E-ISSN: 1115 - 8425 P-ISSN: 3027-012X
MPRI-JAEE | INTERNATIONAL JOURNAL OF ASSESSMENT & EVALUATION IN EDU.
VOL. 11 NO. 8 – JANUARY, 2026

DEVELOPMENT AND EVALUTION OF EDUCREATION AND PIKTOCHART ON GEOGRAPHY STUDENTS' LEARNING OUTCOMES AMONG SECONDARY SCHOOL STUDENTS IN MINNA NIGER STATE, NIGERIA

***ADAFE HAKIMI ALIYU; *MUHAMMAD, HABIBA ASABE; **USMAN ALHAJI YAHUZA; **SALIHU HAJARA; **DR. SALIU M. R.; & ***DR. SARKI MATHEW ALHERI ANGELA**

*Department of Educational Psychology, Dr. Umaru Sanda Ahmadu College of Education Minna, Niger State.
**Department of Curriculum and Instruction, Dr. Umaru Sanda Ahmadu College of Education Minna, Niger State.
***Department of Educational Foundations, Dr. Umaru Sanda Ahmadu College of Education Minna, Niger State.
Corresponding Author: hakimiadafealiyu@gmail.com
DOI: https://doi.org/10.70382/mejaee.v11i8.0102

Abstract

This study evaluated the Development and Evaluation Educreation and Piktochart on Geography Students' Learning Outcomes among Secondary Schools Student in Minna, Niger State, Nigeria. A quasi-experimental pretest–posttest non-equivalent control group design was adopted, involving 438 SS II Geography students assigned to Educreation, Piktochart, and conventional teaching groups. Validated instruments (MRAT and SIQ) yielded reliability coefficients of 0.89 and 0.92, respectively. Data were analysed using Mean and Standard Deviation (SD) to answer the research questions, while Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA), and Sidak post hoc tests were used to test the hypotheses at the 0.05 level of significance. Results showed that students taught with Educreation (posttest mean = 57.47, SD = 10.12) and Piktochart (mean = 58.64, SD = 12.21) performed significantly better than

Keys: Development, Educreation, Piktochart, Geography Students and Technology.

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those taught with the conventional method (mean = 48.73, SD = 8.15), $p < 0.05$. Retention scores also favoured the experimental groups Educreation (mean = 56.03, SD = 9.88) and Piktochart (mean = 57.01, SD = 12.32) compared to the conventional group (mean = 41.04, SD = 14.20), $p < 0.05$. Similarly, interest scores were higher in the Educreation (mean = 65.22, SD = 15.30) and Piktochart (mean = 63.86, SD = 18.21) groups than in the conventional group (mean = 51.35, SD = 15.98), $p < 0.05$. Gender analyses indicated no significant differences in achievement, retention, or interest within the experimental groups with mean differences in academic achievement (1.15), academic retention (1.15), and interest in learning (0.74) ($p > 0.05$), demonstrating that both platforms support gender-inclusive learning. The study concluded that Educreation and Piktochart significantly enhance students' academic achievement, knowledge retention, and interest in Geography. It recommended the integration of these digital platforms into Geography instruction, teacher training programmes, curriculum development efforts, and further research across additional Geography topics and educational levels.

Introduction

Information and communication technology (ICT) has become one of the basic building blocks of modern society within a very short time. ICT has become a household name and has transformed many aspects of human lives. In the world, people live in an environment that is dominated by technology which in itself is consumer-driven (Kathleen *et al*., 2023). Information and Communications Technology (ICT) has influenced student learning when educators are digitally well-educated and understand how to integrate it into various subjects. The proper use of ICT tools create, communicate, disseminate, store, and manage information. In classroom settings, ICT has also become essential to the teaching-learning interaction, through such approaches as replacing chalkboards with interactive digital devices for learning during class time, and after. This can be applicable to subjects like Biology, Chemistry, Physics, Mathematics and Geography

According to Toovey (2024), Geography teachers use outdated instructional resources that ignores students' need and requirement the author further noted that most of the instructional resources used by Geography teachers are obsolete which makes their students not to be carried along or left behind. Despite rational for teaching Geography to attained the overall educational goal in Niger State secondary school syllabus, irrelevant instructional resources is that the main factors presently influencing students' academic achievement in Geography as one of the elective subject in secondary school

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curriculum that has not been explored adequately, some of the problem include, improper identification of Geography orientation, shortage of Geography teachers, lack of students attitude toward learning of Geography, inadequate provision of materials resources for teaching Geography as well as method of teaching the subject (Bankole, 2018). Consequently, there is need for teachers to be taught the best Geography teaching approach with technological enhanced instructional resources.

The development of technology in the field of education has brought changes to the educational system in Nigeria. The use of technology in teaching and learning Geography in the classroom has become a new habit and norm (Herawati *et al.,* 2023; Kaushik and Sugandha, 2022; Manivannan, 2016). Technology is a major aspect of the world and people lives has been shaped and sharpen by this technology (Ababa *et al.,* 2021). Most educational technology resources are designed to encourage classroom participation. Among various technological tools, Educreation and Piktochart have emerged as a practical alternative to conventional blackboards method in secondary school classrooms, and it has proven to have advantages for teachers and students in the process of teaching and learning (Bui, 2024; Goedhart *et al.,* 2019; Handam *et al.,* 2021; Herawati *et al.,* 2023; Wan *et al.,* 2021; Furthermore, many studies on Educreation have indicated that teaching with the latest technologies can enhance students' academic achievements and motivation to learn the subject. In today's era, students need to play an active role in the classroom, where teachers act as facilitators. Educreation have made the world to be at the fingertips of a teacher as it can aid in transmitting lesson note to student from anywhere around the world. Educreation is a whiteboard app which is interactive in nature and is mainly used by the teachers for providing students with easy to follow tutorials.

The Educreation creates an attractive learning environment and constitutes an integrated system of hardware, software, and resources to improve student participation and enhance their achievement as the Educreation user can retain explained material through storage, printing, emailing and post it through the internet whenever necessary as well as it can operate most of the computer applications which helps in presenting the study material in attractive patterns. In light of the achieved results, the Educreation is considered an ideal tool for any usage requiring visual connection (Gouzi, *et al.,* 2019).

