

EFFECTS OF INTELLIGENT TUTOR SYSTEM ON STUDENTS' ACHIEVEMENT IN COMPUTER GRAPHICS IN UNIVERSITIES IN ENUGU STATE

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Abstract

This study determined the effects of an Intelligent Tutor System (ITS) on students' achievement in computer graphics in universities in Enugu state Nigeria. The study adopted a quasi-experimental design. The population of the study is 171 final year computer education students in the four universities in the area that offer computer education in the 2022/2023 academic session. 130 computer education students from two intact classes were used as sample for the sample study. The instrument that was used for data collection was the Computer Graphics Achievement Test (CGAT). Kuder Richardson formula 20(K-R 20) was used to determine the reliability of CGAT, which yielded a reliability index of 0.92. The data collected were analysed using mean, standard deviation and analysis of covariance (ANCOVA). The hypotheses were tested at 0.05 level of significance. The result of the study shows that students who were taught using ITS had higher mean achievement scores compared to those taught using the conventional lecture method. There was also a significant difference in the mean achievement and interest scores of students based on method of instruction used in teaching computer graphics. The male students taught computer graphics using ITS had a slightly higher mean and interest scores when compared to their female counterparts. However, there was no significant difference in the mean achievement scores of the students based on gender. It was therefore recommended that ITS be included in the computer graphics programme in universities to foster effective utilization in teaching considering its benefits.

Keywords: Effect Intelligent Tutor System, Students' Achievement, Computer Graphics, Universities.

Introduction

The importance of graphical presentation in teaching and learning cannot be overemphasized. This graphical presentation has the ability to catch learners' attention to learned material, hence leading to improved learning for those who have adopted this technique. Therefore, the knowledge of the use of graphic applications has become necessary for teachers in training institutions around the world. Now, computer graphics is an essential course of study for most computer education related disciplines in tertiary institutions in Nigeria.

Computer Graphics is a creative visual/innovation process of communication that combines art and technology to communicate ideas to the audience (Ablameyko & Pridmore, 2018). It requires a calculative, initiative and creative mind depends on more cognitive and psychomotor domain/ability of individuals. Computer graphics is an eye-catching mode of communication for attraction and money making by the designers. According to Ablameyko and Pridmore (2012), Computer graphic is defined as an interdisciplinary, problem-solving activity which combines visual sensitivity with skill and knowledge in areas of communications, technology and business. The author further posited that the computer graphic process is a problem-solving process, one that requires substantial creativity, innovation and technical expertise. Graphic design requires a lot of skill (Ablameyko & Pridmore 2017). Some of the major contents of computer graphics are: definition of computer graphics, applications of computer graphics, element of computer graphics, Categories of computer graphic, mapping of an object to a graphics device, displaying a graphics pipeline, computer Animation, computing objects into a group, creating a multipage spread, three Dimensional graphic designs, basics of three dimensional transformations, 3D translation and rotation, transformations using clip arts, using rendition shapes, Appearance and revising of objects or images (John Wiley, 2016).

An image is basically representation of a real-world object on a computer. It can be an actual picture display, a stored page in a video memory, or a source code generated by a program. Mathematically, an image is a two-dimensional array of data with intensity or a color value at each element of the array. Image representation is the approximations of the real world displayed in a computer. a picture graphics is represented as a collection of discrete picture elements termed as pixels. A “Picture” is a “scene” consists of different objects. The individual objects are represented by coordinates called as “model” or “local” or “master” coordinates (Robert, 2016). These images could be in 2D or 3D format.

The basic idea of the 3D viewing transformation is similar to the 2D viewing transformation. That is, a viewing window is defined in world space that specifies how the viewer is viewing the scene. A corresponding view port is defined in screen space based on these specifications. The application of fractal has mostly been in the field of animations, motion pictures and visualizations by Dam (2019). Skills can be acquired through university education. Which includes the basic knowledge of computer graphics, skills, ideas and the basic terminologies related to the computer graphic? The researcher further explains that, computer graphic is also the potentials of a computer system, how a computer graphic can be used to solve different problems of day-to-day life issues or how intelligent tutor system can

be programmed to solve the extreme problem. Interestingly, introduction of computer graphics in schools has brought about an awareness of the indispensable use of computers which has positively enhanced student's academic achievement in computer graphics among 400L students in Universities (John Wiley, 2016).

