

Sn	Use of GeoGebra in the Colleges	SA	A	U	D	SD	Mean	Std. Dev.
1	Using GeoGebra can make my lesson more practical	16(29.6)	24(44.4)	7(13.0)	5(9.3)	2(3.7)	3.87	1.065
2	I can use GeoGebra to meet the needs of my students	7(13.0)	29(53.7)	12(22.2)	5(9.3)	1(1.9)	3.67	0.890
3	GeoGebra software can help me reach out to more students	6(11.1)	26(48.1)	15(27.8)	5(9.3)	2(3.7)	3.54	0.946
4	GeoGebra software will help me design meaningful activities for my students	7(13.0)	24(44.4)	16(29.6)	5(9.3)	2(3.7)	3.54	0.966
5	GeoGebra software motivates me to find an effective approach to teaching coordinate geometry	11(20.4)	22(40.7)	15(27.8)	5(9.3)	1(1.9)	3.69	0.968

(Benchmark = 3.00)

The scores in Table 4, clearly demonstrated that the lecturers could be said to be using the GeoGebra for their teaching and learning the selected Colleges of education. In the table, 29.6% and 44.4% of the lecturers strongly agreed and agreed with the suggestion that using the software could make their lessons more practical and 13.0% along with 53.7% strongly agreed and agreed that they could use the software to meet the needs of their students while 11.1% and 48.1% strongly agreed and agreed respectively that the software could make them reach out to more students. Similarly, 13.0% and 44.4% of the lecturers strongly agreed and agreed with the suggestion that the software could help them to design meaningful activities for their students and 20.4% along with 40.7% of the lecturers strongly agreed and agreed respectively that GeoGebra software motivates them to find effective approach in teaching coordinate geometry. The expressed opinions here are clear indications that the lecturers were using the software for teaching and learning the Colleges.

Hypotheses

The null hypothesis formulated to test and establish the extent or significance of the expressed opinion on the attitude of Colleges of Education lecturers towards the use of GeoGebra visualization in the teaching and learning of Coordinate Geometry was tested as follows:

H01: Colleges of Education lecturers are not significantly aware of GeoGebra software.

The mean scores on awareness of GeoGebra software assessed in Table 2 were compared with the benchmark average (3.00) here to determine the extent of the expressed opinion of the lecturer's knowledge of the software. The result of one sample t-test used for the test is summarized in Table 9.

Table 9: One sample t-test on awareness of GeoGebra software by lecturers in the selected Colleges of Education

Variables	N	Mean	Std. Dev.	Std. Error	t-value	df	p-value
Awareness	54	3.51	1.022	0.139	3.703	53	0.001
Test value	54	3.00	0.000	0.000			

(t-critical = 1.96, p < 0.05)

The test revealed that the lecturers' awareness of the GeoGebra software for teaching and learning of Coordinate Geometry in the selected Colleges of Education was highly significant. The observed mean score (3.51) was significantly higher than the benchmark average of 3.00. This is indicated with an observed t-value (3.703) for the test with a p-value of 0.001 ($p < 0.05$) obtained at 53, degree of freedom (df). The result implied that the lecturers have adequate and significant awareness of the software. The null hypothesis that Colleges of Education lecturers are not significantly aware of GeoGebra software is therefore rejected

H02: Colleges of Education lecturers in the North West have no positive attitude towards GeoGebra software.

The mean scores in Table 3 were compared with the benchmark (3.00) here to determine the level of the lecturers' attitude towards GeoGebra software used in the teaching and learning of Coordinate Geometry in the selected Colleges of Education. A summary of the one-sample t-test used for the test is presented in Table 10.

Table 10: One sample t-test on attitude towards GeoGebra software for teaching and learning by lecturers in the Colleges of Education

Variables	N	Mean	SD	SE	t-value	df	p-value
Attitude	54	3.58	0.888	0.121	4.780	53	.000
Test value	54	3.00	0.000	0.000			

(t-critical = 1.96, p < 0.05)

The test revealed that the lecturers had a positive and significant attitude towards GeoGebra software for teaching and learning in the selected Colleges of Education**.** The observed t-value for the test was 4.780 with a p-value of 0.000($p < 0.05$) obtained at 53, degrees of freedom (df). These observations are clear indications that the attitude of the lecturers towards GeoGebra software for teaching and learning in the Colleges of Education was positive. The null hypothesis that Colleges of Education lecturers in the North West have no positive attitude towards GeoGebra software is therefore rejected

H03: Colleges of Education lecturers in the North West Zones do not use GeoGebra software as an instructional strategy.

The mean scores in Table 4 were compared with the benchmark (3.00) here to determine the extent of usage of the software by the lecturers as an instructional strategy for teaching and learning Coordinate Geometry in the selected Colleges of Education. The result of the one-sample t-test used for the test is summarized in Table 11.

Table 11: One sample t-test on the use of GeoGebra software as an instructional strategy for teaching and learning in the Colleges of Education.

Variables	N	Mean	SD.	SE	t-value	df	p-value
GeoGebra Use	54	3.66	0.783	0.107	6.184	53	.000
Test value	54	3.00	0.000	0.000			

(t-critical = 1.96, p < 0.05)

The test revealed that the lecturers significantly used the software as an instructional strategy for teaching and learning Coordinate Geometry in the selected Colleges of Education. The t-value obtained for the test at 53, degrees of freedom (df) was 6.184 with a p-value of 0.000 ($p < 0.05$). These observations provided sufficient evidence for rejecting the null hypothesis. The null hypothesis that Colleges of Education lecturers in the North West Zones do not use GeoGebra software as an instructional strategy is therefore rejected. These findings are in agreement with the findings of Fletcher and Musdav (2019), Saidu, (2019) and also that of Onwusu et al. (2023), who reported that

GeoGebra is not only used for teaching learning mathematics but it also helps in improving student performance and attitude towards mathematics.

Conclusion

The study established that the lecturers of colleges of education in the zone are aware of GeoGebra software as a software that can enhance the teaching and learning of mathematics. The lecturers also have a positive attitude towards integrating the software into their teaching. Most importantly, a significant number of lecturers indicated that they use GeoGebra software as a pedagogical strategy in the teaching of Coordinate Geometry. However, the study did not find out how often and the depth of usage of the software in the classroom. Apart from this one important thing to note is the slow nature of accepting innovation in the education sector in Nigeria and other African countries. As GeoGebra is 23 years old and teachers are yet to fully utilize it for the benefit of their students.

Recommendations

(i) Mathematics Lecturers in the colleges of education should learn more about GeoGebra and other wares that can enhance the teaching of the subject
(ii) Mathematics Departments in colleges of education should organize seminars and workshops for their lecturers on GeoGebra and other relevant software so that they can update the knowledge of their lecturer
(iii) The National Commission for Colleges of Education should introduce more courses on the application of computers to mathematics.

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