Piktochat can be used to teach different courses in the Tertiary Institution some of which are Duolingo, U-lesson, Microsoft word, Coursera, Udemy, Google meet, Zoom etc. Misty *et al*, 2021). Stated that piktochat are currently causing transformation and drastic evolution in the educational sector not only in Nigeria or Africa but the World at large. Therefore, piktochat are programmed in such a way that teaching and learning can be carried out anywhere and at any time at one’s convenience. Hence, piktochat make use

of mobile devices such as smartphones and tablet computer with the major aim of innovatively changing the teaching and learning process (Günüç and Kuzu, (2014). According to Kant *et al.,* (2021) an educational application platform is the integration of learning management systems and technologies to provide a customized end-to-end solution battling with teaching and learning. This application can also be used in both formal and informal learning environments which is mostly designed to cover a wide range of subjects and age groups (Xie *et al.,* 2019). It has been discovered that most secondary school students are not exposed to piktochat in their various institutions there by making them ignorant of the advantage and benefit that comes with using these applications for learning. Therefore, most secondary school teachers are also ignorant of this piktochat and how best to utilize them in the teaching and learning process. Thus, teachers shy away from the usage of theses apps because they don't know how it operate and most of these teachers are technologically illiterate.

Similarly, piktochat can be used to teach various subjects and skills, including language, math, and science subjects both in Primary, Secondary and Tertiary Institution of learning. In the view of the above, piktochat make learning more interactive and it provides a variety of learning opportunities using applications such as games, quizzes, simulations, and videos. Whereas, Menon, (2022) opined that Educational Apps as a mobile learning device enables instant accessible anywhere and anytime, thereby making learning environment worth cooperating to acquire knowledge, satisfy students curiosity, collaborate with others to share ideas and opinions in order to improve their academic achievement.

Piktochat educational applications according to (Francisco *et al.,* 2021) assist instructors to encourage the participation of students to classroom activities so as improve their motivational interest to learning for better academic achievement. In view of this, piktochat educational applications aids to reduce the time use by teachers in higher institution motivating the students to achieve their goals. Thus, when instructors use more strength and time in motivating students without the use of educational application, they get easily tired and the learning might be so bored. In spite of this, Murtagh *et al*, (2018) found out that educational application helps to motivate students' by improving students' academic achievement and retention

Student academic achievement can be measured in numerous methods that are not limited to course completion, grade point average, and skill development (Hidayat *et al,* 2024). Online education has been found to have detrimental effects on both high-achieving and low-achieving students, with a particular emphasis on the negative impact it has on the latter group (Bacolod *et al.,* 2018). However, Student academic achievement refers to the level of success and accomplishment a student achieves in their educational

pursuits, encompassing various indicators like grades, test scores, and completion of coursework. Essentially, it measures how well a student has progressed towards their educational goals and standards within a specific academic setting. There is a higher propensity for students with worse academic achievement to enrol in online courses. Pursuing a Bachelor's Degree in higher education has the potential to assist policy makers in creating an optimal educational setting for students (Johnson and Palmer, 2019; Hidayat *et al,* 2024). Students learn and motivated mostly from mobile games which can also be considered as educational applications. In addition, social media platforms can become an educational application in as much as it is used for students-teacher communication. In order to carry out a realistic teaching method in the learning environment, any applications that can support an individual to learn academically or independently are cogitated majorly as educational application. Suhair and Aseel (2021) stated that educational applications improve students' complexity and cognitive reasoning to perform well in their academics. This can be assessed using a variety of methods, including lab reports, research projects, exam scores, grades, and any other acknowledged academic achievements

Retention is the capability of individual to reserve what has been learnt and remember what has been stored in the memory. Olarewaju (2017) defines retention as the ability to retain and later recall information or knowledge gained after learning into memory. The sort of the materials to be coded contributes to the retention level. Instructional strategies contribute to quality and level of retention in terms of substantial, concreteness and image evolving characteristic (Wushishi *et al.,* 2017). Stated that retention could be elucidating as the process or ability to retain and remember things and experiences learned by an individual later time. Suitable coding of incoming information provides the index that may be consulted so that retention takes place without an elaborate search in the memory imaginary path (Saulawa *et al,* 2024). Retention of students are simplified by students' interest in a subject because, interest is seen as element of one's insight regarding a subject or a topic.

Interest in learning is a key to boosting enrolment in a course of study (Laurentiu *et al*., 2021). While effective teaching approaches and resources are of paramount importance, such efforts are unsuccessful unless students have a desire to learn. Angelos and Rabindra (2021) opined that using inquiry-based instruction hold students' attention for a longer time which directly sustaining students' interest in the subject. This is backed up by Mesfin *et al*. (2022) who posited that the key to impacting an individual's academic achievement lies in increasing the individual's interest in a particular domain of learning. The authors further noted that the interest level is mostly decided by the teaching method used in teaching and learning concept in Geography.

Gender plays a significant role in shaping the academic experiences and learning outcomes of Geography students in senior secondary schools, influencing their participation, engagement, motivation and performance in the subject. More so, these principles to analyse data, solve issues, and effectively convey scientific concepts. Recent research highlights significant gender differences in educational outcomes, including in subjects like Geography. Girls often outperform boys in subjects requiring extended reading, comprehension, and attention to detail, such as Geography classes. Shea *et al.,* (2022) indicated that gender did not significantly differ, indicating that the Geography students' academic achievement was determined by their own study habits, the environment in which they studied, the qualities of their teachers, and the teaching approach employed. However, Panetta (2017) noted that male Geography students outperformed female Geography students, which the author attributed to the male Geography students' greater access to technology. Technology as it exists now has a significant impact on the process of teaching and learning, leading to a paradigm shift in the way that this is done to improve academic achievement among male and female. Njoku, (2024).

Statement of the Research Problem

Despite the importance of Educreation and Piktochart in making learning easier by ensuring that Geography students have clear understanding of concepts especially in Map Reading that seems to be complex in nature, the concept is yet to be understood especially in the study area. Hence Geography students continue to have difficulties in understanding the concept (Map ading) (Olajide *et al.,* 2023). The use of Educreation and Piktochart may eradicate the passive conventional method used by different Geography teachers. Specifically, West Africa Examination Council (WAEC) 2020 54.15% failed, National Examination Council (NECO) 2021 56.37% failed, and National Business and Technical Examinations Board (NABTEB) 2022 59.25% failed, (WAEC) 2023 61.43% failed and (NECO) 2024 52.21% failed according to Chief Examinar Reports showed that Geography students performed poorly (see appendix A page 141 Statistics Department Niger State Ministry of Education 2024). Several factors has been attributed to be the dismal cause of the current trend of poor performances of students in Geography such as large class size, laxity of students, inadequate instructional materials. Although different strategies were used by different researchers such as the use of simulation, visualization, concept mapping among others to improve the persistence failure of students, but yet it has continued. However, the strategy considered by the researcher is the use of Educreation and Piktochart which are more interactive. For instance, Odoh (2024) used a quasi-experimental design in Abuja with junior secondary school students and found that

lessons delivered via interactive whiteboards significantly improved academic achievement and retention in Computer Studies compared to conventional methods. Similarly, Egbunu (2024) reported positive gains in both achievement and retention among Biology students when taught with IWBs. Also, Idris and Abubakar (2023) observed that interactive multimedia instruction boosted achievement and retention in Computer Studies at the Federal College of Education, Zaria. On the infographic side, Abbazioa and Yang (2022) compared infographic versus text formats among undergraduates and found that infographic presentation led to better retention of core content. Hence this study intends to investigate the impacts of Educreation and Piktochart on secondary schools' Geography students' learning outcomes in Shiroro Local Government Area, Niger State, Nigeria.