Computer graphics in university education refers to a large and diverse institution of higher learning created to educate students for life and for professional certification. Golchai, Nazari, Hassani and Bahadori (2012) defined university education as an institution of learning that provides training in order to prepare students to work in various sectors of the economy. According to Ejiofor and Nwakile (2016), university education is the totality of specialized knowledge and skills that enable graduates to solve problems encountered in industry or to perform scientific research or pedagogical work within their area of specialization. Therefore, university education is an establishment of higher learning that provides professional training to students to achieve self-reliance and achievement.

However, existing literature have shown that students' performance in computer graphics is not very good (González Campos, Sánchez-Navarro, & Arnedo-Moreno, 2019; Nyah, 2014; Agbatogun & Banjo, 2010). The result of 400L students of the University of Nigeria Nsukka in 2022/2023 showed that only 6% scored "A" while only 24% scored "B" and 19% scored "C". A total of 51% of the students scored below 50. Similar results were observed in other tertiary education institution in Enugu State Nigeria. These findings are disturbing because the course, computer graphics is supposed to be entertaining and attention catching because it involves the design and constructions of beautiful images, yet students recorded low achievement.

Achievement refers to a thing done successfully with effort, skill, or courage. According to Hancock and Algozzine (2017), achievement in education specifically refers to students' success in learning specified aspect of curriculum content. Blikstein (2018) stated that students' achievement has a close link with the method of instructional delivery use in the process of teaching and learning. Students' achievement is greatly influenced by teaching methods, instructional delivery channel and students' ability to transfer information to long term memory. Student's memory attainment in course or subject, includes excellence in academic pursuit, behaviour, confidence, communication skill, punctuality, assertiveness, social skill, and likes. Students' achievement is commonly measured by their success in classroom assignment, exercise, continuous assessment test or examination. Students' poor achievement is largely attributed to poor instructional strategies employed by lecturers in a

class due to an inappropriate medium (Usulor, 2018). The author further found that these poor instructional approaches has resulted in students' lack of interest in learning.

Gender has been identified as one of the factors influencing student's achievement in computer appreciation (Cassidy, 2017). According to Muehlenhard and Peterson (2019), gender refers to all the characteristics of males and females which describes behaviours and attributes expected of individuals on the basis of being either a male or female in a given society. Lev (2018) stated that gender is a terminology that categorizes human beings into males and females. Concerning teaching and learning situations. Hancock and Algozzine (2017) observed that different results and views of researchers in studies of different subjects showed that male and female students perform differently as a result of cultural and traditional reasons. One of the proven ways of preventing poor achievement of students and stimulating their interest in learning is the use of interactive teaching methods, which if handled well improve the academic achievement of both male and female students in computer appreciation (Dorgu, 2016; Schmidt, Rotgans & Yew, 2018).

There is a gender gap in the use of Information and Communication Technology (ICT) (Galyani-Moghaddam, 2010). As a result of gender roles assigned by different cultures, many female students in Universities in Enugu State seem to have been brought up to see computers and it uses as reserved for the male gender. In line with this, Hill, Corbett and Rose (2019) posited that women look at computers and see more than machines, thus considering computers as masculine and complicated to use. The authors further posited that these factors could include the media depicting men as experts in technology, social expectations of different goals for boys and girls, the structure of learning tasks, the nature of feedback in performance situations and the organization of classroom settings. These factors are often subtle, they go unnoticed; it is little wonder why girls might not be as much interested in computer technology. This situation has led to what scholars have termed the gender digital divide. Explaining this, (Conole and Alevizoustate 2010), that the gender digital divide is manifested in the poor performance of female students in computer applications as compared to male students. However, there is a dearth of literature to ascertain if this is still the case in Enugu State. Furthermore, literature has suggested that the use of intelligent tutoring systems could improve students achievement in learning computer related courses, and also bridge the gender gap in achievement experienced in these computer related courses.

