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IMPACT OF TEACHING USING GOOGLE EARTH SOFTWARE ON STUDENTS' LONGITUDE AND LATITUDE PERFORMANCE IN MATHEMATICS IN LAGOS STATE SENIOR SECONDARY SCHOOLS, NIGERIA

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Abstract
This study examines how teaching longitude and latitude in senior secondary school mathematics in Lagos State is impacted by the use of Google Earth software. Using interactive and visual representations, Google Earth, a potent geospatial tool, is being incorporated into the educational process to improve students' comprehension and application of the geographical concepts of longitude and latitude in mathematics. The study uses a quasi-experimental design with two groups: a control group that gets conventional training and an experimental group that uses Google Earth in its lessons. Before and after the intervention, students' knowledge and comprehension of longitude and latitude were evaluated using pre-tests and post-tests. The findings indicate that the use of Google Earth significantly improves students' achievement scores in latitude and longitude compared to traditional methods. There were no significant differences in the mean achievement scores of males and females in the experimental group. The study concludes that Google Earth can be an effective pedagogical tool for teaching complex geographical concepts in mathematics, such as longitude and latitude, ultimately offering a more engaging and comprehensive learning experience. Recommendations are made for broader implementation of geospatial technologies in teaching related mathematics topics to enhance the interdisciplinary nature of mathematics and stimulate greater student interest in the subject.

Keywords: *Google Earth; Mathematics performance; Teaching and Learning; Longitude and Latitude*

INTRODUCTION

Mathematics as a subject stands out among all other science subjects based on the scope of its usefulness and applicability in all spheres of life and to all fields of human endeavour. Mathematics not only prepares man for life, it involves life itself since it is indispensable in all human endeavours (Okwuoza et al., 2018). Ehiwario et al. (2018) view Mathematics as an activity subject that demands that the mathematics teacher helps the students acquire basic Mathematics knowledge, skills, and a positive attitude towards solving life problems. A solid understanding of mathematics equips students with mathematical reasoning and quantitative skills required to excel in the sciences, humanities, and other related fields (Onoshakpokaiye, 2023). As a fundamental discipline, mathematics empowers students and prepares them for a successful future, and also helps them develop creativity and critical thinking (Belbase et al., 2021). One of the topics taught in senior secondary schools is longitude and latitude; the knowledge is of significant importance, and it aids creative innovation in other areas of specialization (Yusha'u et al., 2018). The introduction and use of technology will play a significant role in the teaching and learning of longitude and latitude.

Geospatial technology is used to visualize, quantify, and analyze phenomena that occur on Earth. Geospatial technologies offer a huge potential to improve mathematical learning activities since the features that exist on Earth are related to mathematical ideas (Mailizar, 2012). Spatial ability is essential to succeed in learning mathematics. Geospatial tools, such as Google Earth, can help pupils improve their spatial thinking. Moreover, integrating Google Earth technology will help learners connect mathematical concepts to the real world. Furthermore, integration will improve students' capacity to make links between mathematical concepts and other courses (Herrera et al., 2024).

Google Earth software provides a dynamic platform for educators to create engaging lessons. It allows for exploring geographic coordinates, spatial relationships, and real-world mathematical applications (Xin and Zhang, 2018). Using Google Earth, teachers can design activities that encourage students to investigate and analyze spatial data, enhancing their understanding of mathematical concepts and their applications (Markowitz and Whitworth, 2020). It can improve students' spatial thinking and geographic literacy (Nilsson and Gabriel, 2022). This tool supports a constructivist approach to learning, where students actively construct knowledge through exploration and discovery.

Research suggests that introducing technology into mathematics instruction can improve students' engagement, comprehension, and retention of complicated topics (Higgins et al., 2017; Smith and Lee, 2022). Educators may create a more interactive and engaging learning environment by incorporating Google Earth into mathematics instruction, particularly in the knowledge of longitude and latitude. This approach supports a variety of learning styles and can help demystify complex concepts through visual and practical applications. Furthermore, taking gender differences in spatial reasoning into account can assist in personalizing these teaching tools to successfully support all students, resulting in a more inclusive classroom setting.