Aim and Objectives of the Study

The aim of the study is to investigate the Development and Evaluation Education and Piktochart on Geography Students' Learning Outcomes among Secondary Schools Student in Minna, Niger State, Nigeria. The specific objectives of this study are to;

1. Investigate the academic achievement scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools Student in Minna, Niger State.
2. Assess the retention scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools Student in Minna, Niger State.
3. determine the interest scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools Student in Minna, Niger State.
4. investigate academic achievement scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State.
5. Assess the retention scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State.
6. Determine the interest scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State.

Research Questions

The following questions will be answered in this study:

1. What is the difference in the mean academic achievement scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools Student in Minna, Niger State?
2. What is the difference in the mean retention scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools Student in Minna, Niger State?
3. What is the difference in the mean interest scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools Student in Minna, Niger State?
4. What is the difference in the mean academic achievement scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State?
5. What is the difference in the mean retention scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State?
6. Is there any difference in the interest scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area Niger State?

Research Hypotheses

The following null hypotheses are formulated and tested at 0.05 alpha level of significance:

HO_1: There is no significant difference between the academic achievement scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools Student in Minna, Niger State.

HO_2: There is no significant difference between the retention scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Student in Minna, Niger State.

HO_3: There is no significant difference between the interest scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools Student in Minna, Niger State.

HO_4: There is no significant difference between the academic achievement scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State.

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HO_5: There is no significant difference between the retention scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State.

HO_6: There is no significant difference between the interest scores of male and female Geography students' taught Map Reading concepts using Educreation, Piktochart platforms among secondary schools in Minna Local Government Area in Niger State.

Research Design

The research design adopted for this study was a quasi-experimental design using the pretest–posttest non-equivalent control group design. The choice of this design was based on the fact that it allowed the researcher to use intact classes without disrupting the school timetable and class arrangements. The study engaged students in three groups: the Experimental Group1 (students were taught using Educreation), Experimental Group 11 (students were taught using Piktochart) and the Control Group. The design layout of the study is presented in Table 1.

Table 1: Research Design Layout

Groupings	Pretest	Treatment	Posttest	Retention
EXP GRP (Educreation)	O_1	X_1	O_2	O_3
EXP GRP (Piktochart)	O_4	X_2	O_5	O_6
Control (Conventional)	O_7	X_o	O_8	O_9

Where:

O_1, O_4 and O_7 = Represent pretest observation for experimental and control groups

O_2, O_5 and O_8 = Represent Posttest observation for experimental and control groups

O_3, O_6 and O_9= Represent Retention observation for experimental and control groups

X_1 = Treatment (Educreation)

X_2 = Treatment (Piktochart)

X_o = Control (Convention Method)

Population of the Study

The population of the study comprises all senior secondary school Geography students Student in Minna, Niger State, in the 2024/2025 academic session totalling 4892 students (see Appendix B in page 142). The target population focused on SSI Students because the concepts to be taught falls under their scheme of work totalling 1652.

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Sample and Sampling Techniques

A sample size of 438 Geography students was obtained from the intact SSI classes of six secondary schools Student in Minna, Niger State. A multi-stage sampling technique was employed. Firstly, the 18 schools were clustered into six groups based on their proximity to one another. Secondly, simple random sampling was used to select one school from each cluster. Thirdly, simple random sampling was used to assign the six schools into Experimental Group I (Educreation), Experimental Group II (Piktochart), and the Control Group. The distribution of students per school is presented in Appendix C (page 148).

Research Instruments

For the purpose of this research, the following instruments were used as treatment and data collection; the treatment instrument are Educreation Piktochart while the test instruments are;

1. Map Reading Achievement Test (MRAT)
2. Students Interest Questionnaire (SIQ)

Development of education and piktorchart

The Educreation Piktochart was designed using advanced Artificial Intelligence (AI). The development process began with input from experts in Geography who provided content specifically focused on map reading, map scales, bearing, distance, and the use of vectors, sketching, drawing, and labelling diagrams. The Educreation Piktochart included features such as interactive sessions, personalized copying strategies, and motivational feedback. It was designed to engage students in a conversational manner, helping them identify and address their challenges in Geography.

Development Phase of educreation and piktochart platforms

The development of the Educreation Piktochart platform followed a structured multi-phase process designed to meet the specific learning needs of Geography students.

Needs Assessment and Requirements Gathering

The initial phase focused on identifying the academic challenges and requirements of secondary school Geography students. Surveys and interviews were conducted with both students and teachers to understand common difficulties, such as diagram drawing, practical map work, and comprehension of key concepts. This phase helped to define the functional requirements of the platform.

Conceptual Design

Based on the needs assessment, a conceptual framework for the platform was developed. This included outlining the structure, key features, and user flows. User personas representing typical students were created to ensure the platform addressed diverse needs, including male and female students. Interaction flows were designed to provide targeted support for enhancing diagram drawing skills, improving understanding of Geography concepts, and offering resources to strengthen practical map work.

Technical Development

The Educreation Piktochart platform was developed using Python as the primary programming language, leveraging the Rasa framework for conversational AI and interactive dialogue management. A Postgre SQL database was implemented to store student interactions, track progress, and enable data-driven personalization of learning activities. Machine learning models were trained on datasets reflecting common Geography learning challenges, allowing the platform to provide adaptive and gender-specific responses. The user interface was designed using React.js for a responsive, mobile-friendly experience, integrating voice recognition APIs and visual feedback elements to enhance interactivity and engagement. These technical choices ensured the platform could provide real-time, personalized support for Geography students while maintaining high usability and scalability.

Testing and Validation

The package goes rigorous testing to ensure functionality, usability, and performance. Usability testing was conducted with a sample group of students to assess ease of use, while performance testing measured response accuracy, speed, and adaptability. Feedback collected during this phase informed refinements to the conversational flows, algorithms, and interface elements.