Intelligent tutor system is computer software designed to simulate a human instructor's skills behaviour and guidance in computer graphics (Al-Bastami & Naser, 2017). The author further posited that the system is capable of interpreting complex student responses and can

learn as they work as well as able to distinguish where and why a student's understanding has gone amiss and to give it hints to aid the student understand of the material given. Intelligent tutoring system delivers numerous of the benefits of a human instructor to very large numbers of students.

An intelligent tutoring system is application-based software that presents learning resources in a flexible and personalized way (Johnson, 2018). However, educational institutions cannot assign a human tutor to each student at any time and at anywhere, hence, intelligent tutoring system is a useful option for providing students individualized learning (Almurshidi & Naser, 2017). Intelligent tutor system can transform teaching strategies; give explanations, examples, demonstrations and practical exercises when needed (Mahdi, Alhabbash & Naser, 2016). An intelligent tutoring system is application software designed to emulate human teacher during the process of teaching and learning computer networking. The standard model of ITS architecture has four main models which are the domain model, student model, tutoring model and user interface model (Fehaid, & Naeem, 2019).

The domain model consists of the concepts, facts, rules, and problem-solving strategies of what is to be taught (Kee, 2018). The author further explained that it serves as basis for expert knowledge, a standard for assessment of the student's performance and determines the student's likely response to tutorial actions. The student model contains a great deal of knowledge regarding the student's cognitive and affective states and their evaluation as the learning process advances (Nkambou & Bourdeau, 2010). The authors further stated that student model must be lively, because it provides up to date knowledge regarding the student while using the ITS. The user interface model is the communicating channel of the ITS which controls communication between the learner and the system. The tutor model depends on the knowledge provided by student modelling so as to regulate its intelligence during development to provide immediate feedback and individualized tutoring.

Therefore, this study seeks to determine the effects of ITS on computer education students' achievement in computer graphic course in universities in Enugu State.

Purpose of the Study

The main purpose of this study is to determine the effects of an Intelligent Tutor System (ITS) on students' achievement in computer graphics in universities in Enugu state Nigeria. Specifically, the study determined the:

1. mean achievement score of students taught computer graphics with the Intelligent Tutor System (ITS) and those taught with the conventional approach

2. influence of gender on mean achievement score of students taught computer graphics using ITS
3. interaction effect of methods and gender on students mean achievement score in computer graphics

Research Questions

The following research questions guided the study.

1. What is the mean achievement score of students taught computer graphics with the Intelligent Tutor System (ITS) and those taught with the conventional approach?
2. What is the influence of gender on mean achievement score of students taught computer graphics using ITS?
3. What is the interaction effect of methods and gender on students mean achievement score in computer graphics?

Hypotheses

The following hypothesis were formulated and tested at 0.05 level of significance

- H₀₁:** There is no significant difference in the mean achievement score of students taught computer graphics with the Intelligent Tutor System (ITS) and those taught with the conventional approach
- H₀₂:** Gender does not significantly influence the mean achievement score of students when taught computer graphics using ITS
- H₀₃:** There is no significant Interaction effect of methods and gender on students' mean achievement score in computer graphics