THEORETICAL FRAMEWORK

This study is based on constructivism, which emphasizes the role of cognitive development in problem solving and knowledge acquisition. The hypothesis highlights the importance of environmental experiences and interactions in molding students' cognitive development (Rabillas et al., 2023). The way a person approaches problem-solving determines the outcome. As a result, students should be exposed to a diverse range of challenges to develop the necessary skills for effective problem solving (Naufal and Juandi, 2024).

The constructivist learning theory, established by Jean Piaget, holds that learners gain insight and knowledge of the world via experiences and reflections on them. Students actively connect with geographical data when using Google Earth, developing knowledge through exploration and engagement (Fox & Riconscente, 2020). This method is consistent with the constructivist view of learning as an active process in which students build connections between new information and prior knowledge (Woolfolk, 2019).

According to John Sweller's Cognitive Load Theory (CLT), learning is impaired when the cognitive load exceeds the learner's capacity. Interactive tools such as Google Earth can help manage cognitive load by breaking down complex geographical concepts into digestible visual and interactive aspects, resulting in improved comprehension and recall (Sweller, 2024). This theory suggests that instructional technologies should be developed to optimize cognitive load, allowing pupils to digest knowledge quickly (Kirschner et al., 2006).

According to the Dual Coding Theory, both visual and verbal information are employed to represent information. It proposes that when learners engage with both types of information at the same time, they are more likely to retain and recall the information (Clark and Paivio, 2020). Google Earth combines visual data (maps, satellite photos) with spoken data (descriptions, labels), boosting the learning process through dual coding. The combination of visual and verbal stimuli can boost comprehension and memory retention (Paivio, 2019).

LITERATURE REVIEW

Longitude and latitude are critical aspects of spatial awareness in the mathematics curriculum (Nigeria Education Research Development Council (NERDC), 2014). Understanding these ideas is essential for interpreting maps, calculating global distances, estimating times, and using global positioning systems (GPS). According to chief examiner reports from the West African Examinations Council [WAEC] (2017-2023), students generally struggle with longitude and latitude issues. Common concerns include a lack of knowledge of the ideas, an inability to appropriately plot points on a map, and trouble reading and applying coordinates correctly. According to the reports, many students do not understand the fundamental principles of Longitude and Latitude, such as degrees, minutes, and seconds in mathematical coordinates; and students are challenged in practical applications, such as identifying specific locations on a map using given coordinates and calculating the distance between two points using Latitude and Longitude.

The WAEC reports also recommend that teachers use more interactive and practical teaching methods to help students have better learning experiences and understand longitude and latitude, as effective teaching methods are critical for fostering a deep understanding of mathematical concepts such as longitude and latitude. Modern educational practices emphasize student-centered learning, with technology playing an important role in engaging students and facilitating individualized instruction (Hattie and Timperley, 2007).

Learning is an active process in which students gain knowledge via their experiences and relationships. Integrating technology into teaching can lead to more meaningful learning experiences by creating immersive, context-rich settings that make learning more participatory and practical (Mayer, 2019; Tondeur et al., 2016). Using tools like Google Earth can help make learning more engaging and concrete. Google Earth is one such tool, and it is particularly useful for teaching and learning mathematics and geography. It enables teachers to design interactive classes that let students visualize and explore concepts like longitude and latitude in a real-world setting. Google Earth enables pupils to perceive the Earth's surface in a detailed and dynamic manner, resulting in a better knowledge of longitude and latitude.

Recent research has looked into the impact of Google Earth on education, particularly in mathematics and geography. Since the early 2000s, numerous web-based virtual globes, such as Google Earth, have been utilized for instructional purposes. These virtual globes enable users to see the Earth as a three-dimensional globe that they may "fly" around, making them useful tools for teaching spatial concepts (Da Silva et al., 2022). They enhance the learning process by making abstract topics more approachable and interesting (Elwood et al., 2019; Kerski, 2021). Google Earth has been extensively researched for its impact on geography education, and it has been found to improve students' grasp of geographical ideas by offering a dynamic and interactive learning environment (Oktavianto et al., 2023). However, concerns regarding the accuracy and potential for disinformation in user-generated content persist (Sui, 2021).

According to research, Google Earth is an effective tool for developing pupils' spatial reasoning and geographic concepts. Students who used Google Earth demonstrated significant improvements in their ability to comprehend and apply geographical knowledge, as well as critical thinking, exploration of real-world locations, higher levels of motivation, and better comprehension of spatial relationships (Xiang & Liu, 2017; Patterson, 2020; Ma et al., 2020). Furthermore, Google Earth has been found to help kids build critical thinking skills by allowing them to study real-world data and use it to solve problems.