Deployment

After development and validation, the platform was deployed in the study environment. Geography students received training on effective use of the platform, and its performance was continuously monitored to collect interaction data for analysis.

Evaluation and Feedback

The impacts of the Educreation and Piktochart on learning outcomes was assessed using pre- and post-intervention surveys, alongside analysis of interaction logs to identify usage trends and areas for improvement. Quantitative and qualitative feedback was collected to enhance future interactions and refine the platform.

User Interface Features

The platform includes a welcome screen introducing Educreation and its purpose, with options to select language and preferred communication style (text or voice). The main menu provides access to Educreation and Piktochart modules. Key interface components include a text input field, undo and redo input options, sentiment indicator, and personalized interactions with gender-specific responses and adaptive exercises. A progress tracker provides visual metrics on improvements in practical map work, diagram drawing, and other skills, while a feedback mechanism allows users to complete surveys and report issues or requests for new features.

Development of map reading achievement test (MRAT)

The instrument consisted of two sections: Section A and Section B. Section A generated data on students' bio-data, while Section B provided information on students' cognitive achievement. The test was developed by the researcher in line with the Geography concepts taught to students. The test instrument consisted of 60 objective test items with four options (A–D), containing one correct answer and three distractors (see Appendix D, page 156). The items focused on knowledge, comprehension, and application, which are lower cognitive domain levels, because they are suitable for assessing secondary school students' foundational understanding and basic application of learned concepts. The test was used to gather data on students' achievement after the treatments (posttest). The test blueprint (table of specification) is presented in Table 2.

Table 2: Table of Specification for (MRAT) Construction

S/N	Test Items	Knowledge (30%)	Comprehension (34%)	Application (36%)	Total
1	Concept and meaning of map scale (25%)	5	5	5	15
2	Types of map scales with examples (25%)	5	5	5	15
3	Uses of map scales (50%)	8	10	12	30
Total		**18**	**20**	**22**	**60**

Source: Field survey

Development of map reading retention test (MRRT)

The Map Reading Retention Test (MRRT) was composed of the same questions as the Map that the MRRT items were derived from the MRAT items, which were interchanged such that questions 21–30 became questions 1–10, and questions 11–20 became questions 1–10. The options A–D were also interchanged accordingly.

Development of students' interest questionnaire (SIQ)

Reading Achievement Test (MRAT); nevertheless, the questions were reshuffled. This means This questionnaire is constructed to help evaluate how these digital tools influence students' interest and engagement and also assess students' interest levels in map reading, Identify areas of difficulty or disinterest, Guide teachers in making map reading more engaging and Collect feedback for improving geography lessons. Section A consist of Bio-data information of students such as their name, class, age and gender. Section B Likert scale consist of 20 items were measured on five most commonly response options namely Strongly Disagree (SD)=5 points, Disagree (D)=4points, Neutra (N)=3points, Strongly Agree (SA)=2 points and Agree (A)=1point, (See Appendix E page 172). The students' interest was determined with arithmetic means of 3.0 and above as acceptable mean target while a mean less than 3.0 considered unacceptable.

Validation of the Research Instruments

1. **Validity of educreation and piktochart**: Educreation and Piktochart which are the treatment packages were given to three educational technology experts from Department of Educational Technology, Federal University of Technology, Minna, with three computer experts from Department of Computer Science, Federal University of Technology, Minna and three teachers from senior secondary schools in order to determine the following; logical presentation, subject matter content and coverage, its appropriateness in terms of clarity and simplicity, text, spelling, colour used, as well as the font size used. Useful suggestions made by the experts were used to amend the packages.
2. **Validity of map reading achievement test (MRAT):** MRAT was subjected to experts for Face and content validation. Three educational Technology lecturers, three lectures in Science Education Department, three lecturers in the Department of Geography, all in Federal University of Technology, Minna. Similarly, three teachers from senior secondary schools also validated the instrument because they are the teachers taking those subject/topic at secondary school level. The experts checked the face validity of MRAT items in terms of arrangement and logical sequence. On the content validity, the experts checked the instructional objectives covered, the appropriateness of the instructional plans, sufficiency of test items, rational order as well as appropriateness of the geographical terms used. The corrections pointed out by the experts were used to modify the items.
3. **Validity of students' interest questionnaire (SIQ):** To ensure the validity of the SIQ instrument, the draft items were presented to subject-matter experts and educational psychologists from Department of Science Education, Federal University

of Technology, Minna, for review. Their inputs were used to refine the items, ensuring that they were age-appropriate, culturally relevant, and aligned with the study objectives. The validators' comments are presented in Appendix F (page 174).

Reliability of the Research Instruments

To establish the reliability of the instruments, both the Map Reading Achievement Test (MRAT) and the Geography Interest Questionnaire (GIQ) were subjected to a pilot study. The pilot school was part of the study population but not included in the sampled schools for the main study. The MRAT, consisting of 60 validated multiple-choice items, was administered twice to 30 students using the test–retest method. The two sets of scores were analysed using the Pearson Product Moment Correlation (PPMC), which yielded a coefficient of 0.89 ($p < .001$), indicating a very strong positive correlation which shows that the instrument was reliable (See Appendix G page 182). In addition, the GIQ, made up of 20 Likert-type items, which was administered once to the same students, and its internal consistency was determined using ronbach's Alpha, which produced an alpha value of 0.92). The reliability index exceeded 0.70 threshold recommended by Edmonds and Kennedy (2017), confirming that the instruments were highly reliable for the main study.

Method of Data Collection

The researcher obtained an introductory letter from the Head of the Department of Educational Technology to gain access to the study area and visited the six sampled school authorities to obtain permission and train the research assistants on the operational guides of the treatment instruments. The pretest was administered in the third week of the study to assess the students' entry behaviour. From the fourth to the eighth weeks, the treatments were administered. In the ninth week, the MRAT was administered to students in the groups simultaneously. After the administration of the test items, there was an interval of two weeks before the administration of the retention test (MRRT). It is important to note that, at every point during the administration of the tests, the numbering and options were reshuffled so that they appeared different from those in the pretest. The time frame for the research study is presented in Appendix I (page 190).

Method of Data Analyses

The data obtained from both groups were analysed using descriptive and inferential statistics. Descriptive statistics such as mean and standard deviation were used to answer the research questions. Similarly, inferential statistics were used to test the six null

hypotheses at 0.05 level of significance. Analysis of Variance (ANOVA) was used at the pre-test stage to determine whether a significant difference existed between the groups. Where a significant difference was found, Analysis of Covariance (ANCOVA) was employed at the post-test stage to adjust for pre-existing group differences identified at the pre-test. Furthermore, when the ANCOVA result revealed a significant difference, the Sidak post hoc test was used to determine the direction and source of the difference among the groups. The entire analysis was carried out using the Statistical Package for the Social Sciences (SPSS) version 23.0.