Methodology

The study adopted a quasi-experimental design. The population of the study is 171 final year computer education students in the four universities in the in Enugu state that offer computer education in the 2022/2023 academic session. The universities include: University of Nigeria Nsukka, Enugu State University of Science and Technology, Godfrey Okoye University Enugu and Coal City University Enugu. Multi-stage sampling technique was used in selecting the sample for the study. Firstly, simple random sampling technique was used to select two universities out of the four universities that offer computer education programme. In the second stage, random sampling technique was used to assign one of the two universities to the experimental group while the other was assigned to the control group. Hence, 130 computer education students would be the sample for the study The instrument that was used

for data collection was the Computer Graphics Achievement Test (CGAT). Kuder Richardson formula 20(K-R 20) was used to determine the reliability of CGAT, which yielded a reliability index of 0.92. The data collected was analysed using mean, standard deviation and analysis of covariance (ANCOVA). The use of ANCOVA will be to control the errors of initial non-equivalence arising from the intact classes as subjects of the study. For the hypotheses any item whose significant value is less than 0.05 would be regarded as having significant difference and therefore the hypothesis would be rejected while any whose significant value is greater than or equal to 0.05 would be regarded as having no significant difference. The hypotheses were tested at 0.05 level of significance.

Results

This contains the analysis of data collected in the study under the following sub-headings: Presentation of the results, findings of the study, and discussion of findings. The data collected were analyzed based on the research and the null hypothesis generated.

Research Question One:

What is the mean achievement score of students taught computer graphics with the Intelligent Tutor System (ITS) and those taught with the conventional approach?

Table 1: Pre-test/Post test Mean and Standard Deviation (SD) of the Achievement Score of Students Taught Computer Graphics with the Intelligent Tutor System (ITS) and those Taught with the Conventional Approach

Methods	N	Pre-test		Post-test		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
ITS	70	49.61	7.76	74.46	9.97	24.85
Conv. Lecture Method	60	48.53	7.59	53.57	5.57	5.04

Table 1 shows that the students in the treatment group (taught using the Intelligent Tutor System) had a pre-test mean achievement score of ($X = 49.61$, $SD = 7.76$) and a post-test mean achievement score of ($X = 74.46$, $SD = 9.97$). Students in the control group (taught using the conventional lecture method) had a pre-test mean achievement score of ($X = 48.53$, $SD = 7.59$) and a post-test mean achievement score of ($X = 53.57$, $SD = 5.57$). This result showed that students in the treatment group taught with ITS had a mean gain score of 24.85, compared to their counterparts in the control group taught with the conventional lecture method, who had a

mean gain score of 5.04. This result shows that students who were taught using ITS had higher mean achievement scores compared to those taught using the conventional lecture method.

H₀₁: There is no significant difference in the mean achievement score of students taught computer graphics with the Intelligent Tutor System (ITS) and those taught with the conventional approach

Table 2. Analysis of Covariance of Students' Mean Achievement Scores in Computer Graphics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Remark
Corrected Model	14964.787 ^a	4	3741.197	59.796	.000	.657	Significant
Intercept	7431.991	1	7431.991	118.786	.000	.487	Significant
Pretest_CGAT	620.850	1	620.850	9.923	.002	.074	Significant
Method	13546.142	1	13546.142	216.509	.000	.634	Significant
Gender	55.806	1	55.806	.892	.347	.007	Not Significant
Method * Gender	137.598	1	137.598	2.199	.141	.017	Not Significant
Error	7820.782	125	62.566				
Total	568920.000	130					
Corrected Total	22785.569	129					

a. R Squared = .657 (Adjusted R Squared = .646)

Table 2 shows a statistically significant main effect of instructional method on mean achievement score of students in computer graphics, $F(1, 125) = 216.509$, $p < .05$. Thus, the null hypothesis was rejected, meaning that there is a significant difference in the mean achievement scores of students based on method of instruction used in teaching computer graphics. A partial eta squared of 0.634 on method showed that 63.4% of variability in students' achievement is accounted for by methods of teaching.

Research Question Two:

What is the influence of gender on mean achievement score of students taught computer graphics using ITS?

Result in Table 3 shows that male students taught computer graphics using ITS had a pre-test mean achievement score of ($X = 49.83$, $SD = 7.69$) and a post-test mean achievement score of ($X = 76.17$, $SD = 9.76$). While the female students had a pre-test mean achievement score of ($X = 49.38$, $SD = 7.77$) and a post-test score of ($X = 72.65$, $SD = 10.01$). The male students had a

mean gain of 26.34 while their female counterparts had a mean gain of 23.31. This means that the male students taught computer graphics using ITS had a slightly higher mean score as compared to their female counterparts.