In Nigeria, the use of technology-enhanced learning tools, such as Google Earth, has grown in recent years. The usage of Google Earth in Nigerian classrooms has been cited as a successful method of teaching geographical concepts, with students demonstrating enhanced involvement and spatial knowledge. The availability of technology has resulted in more dynamic and engaging learning experiences for pupils across Nigeria (Wakil et al., 2024).

Gender matters in education because it influences how students engage with and interpret courses such as mathematics. According to Stoet and Geary (2018), there can be gender disparities in spatial ability and learning tool preferences. It is critical to ensure that instructional resources such as Google Earth are used in an inclusive and supportive manner for all students, regardless of gender. Educators can help to close the gender gap in STEM professions by offering equitable opportunities and encouraging both boys and girls to use these technologies (Azra et al., 2016).

Despite the importance of understanding geographic coordinates in mathematics, many students struggle to grasp the concepts of longitude and latitude using traditional teaching methods (National Center for Education Statistics [NCES], 2020; Shin, 2018). These methods often lack interactivity and fail to engage students effectively, leading to poor comprehension, application, and ultimately poor performance. There is a critical need for innovative instructional strategies that can bridge this gap and enhance students' learning experiences on this topic.

The literature reviewed indicates a consensus on the positive effects of using technology, specifically Google Earth, in education. Constructivist and cognitive theories provide a strong theoretical foundation for its use, suggesting that it enhances active learning and manages cognitive load effectively. Empirical studies support these theoretical claims, showing improved engagement, spatial thinking, and academic performance among students using Google Earth. Therefore, the reviewed literature strongly supports the potential benefits of Google Earth instruction in teaching longitude and latitude.

However, the authors have not found any studies that have looked into the usage of this technology in the mathematics classroom. As a result, this study investigated how Google Earth software training influenced students' longitude and latitude achievement scores in senior secondary schools in Lagos State, Nigeria. The primary purpose of the study was to look at the impact of Google Earth software teaching on students' performance in a mathematics achievement test on longitude and latitude in senior secondary schools in Lagos State, Nigeria, as well as to see if gender influenced their test scores.

Research Hypotheses

The following hypotheses are proposed:

HO1: There is no significant difference in the mean achievement scores of pupils taught longitude and latitude using Google Earth Instructional software against those taught using traditional teaching methods.

HO2: There is no significant difference in male and female students' mean achievement scores when longitude and latitude are taught using Google Earth Instructional software.

METHODOLOGY

The study used a quasi-experimental research design with pre- and post-tests. Convenience sampling was utilized to choose one educational district for the study, from which all mixed public senior high schools were purposefully picked. From this set, two secondary schools in Lagos State's Ikeja Local Government Area were chosen at random: one as the experimental group and the other as the control group. This design allows for a comparison between the experimental group, which received instruction from the researchers via Google Earth software, and the control group, which was taught by the school mathematics teacher using the conventional/traditional technique.

The study included two senior secondary (SS) students from each of the two schools' intact classes. The school administration was approached, and they consented on behalf of the children because they had a duty of care for them. Longitude and latitude are taught at the SS2 level; thus, students were chosen for this. In addition, the researchers described the process to the children in each school, assuring them that it was purely for research purposes and that they may opt out and cease participating at any moment if they so desired. The experimental group had an estimated 18 females and 12 male students from each intact class, while the control group included 16 females and 14 male students. This led to a total sample size of 60 students for the study.

The research instrument was a Mathematics Achievement Test (MAT) with 20 multiple-choice questions about longitude and latitude taken from WAEC's previous questions from 2017 to 2023. WAEC's former questions were chosen because they had previously been validated by the WAEC Test Development Division [TDD]. The selected questions addressed both previously taught and newly introduced content areas to the students. The researchers taught the pupils for four weeks.

The pre-test was given before the start of treatment, and the post-test score was obtained at the end of treatment, utilizing MAT with the same questions. The experimental and control groups' pre-test and post-test scores were analyzed using a t-test/ANOVA.