1. Pretest result

The analysis of variance (ANOVA) was conducted to determine whether there were significant differences in the pre-test mean scores of students' academic achievement and interest across the three instructional groups prior to treatment as presented in Table 4.1 and Table 4.2.

Table 3: Pretest Analysis of Variance (ANOVA) on Academic Achievement of Geography Students

		Sum of Squares	df	Mean Square	F	Sig.
Pretest Academics Achievement	Between Groups	4304.656	2	2152.328	11.930	.000
	Within Groups	78478.953	435	180.411		
	Total	82783.610	437			

In Table 3, the ANOVA result for academic achievement revealed an F-value of 11.930 with a p-value of .000, which is less than the 0.05 level of significance. This indicates that there was a statistically significant difference in the pretest academic achievement scores among the groups before the experimental treatment.

Table 4: Pretest Analysis of Variance (ANOVA) on Interest Score of Geography Students

		Sum of Squares	df	Mean Square	F	Sig.
Pretest Interest	Between Groups	2321.288	2	1160.644	9.635	.000
	Within Groups	52401.588	435	120.463		
	Total	54722.877	437			

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Similarly, Table 3 ANOVA result showed an F-value of 9.635 with a p-value of .000, also less than 0.05. This implies that there was a significant difference in students' pretest interest scores among the groups prior to the intervention.
However, since these differences occurred at the pretest stage, they may be attributed to initial group variations rather than the effects of the instructional strategies. Therefore, in subsequent analyses, ANCOVA was employed to control for these initial differences in pretest scores when examining the posttest outcomes.

Analysis of research questions

Research Question One: What is the difference in the mean academic achievement scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools Student in Minna, Niger State?
The results of this analysis are presented in Table 4.3 and interpreted accordingly.

Table 5: Mean and Standard Deviation of Academic Achievement Scores of Geography Students Taught Map Reading Concepts Using Educreation, Piktochart, and the Conventional Approach

Group	Strategy	N	Pretest		Posttest		Mean Gain
			$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	
Experimental I	Educreation	121	27.75	15.63	57.07	10.14	29.32
Experimental II	Piktochart	157	20.78	12.44	58.35	12.52	37.57
Control Group	Conventional	160	20.71	12.54	48.99	6.96	28.28

$\bar{x}_1$: Mean of Pretest; SD_1= Standard Deviation of Pretest; $\bar{x}_2$: Mean of Posttest; SD_2= Standard Deviation of Posttest

Table 5 shows that the Experimental Group I (students taught using Educreation) had a pretest mean score of 27.75 with a standard deviation of 15.63, and a posttest mean score of 57.07 with a standard deviation of 10.14, resulting in a mean gain of 29.32. The Experimental Group II (students taught using Piktochart) recorded a pretest mean score of 20.78 with a standard deviation of 12.44, and a posttest mean score of 58.35 with a standard deviation of 12.52, giving a mean gain of 37.57. The Control Group (students taught using the conventional method) had a pretest mean of 20.71 and a posttest mean of 48.99, resulting in a mean gain of 28.28.
From these results, all three instructional approaches improved students' academic achievement in map reading. However, the Piktochart group recorded the highest mean gain (37.57), indicating that the use of Piktochart was the most effective in enhancing

students' achievement, followed by Educreation (29.32) and the conventional method (28.28).

Furthermore, the posttest standard deviations indicate that Educreation (SD = 10.14) and Piktochart (SD = 12.52) produced relatively more consistent student performance compared to the pretest scores, which showed wider variability. In contrast, although the conventional group had a smaller posttest standard deviation (6.96), its lower mean gain suggests less instructional impact compared to the technology-enhanced approaches.

Research Question Two: What is the difference in the mean retention scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools Student in Minna, Niger State?

To address this research question, data collected were analysed using mean and standard deviations. The results of this analysis are presented in Table 4.4 and interpreted accordingly

Table 6: Mean and Standard Deviation of Posttest and Retention Scores of Students Taught using Educreation, Piktochart platforms and Conventional Approach

Group	Strategy	N	Posttest		Retention		Mean Loss
			$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	
Experimental I	Educreation	121	57.07	10.14	56.03	9.88	1.04
Experimental II	Piktochart	157	58.35	12.52	57.01	12.32	1.34
Control Group	Conventional	160	48.99	6.96	41.04	14.20	7.95

$\bar{x}_1$: Mean of Pretest; SD_1= Standard Deviation of Pretest; $\bar{x}_2$: Mean of Posttest; SD_2= Standard Deviation of Posttest

Table 6 presents the posttest and retention mean scores of students taught Map Reading concepts using Educreation, Piktochart, and the Conventional instructional approach. The table also shows the mean gain or loss in achievement between the posttest and retention stages. For the Experimental Group I (Educreation), students recorded a posttest mean score of 57.07 (SD = 10.14) and a retention mean score of 56.03 (SD = 9.88), resulting in a slight mean loss of 1.04. This indicates that students' performance dropped marginally between the posttest and the retention assessment.

In the Experimental Group II (Piktochart), the posttest mean score was 58.35 (SD = 12.52), while the retention mean score declined to 57.01 (SD = 12.32), yielding a mean loss of 1.34. Similar to the Educreation group, students in this group also experienced a minimal decline in retention performance, although the loss was slightly higher than that observed in the Educreation group. In contrast, the Control Group (Conventional method) showed a posttest mean score of 48.99 (SD = 6.96) and a retention mean score of 41.04 (SD =

14.20), resulting in a substantial mean loss of 7.95. This notable decline indicates a marked reduction in students' retention of Map Reading concepts when taught through the conventional approach.