Table 3. Mean ($\bar{x}$) and Standard Deviation (SD) on the Influence of Gender on the Mean Achievement Scores of Students Taught Computer Graphics Using ITS

Gender	N	Pre-test $\bar{x}$	SD	Post-test $\bar{x}$	SD	Mean Gain
Male	36	49.83	7.69	76.17	9.76	26.34
Female	34	49.38	7.77	72.65	10.01	23.31

H₀₂: Gender does not significantly influence the mean achievement score of students when taught computer graphics using ITS

The result in Table 2 shows no statistically significant main effect of gender on students' mean achievement score in computer graphics when taught using ITS, $F(1, 125) = .892, p > .05$. The null hypothesis was therefore not rejected, meaning that there was no significant difference in the mean achievement scores of male and female students taught computer graphics course using ITS.

Research Question Three:

What is the interaction effect of methods and gender on students mean achievement score in computer graphics?

Table 4. Estimated Marginal Means on Interaction Effect of Methods and Gender on Students Mean Achievement Score in Computer Graphics

Gender	Method	N	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Male	Intelligent Tutor System (ITS)	36	76.17	1.36	73.47	78.87
	Conventional Lecture Method	29	52.86	1.52	49.85	55.87
Female	Intelligent Tutor System (ITS)	40	72.65	1.40	69.87	75.43
	Conventional Lecture Method	31	54.23	1.47	51.32	57.14

Results in Table 4 showed the estimated marginal mean of interaction between methods and gender on students mean achievement scores in computer graphics. The male students taught using ITS had an adjusted mean achievement score of 76.17 while their female counterparts had an adjusted mean of 72.65. Also, the male students taught with the conventional lecture method had an adjusted mean of 52.86, while their female counterparts had an adjusted mean

of 54.23. This result suggests an interaction of method with gender since the male students recorded a higher mean with ITS while the female students recorded higher estimated mean in the conventional lecture method.