RESULTS

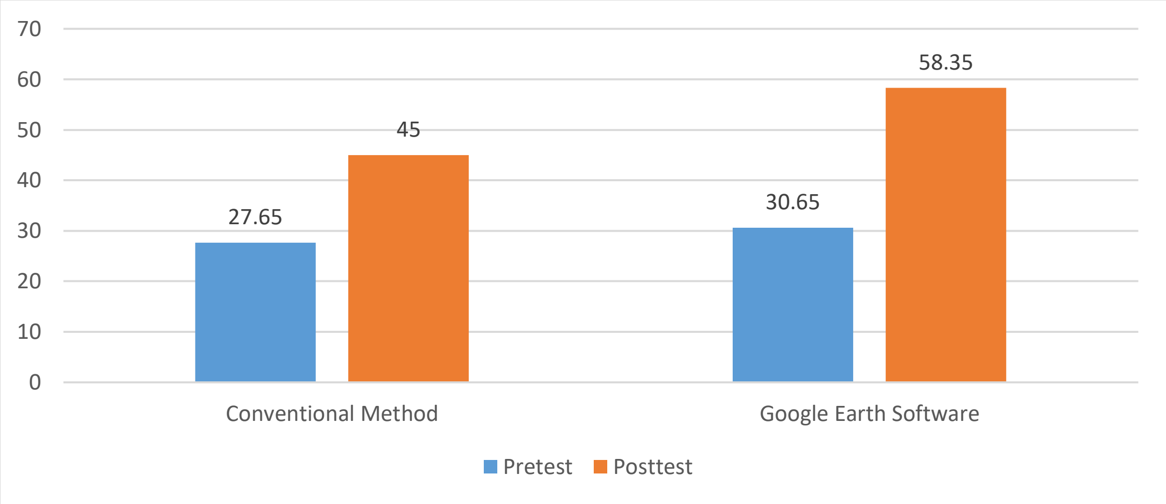

Figure 1. Mean achievement score of students taught longitude and latitude using Google Earth Software.

The outcome in Figure 1 shows that students in the conventional class scored 27.65% and 45%, while those in the Google Earth Software group obtained 30.65% and 58.35% in pre-test and post-test, respectively.

HO1: There is no significant difference in the mean achievement scores of pupils taught longitude and latitude using Google Earth Instructional software against those taught using traditional teaching methods.

Table 1. Effect of Google Earth Instructional software on the mean achievement scores of students taught longitude and latitude

Source	**df**	**Mean Squared**	**F**	**Sig.**	**Partial Eta Squared**	**Observed Power[b]**
Corrected Model	4	38.206	11.248	.000	.450	1.000
Intercept	1	307.795	90.613	.000	.622	1.000
Pre-test	1	81.842	24.094	.000	.305	.998
Group	1	44.990	13.245	.001	.194	.947
Error	55	3.397				
Total	**60**					
Corrected Total	**59**					

The F Ratio $F(1, 65) = 13.25$; $p<0.05$ shows a significant effect of Google Earth Software on students' achievement in Longitude and Latitude. Therefore, the null hypothesis of no significant difference in the mean achievement scores of students taught longitude and latitude using Google Earth Instructional software and those taught with the conventional teaching method was rejected.