Research Question Three: What is the difference in the mean interest scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools Student in Minna, Niger State? The results of this analysis are presented in Table 7 and interpreted accordingly

Table 7: Mean and Standard Deviation of Interest Scores of Geography Students Taught Using Educreation, Piktochart, and the Conventional Approach

Group	Strategy	N	Pretest		Posttest		Mean Gain
			$\bar{x}_1$	SD_1	$\bar{x}_2$	SD_2	
Experimental I	Educreation	121	44.88	9.37	64.76	15.54	19.88
Experimental II	Piktochart	157	40.32	8.67	63.09	19.30	22.77
Control Group	Conventional	160	45.29	13.77	49.59	16.44	4.30

$\bar{x}_1$: Mean of Pretest; SD_1= Standard Deviation of Pretest; $\bar{x}_2$: Mean of Posttest; SD_2= Standard Deviation of Posttest

Table 7 reveals that the Experimental Group I (Educreation) had a pretest mean interest score of 44.88 with a standard deviation of 9.37, and a posttest mean score of 64.76 with a standard deviation of 15.54, resulting in a mean gain of 19.88. The Experimental Group II (Piktochart) recorded a pretest mean score of 40.32 (SD = 8.67) and a posttest mean score of 63.09 (SD = 19.30), yielding a mean gain of 22.77. The Control Group (Conventional method) obtained a pretest mean score of 45.29 (SD = 13.77) and a posttest mean score of 49.59 (SD = 16.44), giving a mean gain of 4.30. From these results, all three instructional strategies led to an improvement in students' interest in Geography, particularly in map reading concepts. However, students exposed to the Piktochart platform recorded the highest mean gain (22.77), indicating that it was the most effective in enhancing learners' interest. This was closely followed by those taught using Educreation (mean gain = 19.88), while the Conventional group showed only a modest increase in interest (mean gain = 4.30).

Hypothesis One

The results of hypothesis one which state that there is no significant difference between the academic achievement scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools in Student in Minna, Niger State is present in Table 4.9.

Table 8: Summary of ANCOVA on Academic Achievement Scores of Students Taught Using Educreation, Piktochart, and Conventional Methods

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8089.954[a]	3	2696.651	26.356	.000
Intercept	340410.379	1	340410.379	3327.079	.000
Pretest (Covariate)	112.308	1	112.308	1.098	.295
Group (Treatment)	8082.218	2	4041.109	39.497	.000*
Error	44404.749	434	102.315		
Total	1,357,282.000	438			
Corrected Total	52,494.703	437			

[a] *R Squared = .154 (Adjusted R Squared = .148) Significant at 0.05 level*

The analysis of covariance (ANCOVA) presented in Table 4.8 tested the effect of instructional strategies (Educreation, Piktochart, and Conventional method) on students' academic achievement in Map Reading, after controlling for pretest scores. The result revealed a significant main effect of treatment on students' achievement, $F(2, 434) = 39.497$, $p < .05$. This indicates that the instructional strategy used had a statistically significant influence on students' academic achievement in Geography.

Since the calculated p-value (.000) is less than 0.05, the null hypothesis (Ho_1) which states that there is no significant difference in the academic achievement of students taught using Educreation, Piktochart, and Conventional methods is rejected. This implies that the observed differences in posttest mean achievement among the groups were not due to chance but to the different instructional approaches employed.

To determine the direction of these differences, a post hoc (Sidak) analysis was conducted, as shown in Table 9.

Table 9: Sidak Post Hoc Analysis of Mean Academic Achievement Scores of Students Taught Using Educreation, Piktochart, and Conventional Methods

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
EXP GRP I (Educreation)	EXP GRP II (Piktochart)	-1.28	1.224	.654
	Control (Conventional)	8.08*	1.219	.000
EXP GRP II (Piktochart)	EXP GRP I (Educreation)	1.28	1.224	.654
	Control (Conventional)	9.36*	1.136	.000
Control (Conventional)	EXP GRP I (Educreation)	-8.08*	1.219	.000
	EXP GRP II (Piktochart)	-9.36*	1.136	.000

Significant at 0.05 level

The Sidak multiple comparison test in Table 9 revealed no significant difference between the two experimental groups (Educreation and Piktochart) with a mean difference of 1.28 ($p > .05$). However, both experimental groups differed significantly from the control group.

Specifically, students taught with the Educreation platform achieved significantly higher posttest scores than those taught with the Conventional method (Mean Difference = 8.08, $p < .05$). Likewise, students taught with the Piktochart platform outperformed those in the Conventional group (Mean Difference = 9.36, $p < .05$). This indicates that while both Educreation and Piktochart methods were equally effective in enhancing students' academic achievement, they were significantly more effective than the traditional Conventional teaching approach.

Hypothesis Two

The results of hypothesis two which state that there is no significant difference between the retention scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools Student in Minna, Niger State is present in Table 10.

Table 10: Summary of ANCOVA on Retention Scores of Students Taught Using Educreation, Piktochart, and Conventional Methods

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	52036.860[a]	3	17345.620	188.118	.000
Intercept	995.450	1	995.450	10.796	.001
Posttest (Covariate)	27439.049	1	27439.049	297.584	.000
Group (Treatment)	6434.725	2	3217.362	34.893	.000
Error	40017.487	434	92.206		
Total	1227216.000	438			
Corrected Total	92054.347	437			

[a] *R Squared = .323 (Adjusted R Squared = .318) Significant at 0.05 level*

The analysis of covariance (ANCOVA) presented in Table 8 examined the effect of the instructional strategies Educreation, Piktochart, and Conventional methods on students' retention of Geography Map Reading concepts, while controlling for posttest achievement scores. The results revealed a significant main effect of treatment on students' retention, $F(2, 434) = 34.893$, $p < .05$, indicating that the instructional strategy used significantly influenced how well students retained what they learned. Since the p-value (.000) is less than 0.05, the null hypothesis (Ho_2) which stated that there is no

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significant difference in students' retention scores across the three instructional methods, is rejected. To identify where these differences lie, a Sidak post-hoc analysis was conducted and presented in Table 11.

Table 11: Sidak Post Hoc Analysis of Mean Retention Scores of Students Taught Using Educreation, Piktochart, and Conventional Methods

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
EXP GRP I (Educreation)	EXP GRP II (Piktochart)	-.98	1.506	.886
	Control (Conventional)	14.99*	1.500	.000
EXP GRP II (Piktochart)	EXP GRP I (Educreation)	.98	1.506	.886
	Control (Conventional)	15.97*	1.399	.000
Control (Conventional)	EXP GRP I (Educreation)	-14.99*	1.500	.000
	EXP GRP II (Piktochart)	-15.97*	1.399	.000

Significant at 0.05 level

Table 11 presents the Sidak post hoc comparison of mean retention scores among students taught using Educreation, Piktochart, and the Conventional instructional method. The results show that the difference in retention between the two experimental groups Educreation and Piktochart was not statistically significant. The mean difference between Educreation and Piktochart was –0.98 (p = .886), indicating that both technology-based instructional platforms produced comparable retention outcomes.
However, significant differences were observed when each experimental group was compared with the Conventional group. Students taught with the Educreation platform performed significantly better in retention than those in the Conventional group, with a mean difference of 14.99 (p = .000). Similarly, the Piktochart group demonstrated significantly higher retention than the Conventional group, with a mean difference of 15.97 (p = .000). These results confirm that both Educreation and Piktochart were markedly more effective in enhancing students' long-term retention of Map Reading concepts than the traditional approach.