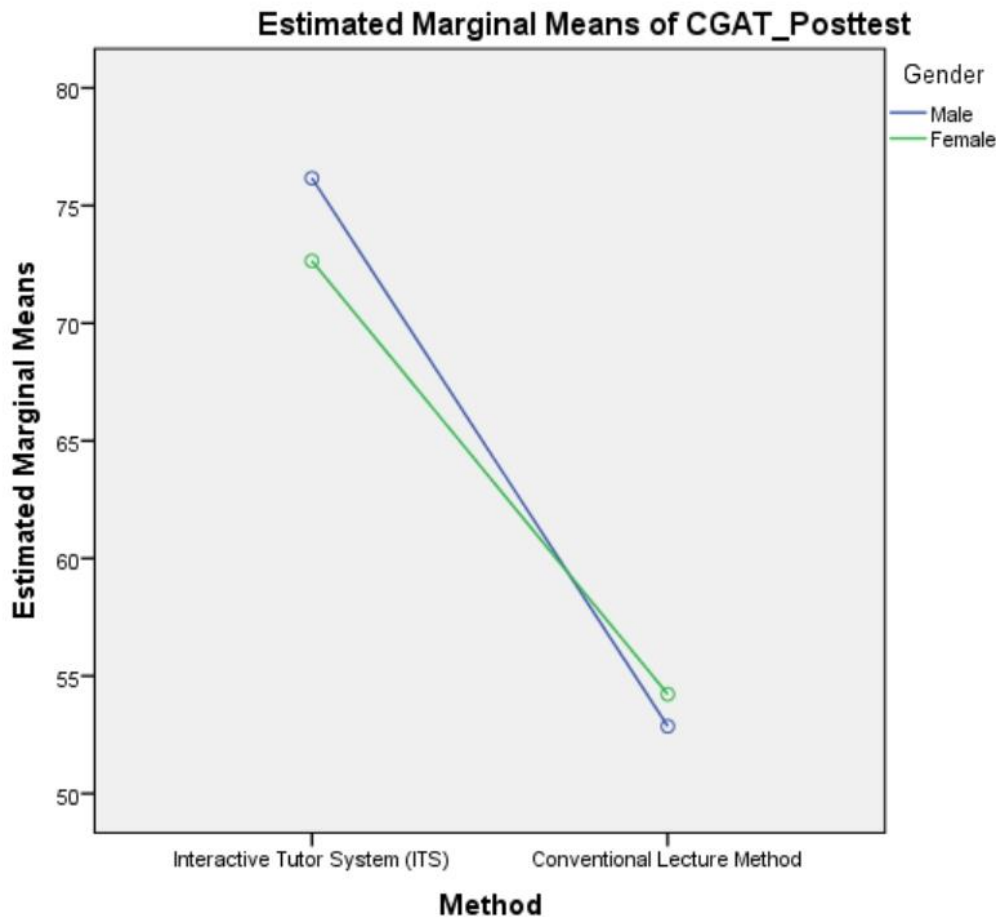


Figure 1: Profile plot showing the Interaction of Methods and Gender on Students' Mean Achievement Score in Computer Graphics

The profile plot in Figure 1 shows that there is an interaction between the method of teaching and gender since the two straight lines cross each other.

H₀₃: There is no significant interaction effect of methods and gender on students' mean achievement score in computer graphics

Table 2 showed a no statistically significant interaction effect of teaching methods and gender on the mean achievement scores of students in computer graphics, $F(1, 125) = 2.199, p > 0.05$. The null hypothesis was therefore retained, indicating that there was no statistically significant interaction of teaching methods and gender on mean achievement scores of students in computer graphics.

Finding of the Study

The findings of the study based on research questions and the hypotheses tested were as follows:

1. Students who were taught using ITS had higher mean achievement scores compared to those taught using the conventional lecture method
2. There was a significant difference in the mean achievement scores of students based on method of instruction used in teaching computer graphics
3. There was no significant difference in the mean achievement scores of male and female students taught computer graphics course using ITS
4. There was no statistically significant interaction of teaching methods and gender on mean achievement scores of students in computer graphics]

Discussion of the Findings

The discussion of findings for this study was done based on the research questions and hypotheses guiding the study.

Research question one determined the mean achievement scores of students taught computer graphics using ITS and those taught using the conventional method. The result of this investigation showed that students who were taught using ITS had higher mean achievement scores compared to those taught using the conventional lecture method. Also, the tested H_{01} found a significant difference in the mean achievement scores of students based on the method of instruction used in teaching computer graphics in favour of those taught using ITS. This result aligns with a broader trend observed in literature, where intelligent and personalized learning environments tend to lead to better outcomes compared to traditional lecture-based methods (Alrakhawi et al., 2023; Schez-Sobrino et al., 2020).

This is plausible because Intelligent Tutor Systems (ITS) often engage students more actively in the learning process compared to passive listening in lectures. When students actively participate in their learning, they tend to retain information better and develop a deeper understanding of the material. ITS can adapt to the individual learning pace and style of each student. This personalized approach ensures that students receive content at the appropriate level of difficulty and in a format that suits their learning preferences (Alrakhawi et al., 2023). In contrast, traditional lectures typically follow a one-size-fits-all approach, which may not cater to the diverse needs of students (Paula, 2019). Furthermore; ITS platforms provide students with hands-on learning experiences, allowing them to actively engage with graphical

concepts and tools. This active involvement can lead to a deeper understanding of the material compared to passive listening in lectures. Hence, higher achievement compared to the conventional lecture method. Also, in a complex subject like computer graphics, where small errors can have significant impacts on the final output, this timely feedback is invaluable for students to refine their skills and avoid common pitfalls.