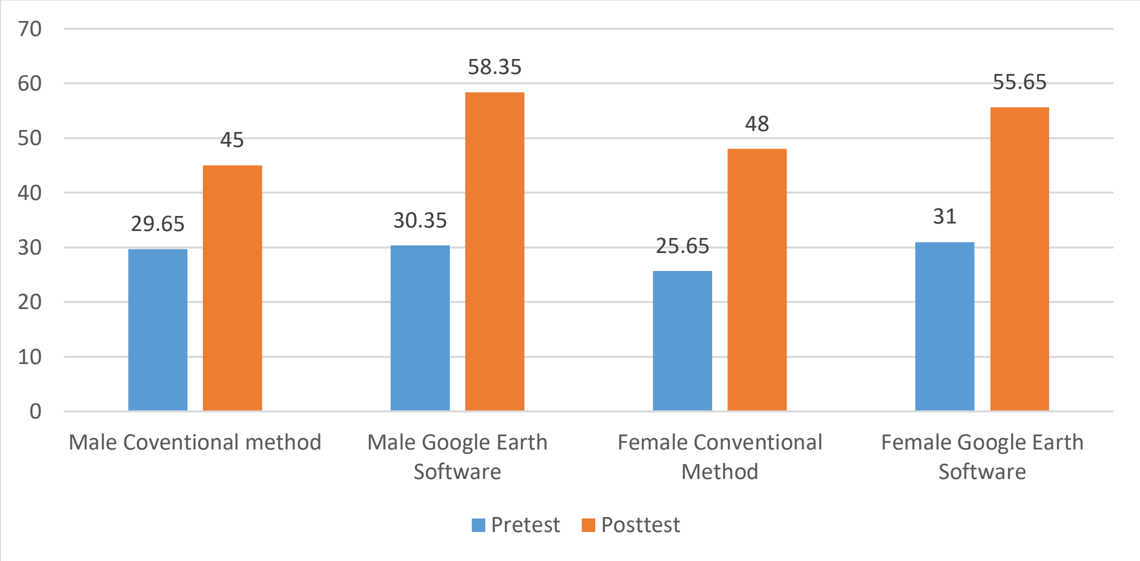

Figure 2. Mean achievement scores of males and females taught longitude and latitude using Google Earth Instructional software

The result in Figure 2 shows that males scored 29.65%, 45% and 30.35%, 58.35% in conventional and Google Earth Software groups, respectively, while females scored 25.65%, 48% and 31%, 55.65% before and after treatment.

HO2: There is no significant difference in male and female students' mean achievement scores when longitude and latitude are taught using Google Earth Instructional software.

Table 2. The difference in gender on students' achievement when taught longitude and latitude using Google Earth Instructional software

Source	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b]
Corrected Model	4	38.206	11.248	.000	.450	1.000
Intercept	1	307.795	90.613	.000	.622	1.000
Pre-test	1	81.842	24.094	.000	.305	.998
Group	1	44.990	13.245	.001	.194	.947
Gender	1	.769	.226	.636	.004	.075
Error	55	3.397				
Total	**60**					
Corrected Total	**59**					

The F Ratio F (1, 55) 0.23; p>0.05 shows no significant difference in gender on students' achievement score in Longitude and Latitude when taught using Google Earth Software. Therefore, the null hypothesis of no significant difference in gender on students' Google Earth Instructional software on the mean achievement scores of students taught longitude and latitude was not rejected.

DISCUSSION

The difference in mean achievement score between students taught longitude and latitude using Google Earth Instructional software and those taught using traditional teaching methods revealed that students taught with Google Earth instruction outperformed those taught using traditional methods of instruction. The experimental group outperformed the control group in terms of test scores. Google Earth's interactive and visual nature enables pupils to visualize spatial relationships between various locations, making abstract notions such as longitude and latitude more concrete and understandable. This is consistent with studies that have indicated that students learn better when computer-assisted training, such as Google Earth, is utilized to bring abstract thinking to life, thereby concretizing information (Kerski, 2015; Lei et al., 2016; Hsu et al., 2017).

The study found that there is no significant difference in male and female students' achievement scores when Google Earth is used as a method of instruction in the teaching process. The findings are consistent with those of Gobert et al. (2012), who found no differences in learning gains when comparing male and female students in geoscience learning with Google Earth, and Bitting et al. (2018), who discovered no significant interactive effects of class format, student gender, or student ethnicity on the magnitude of score increases.

CONCLUSION

In conclusion, this study demonstrates that Google Earth is a powerful and effective instructional tool for improving students' longitude and latitude achievement in Lagos State's senior secondary schools. Its interactive elements and visual capabilities improve student engagement, comprehension, effectiveness, and academic performance. Google Earth has the potential to significantly modernize mathematics instruction and prepare pupils for a society in which spatial thinking and technical literacy are becoming more important. Incorporating technology such as Google Earth into the curriculum has the potential to greatly increase mathematics student outcomes.

RECOMMENDATIONS

The following recommendations are made:

1. Curriculum Integration: Education officials should consider incorporating Google Earth into the curriculum to improve the teaching and learning of longitude and latitude.
2. Teacher Training: Professional development programs should be designed to teach instructors how to successfully incorporate Google Earth and other technical tools into their lessons.
3. Resource Allocation: Schools should allocate resources to ensure that they have the essential technology infrastructure for Google Earth use, such as an internet connection and computer labs.
4. Ongoing Assistance: To maximize the benefits of using Google Earth in the classroom, teachers and students should have ongoing help and resources.

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