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Effect of Artificial Intelligent Tutoring System on Students' Achievement in Mathematics in Nasarawa State Universities: Imperative for Academic Libraries and Librarians

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Abstract
The study focused on the effect of the Artificially Intelligent Tutoring System (AITS) on students' achievement in mathematics in Nasarawa State universities. The study was carried out in Nasarawa state. The study adopted a quasi-experimental design. A sample size of forty (40) first-year undergraduate students was used. Data were collected from the students using a Mathematics Achievement Test (MAT). The MAT had a reliability score of 0.73 using the Kuder-Richardson formula 20. Data was collected and analysed using descriptive statistic of mean and standard deviation while the hypotheses were tested at 0.05% level of significance using the Analysis of Covariance (ANCOVA) as the inferential statistic. Results from the study revealed that students who learned mathematics using the AITS as a tutor achieved higher than those taught with the traditional teaching method. The study also revealed that there was no much significant difference in the achievement of male and female students who were taught using the AITS. The results of the hypotheses. This implies that AITS cater for both kind of learners. The study concluded based on the findings of this stud that the use of Artificial Intelligent Tutoring System (AITS) is viable in enhancing teaching and learning. The study recommended among others that schools, government, and parents should make computers available for the students to engage with both at school and home. Also, software developers should be encouraged to use the Nigerian Mathematics curriculum in the development of software and equally sort them in the different academic levels. Academic libraries are to upgrade themselves in order to enhance their library service delivery using AI.
Keywords: *Computer Assisted Instruction, Artificial Intelligence, Traditional Method, AI Tutoring System, Higher Learners, Lower Learners*

1.1 Introduction

Contemporary shifts in educational practice indicate progressive adaptations in how educators prepare students for an evolving new economy. Parents often assert the notion that students are bombarded with requirements to function in a twenty-first-century world. For example, outside of the classroom, students are constantly learning new content by engaging with social media, communicating internationally in real-time, and acquiring content through technological channels faster than their teachers could deliver within the confines of a traditional

classroom period (Thomas, 2018).

Educational institutions are not only interested in the use of technology to effectively train personnel, but they are also exploring new ways they can provide students with self-directed instruction that meets educational goals. Personalized learning is important because it is impelling learning from traditional teaching practice to a model that can meet every student's learning needs (Tolmie, 2016). Personalized learning moves away from teachers being imparters of knowledge, to showing students how to learn, creating the curiosity and thirst for what to do with knowledge (OECD, 2015).

There has been an increasing awareness that interactions between humans and technologies can facilitate effective teaching and learning (Lu, 2008). Computer tutoring is a late development in the long history of tutoring in education. Whereas human tutoring has been used in schools for 2,500 years—or for as long as schools have existed—computer tutoring is largely a product of the past half-century. The first computer tutoring systems to be used in school classrooms showed the influence of the programmed instruction movement of the time: They presented instruction in short segments or frames, asked questions frequently during instruction, and provided immediate feedback on answers (Kulik & Fletcher, 2017). Grounded in artificial intelligence concepts and cognitive theory, these newer systems guided learners through each step of a problem solution by creating hints and feedback as needed from expert-knowledge databases.

Artificial intelligence refers to applications of software algorithms and techniques that allow computers and machines to simulate human perception and decision-making processes to complete tasks. AI has been applied to simpler tasks, such as sending automated phone calls and texts from banks when an unusual transaction appears on someone's account, and more-complex tasks, such as allowing an automobile with advanced driver-assistance systems to automatically stay in its lane and keep a safe distance from the vehicle immediately in front of it (Bass, Dina, & Ellen, 2017).

The future of higher education is intrinsically linked with developments in new technologies and the computing capacities of the new intelligent machines. In this field, advances in artificial intelligence open new possibilities and challenges for teaching and learning in higher education, with the potential to fundamentally change governance and the internal architecture of institutions of higher education (Popenici & Kerr, 2017). Artificial intelligence (AI) is becoming more attainable in every sector of the economy, and higher education is no exception. AI opens up the possibility for higher education services to become scalable at an unprecedented rate, both inside and outside the classroom. The first-generation computer tutors have been given the retronym CAI tutors (for computer-assisted instruction tutors); the second-generation tutors are usually called intelligent tutoring systems, or ITSs (VanLehn, 2011).