ITS can adapt to each student's pace and learning style, providing personalized instruction and practice exercises tailored to their individual needs. This adaptability ensures that students receive content at the appropriate level of difficulty and in a format that resonates with them, enhancing interest, comprehension and retention (Bach et al., 2023). This ITS platform often collects data on student interactions and performance, providing instructors with valuable insights into students' progress and areas of difficulty. This data-driven approach enables lecturers to tailor their teaching strategies and interventions to better support student learning.

Research question two determined the influence of gender on students' mean achievement scores in computer graphics when taught with ITS. The result showed that the male students taught computer graphics using ITS had a slightly higher mean score as compared to their female counterparts. However, the tested H_{03} showed that there was no significant difference in the mean achievement scores of male and female students taught computer graphics courses using ITS. The result aligns because ITS provide equal access to learning materials and resources for all students, regardless of gender. This ensures that both male and female students have the same opportunities to engage with the material and master the content. Also, the ITS platform can adapt to each student's learning style and pace, providing personalized instruction and practice exercises tailored to their individual needs. This personalized approach may help mitigate any potential differences in learning preferences or abilities between male and female students, leading to similar achievement scores for both groups.

Furthermore, this result is not surprising because the lecturers teaching these courses were trained on how to treat both male and female students equally in terms of instruction, guidance, and support throughout the course. This result agrees with Joaquim, Bittencourt, de Amorim Silva, Espinheira, and Reis (2022) which showed that there is no significant difference in the mean achievement scores of male and female students when taught using ITS. However, it disagrees with Hanham, Lee and Teo (2021) which found a significant difference in mean achievement of students based on gender when taught using the ITS.

Research question three determined the interaction effect of methods and gender on mean achievement scores of students in computer graphics. The result showed that there was an interaction of method with gender as the male students recorded a higher mean score with ITS while the female students recorded a higher estimated mean in the conventional lecture method. However, there was no statistically significant interaction between teaching methods and gender on the mean achievement scores of students in computer graphics.

This result proved that both male and female students achieved similar mean scores regardless of the teaching method used. Or that both teaching methods may have provided equal opportunities for male and female students to excel in the course. It is also plausible that the homogeneous sample of students with similar backgrounds, prior knowledge, and abilities, reducing the variability in achievement scores across genders. This study is in agreement with Ben Ouahi, Ait Hou, Bliya, Hassouni and Al Ibrahmi (2021). which showed no significant interaction effect of methods and gender on mean achievement scores of students in computer graphics.

Conclusion

Based on the findings, this study concludes that intelligent tutoring system as a modern teaching technique is effective in training computer graphic students in universities in Enugu state. The intelligent tutoring system learning approach was found to improve academic achievement of computer graphics students. The study demonstrated that through the various coping strategies imbedded in the intelligent Tutor system, computer graphics students would be better equipped in computer graphics design in and after graduation. Hence all stakeholders in the computer graphics programme like the lecturers, curriculum planners and university administration should ensure that students are exposed to ITS learning approach to attain academic achievement in computer graphics irrespective of gender. Finally, the findings from this study prove that intelligent tutoring system positively enhanced student's interest and academic achievement in computer graphics. This implied that the ITS is effective for teaching computer graphics. Computer graphics teachers should make recourse with ITS software and develop ITS media models to be used in the process of instructional delivery.

Recommendations

Based on the findings of the study, the following were recommended

1. Intelligent tutoring system should be included in the computer graphics programme in universities in Enugu state by the university administration to foster effective utilization this innovation technology to practices among the computer graphics students
2. The Federal and State Ministries of Education should motivate Universities in Enugu state to conduct in-service training for teachers on computer technology such as ITS. This is to enable them embrace the current technological training in teaching and learning of computer graphics
3. General sensitization should be provided by the computer education departments on the effects ITS on academic achievements of students in computer graphics during their orientation to enable the students avail themselves to ITS learning approach.
4. Non-government organizations should ensure they support universities with state-of-the-art facilities like whiteboard and music equipment to ensure that ITS is effectively administered to Computer graphics students.

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