Hypothesis Three

The results of hypothesis three which state that there is no significant difference between the interest scores of Geography students' taught Map Reading concepts using Educreation, Piktochart platforms in secondary schools Student in Minna, Niger State is present in Table 10.

Table 12: Analysis of Covariance (ANCOVA) on Interest Scores of Experimental and Control Groups

Source	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	22531.027[a]	3	7510.342	25.411	.000
Intercept	117374.929	1	117374.929	397.136	.000
Pre-Interest (Covariate)	1779.277	1	1779.277	6.020	.015
Group (Treatment)	19230.808	2	9615.404	32.534	.000
Error	128270.299	434	295.554		
Total	1655837.000	438			
Corrected Total	150801.326	437			

[a] R^2 = .149 (Adjusted R^2 = .144) *Significant at 0.05 level*

The result in Table 12 shows that there was a significant main effect of treatment on students' interest in Map Reading concepts, $F(2, 434) = 32.534$, $p < .05$. This implies that the teaching approach significantly influenced students' interest scores after controlling for pretest interest levels. Hence, the null hypothesis (H_{03}) which stated that there is no significant difference in students' interest across the three instructional methods was rejected. This finding indicates that the differences in students' posttest interest were not due to chance but to the specific instructional strategies employed (Educreation, Piktochart, and Conventional methods). To identify where these differences lie, a Sidak post-hoc analysis was conducted and presented in Table 4.14.

Table 13: Sidak Post-hoc Analysis on Mean Interest Scores of Students Taught Using Educreation, Piktochart, and Conventional Methods

(I) Group	(J) Group	Mean Difference (I–J)	Std. Error	Sig.
Educreation	Piktochart	1.67	2.092	.810
Educreation	Control	15.17*	2.083	.000
Piktochart	Educreation	-1.67	2.092	.810
Piktochart	Control	13.50*	1.942	.000
Control	Educreation	-15.17*	2.083	.000
Control	Piktochart	-13.50*	1.942	.000

Significant at 0.05 level

The Sidak post-hoc results presented in Table 13 indicate that there was no statistically significant difference in the mean interest scores between students taught using the Educreation and Piktochart platforms, with a mean difference of 1.67 ($p > .05$). However, both experimental groups performed significantly better than the control group.

Students taught with the Educreation platform demonstrated significantly higher interest scores than those taught using the conventional method (Mean Difference = 15.17, $p < .05$). Similarly, students exposed to the Piktochart platform showed significantly greater interest than those in the control group (Mean Difference = 13.50, $p < .05$).

These findings suggest that both Educreation and Piktochart are highly effective in fostering students' interest in learning Map Reading concepts compared to the conventional approach. While Educreation produced a slightly higher mean interest score than Piktochart, the difference between the two technology-based methods was not statistically significant.

Summary of findings

The summary of the findings from the research questions and hypotheses is presented as follows:

1. There was a clear difference in the mean academic achievement scores of Geography students taught Map Reading concepts using Educreation and Piktochart, with both outperforming the conventional method and Educreation showing a slightly higher mean gain.
2. Students taught Map Reading concepts with Educreation and Piktochart retained learned content better than those taught through the conventional approach, indicating that both digital platforms supported stronger learning retention.
3. The mean interest scores of Geography students varied significantly across the instructional groups, with Educreation and Piktochart enhancing students' interest in Map Reading more than the conventional method.
4. There was a significant difference between the academic achievement scores of Geography students taught Map Reading concepts using Educreation, Piktochart, and those taught with the conventional method, leading to the rejection of the null hypothesis.
5. There was a significant difference in the retention scores of Geography students taught Map Reading concepts using Educreation and Piktochart compared to the conventional group, hence the null hypothesis was rejected.
6. There was a significant difference in the interest scores of Geography students taught Map Reading concepts using Educreation and Piktochart compared to those taught through the conventional method, leading to the rejection of the null hypothesis.

Discussion of Results

The findings of the study on the impact of Educreation and Piktochart on Geography students' academic achievement, retention, and interest in secondary schools in Shiroro

Local Government Area, Niger State, Nigeria, revealed that Geography students taught Map Reading concepts using Educreation and Piktochart achieved significantly higher academic achievement scores than those taught with the conventional method, with Educreation showing a slightly higher mean gain. This led to the rejection of the null hypothesis that there is no difference in academic achievement across the instructional approaches.

The superior academic performance of students in the experimental groups can be attributed to the interactive and visually stimulating nature of the Educreation and Piktochart platforms. These digital tools provide dynamic content presentation, such as animations, infographics, and multimedia explanations, which cater to multiple learning styles, enhance cognitive engagement, and facilitate better understanding of abstract Map Reading concepts. By providing opportunities for learners to interact with content, visualize spatial data, and organize information meaningfully, these platforms reduce cognitive overload and strengthen comprehension, ultimately improving academic achievement. This finding aligns with Smith and Kelly (2021), who reported that differentiated instruction using Educreation significantly enhanced Geography students' concept understanding. Similarly, Smith and Li (2023) found that Piktochart improved learners' comprehension and retention in Geography by presenting complex information in a visually appealing and structured format. Pappas (2022) highlighted that Educreation promotes active learning, personalized instruction, and greater engagement, all of which positively influence academic outcomes. Sweller (2011) further supports this assertion by emphasizing the efficiency of multimedia learning in managing cognitive load, thereby enhancing knowledge acquisition. Additionally, Abbazioa and Yang (2022) demonstrated that infographics improve information retention, reinforcing the effectiveness of Piktochart as a visual learning tool.

The study revealed that Geography students taught Map Reading concepts using Educreation and Piktochart retained learned content significantly better than those taught using the conventional method. This confirms the effectiveness of these digital platforms in promoting long-term retention of knowledge and led to the rejection of the null hypothesis that there is no difference in retention across instructional approaches. The superior retention observed among students in the Educreation and Piktochart groups can be attributed to the interactive and visually enriched nature of these platforms. Both tools allow learners to revisit, manipulate, and engage with content in multiple ways, which reinforces memory consolidation. Features such as animated explanations, infographics, and step-by-step demonstrations help students encode and retrieve information more effectively. By catering to different learning styles visual, auditory, and kinesthetic these platforms reduce cognitive overload and facilitate

meaningful learning, which translates to higher retention of Map Reading concepts over time. This finding aligns with Abbazioa and Yang (2022), who reported that infographics improve learners' information retention, while Pappas (2022) highlighted that Educreation supports repeated engagement with content, strengthening long-term memory. Additionally, Orocio and Linaugo (2023) reported that screencast-based and interactive tools improve learners' sustained understanding and recall in science education, reinforcing the current study's findings.

The study found that Geography students taught Map Reading concepts using Educreation and Piktochart reported significantly higher mean interest scores than those taught using the conventional method. This indicates that the digital platforms were more engaging and interactive, leading to the rejection of the null hypothesis that there is no difference in students' interest across instructional approaches.

The heightened interest observed among students in the Educreation and Piktochart groups can be linked to the multimedia-rich, interactive, and visually stimulating features of these platforms. By incorporating animations, infographics, and interactive content, learners are more actively involved in the learning process, which enhances motivation and intrinsic engagement. The ability to manipulate content, revisit lessons at their own pace, and receive immediate feedback fosters curiosity and sustains attention, making learning more enjoyable and meaningful. Such features also support differentiated instruction by accommodating various learning styles, further boosting student engagement.

These findings are supported by Pappas (2022) who emphasized that Educreation promotes active participation and sustained interest through multimedia content and personalized learning pathways. Thompson, Davis, and Moore (2022) also highlighted that multimedia platforms like Educreation enhance student motivation and engagement in classroom instruction. Additionally, Singh *et al*. (2022) and Schrank (2021) reported that infographics and visually structured instructional materials effectively capture learners' attention and stimulate cognitive and emotional involvement, aligning with the current study's findings.

The study revealed that both male and female Geography students achieved high academic performance when taught Map Reading concepts using Educreation and Piktochart, with minimal differences between genders. However, students of both genders in the experimental groups significantly outperformed their counterparts in the conventional method, confirming the effectiveness of the digital platforms and leading to the rejection of the null hypothesis. The minimal gender differences observed suggest that Educreation and Piktochart provide equitable learning opportunities for all students. The interactive and multimedia-rich features of these platforms facilitate comprehension,

allow for self-paced learning, and cater to diverse learning styles, thereby minimizing the influence of gender on academic outcomes. Moreover, both male and female students can revisit content, manipulate visual aids, and engage with the material actively, which supports a more inclusive learning environment and promotes high achievement across genders.

These findings are consistent with Smith and Kelly (2021), who reported that Educreation effectively enhanced Geography students' understanding and performance irrespective of gender. Similarly, Hidayat *et al*. (2024) noted that technology-based learning applications increase students' engagement and comprehension, benefiting all learners equally. Additionally, Thompson, Davis, and Moore (2022) highlighted that multimedia platforms reduce traditional barriers and foster equity in learning, which aligns with the negligible gender differences observed in the present study.

The study found that differences in retention scores between male and female Geography students taught Map Reading concepts using Educreation and Piktochart were marginal, indicating that both genders benefited similarly from the technology-based platforms. Furthermore, both male and female students in the experimental groups retained learned content significantly better than their counterparts in the conventional group, confirming the platforms' effectiveness in promoting long-term retention and leading to the rejection of the null hypothesis.

The similar retention outcomes across genders can be attributed to the interactive, visual, and self-paced nature of Educreation and Piktochart, which reinforce learning and allow students to revisit content as needed. The use of multimedia, diagrams, and animations helps in embedding knowledge into long-term memory by catering to multiple learning styles, thus minimizing gender-based differences in retention. This aligns with cognitive load theory, which suggests that well-structured visual content can enhance understanding and recall for all learners (Sweller, 2011).

These results are consistent with Abbazioa and Yang (2022), who reported that infographics and interactive visual content enhance information retention across learners. Moreso Thompson *et al*. (2022) also emphasized that technology-based instructional platforms improve knowledge retention by providing dynamic, revisit able learning experiences that benefit all students equally.

The study revealed that there were no significant gender differences in the interest scores of Geography students taught Map Reading concepts using Educreation and Piktochart. Both male and female students demonstrated significantly higher interest than their counterparts taught using the conventional method, leading to the rejection of the null hypothesis. The comparable interest levels across genders can be attributed to the interactive and visually appealing nature of Educreation and Piktochart, which actively

engage students through multimedia elements such as animations, diagrams, and interactive quizzes. These features foster curiosity, motivation, and active participation, creating a stimulating learning environment that equally appeals to male and female students. Technology-driven platforms also allow self-paced exploration, which can enhance students' intrinsic motivation and engagement, thereby increasing overall interest. These findings align with Singh *et al*. (2022), who observed that infographics-based teaching processes significantly enhance student engagement and interest across genders. Thompson *et al.* (2022) also emphasized that digital and interactive learning platforms contribute to higher engagement by providing personalized, dynamic, and visually stimulating experiences that appeal to all learners.

Conclusion

The findings of this study on the impacts of Educreation and Piktochart on Geography students' learning outcomes in secondary schools in Shiroro Local Government Area, Niger State, Nigeria, revealed that technology-enhanced instructional platforms significantly improve learning outcomes compared to conventional teaching methods. Students taught Map Reading concepts using Educreation and Piktochart achieved higher academic performance, demonstrating the effectiveness of digital tools in facilitating understanding and mastery of Geography concepts.

Both Educreation and Piktochart supported stronger retention of learned content, indicating that technology-based methods promote durable knowledge acquisition over time. Additionally, students' interest in Map Reading was significantly higher with both platforms, showing that interactive digital platforms enhance engagement, motivation, and enjoyment in learning. Analyses of gender differences indicated minimal variation between male and female students within the experimental groups, suggesting that Educreation and Piktochart provide inclusive benefits across genders. Furthermore, students in the experimental groups significantly outperformed their counterparts taught with the conventional approach, reinforcing the superiority of technology-enhanced instructional methods. Thus, the study demonstrates that Educreation and Piktochart are effective, engaging, and gender-inclusive instructional platforms that offer a viable alternative to conventional teaching methods in secondary school Geography education.

Recommendations

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

1. Geography teachers should integrate Educreation and Piktochart into lesson delivery to enhance academic achievement, knowledge retention, and student interest.
2. Secondary schools should provide resources and training to support the use of technology-enhanced instructional platforms in Geography teaching.

3. Curriculum planners should include interactive digital tools in Geography teaching materials to improve engagement and learning outcomes.
4. Educational policymakers should implement policies to facilitate technology integration and teacher training for digital instructional platforms.
5. Future research should investigate the effectiveness of Educreation and Piktochart on other Geography topics and in other levels of secondary education.
6. Technology-based instructional strategies should be promoted for their gender-inclusive benefits in learning Geography concepts.

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EDITOR-IN-CHIEF
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