Interactive information and communication technologies are increasingly being integrated into day-to-day life. For example, computers are used to support learners in learning environments to achieve more effective and efficient learning. The rapid development of educational technologies has resulted in effective instructional techniques. Specifically, the use of intelligent tutoring systems (ITS) to enhance online learning environments has allowed such environments to be widely used for instructional purposes (Karaci & Arici, 2014). ITS is intelligent because it uses the methods and principles of artificial intelligence such as describing the knowledge level, inference mechanism, and machine learning. An ITS provides learners with opportunities for self-directed and individualized learning. Moreover, such

systems provide intelligent help and guidance that enables flexibility in terms of time and space (Karaci, Akyuz, Bilgici & Arici, 2018).

Mathematics has all through the years been an important subject both in the role it plays in everyday activities and its usefulness to other sciences. Mathematics is a body of knowledge centered on concepts such as quantity, structure, space, change, and also the academic discipline that studies them (Pierce, 2007). Mathematics is widely used throughout the world, in human life, and in many fields including Social Sciences, Natural Sciences, Engineering, Medicine, and Education. It is a vital tool in science, commerce, and technology.

The concept of academic achievement is inevitable in any formal educational institution. It expresses the learning achievement of an individual or a group at the end of an academic programme. It is a criterion for ascertaining the capabilities of a student from which his potential could be inferred. Academic achievement is generally used to determine how well an individual can assimilate, retain, recall and communicate his knowledge of what has been learnt. This concept has close relationship in meaning with academic achievement and academic attainment (Joe, Kpolovie, Osonwa & Iderima, 2014). Joe et al (2014) defined academic achievement as "the demonstrated achievement of learning as opposed to the potential for learning." It further defines achievement as "knowledge attained or skills developed in school subjects usually designed by test scores or marks assigned by the teacher or both." These definitions imply that academic achievement is the observed and measured aspect of a student's mastery of skill(s) or subject content(s).

1.2 Statement of the Problem

The traditional classroom structure, with all students learning in the same place and at the same pace, is no longer feasible for today's educators. Universities rely on the traditional method of teaching lectures so that a large number of students can be reached and this has caused teaching and learning to be ineffective. The lecturer can't distribute the lecture time to students just to meet up with the learners needs or he will not be able to explain the curriculum scheduled during the time of the lecture as allotted. There are also differences in the student's learning ability and speed, for instance some students can understand the lesson from the first time when the lecturer explains it to the students, and there are other students need to re-explain the lesson two or three or more time and this can't be done by the lecturer during the time of the lecture, and for this there is a need to create a solution to assist all kinds of learners.

Another problem is that there are students who do not participate during the lesson and cannot ask questions to the lecturer when they have any problem in the lesson. There are also some students can't understand the lesson from the lecturer despite all his attempts. Also, there are some lessons need more time than the lecture dedicated to it by the university, and the lecturer can't be with the student throughout the day, only in the timing of the lecture student can be learn from the lecturer. These have posed a great challenge to the academic achievement of these students.

Academic achievement, which is measured by the examination results, is one of the major goals of a school. Moreso, the need to effectively disseminate knowledge and skills timely and in an efficient manner to a numerous group of people as in the case of higher institution of learning is now imperative. The researcher would therefore like to study the effect of an Artificially Intelligent Tutoring System (AITS) on the achievement of undergraduate students in Mathematics.

1.3 Research Objectives

The purpose of the study is to investigate the

effect of an Artificially Intelligent Tutoring System (AITS) on students' achievement in Mathematics in Nasarawa State Universities. The study specifically seeks to

1. Investigate the mean achievement scores of students who were taught with AITS as tutor and those who were taught with the traditional method.
2. Find out the mean achievement scores of male and female students who were taught with AITS as tutor.
3. Determine whether AITS cater for both academically higher-level learners and lower-level learners

1.4 Research Questions

The following research questions and hypotheses were developed to elicit answers for the research:

1. What are the mean achievement scores of students who were taught with AITS as tutor and those who were taught with the traditional method?
2. What are the mean achievement scores of male and female students who were taught with AITS as tutor?
3. Does the AITS cater for both academically higher-level learners and lower-level learners?

1.5 Research Hypotheses

1. There is no significant difference between the mean achievement scores of students taught with Artificially Intelligent Tutoring System and those taught with traditional teaching method.

2. There is no significant difference between the mean achievement scores of male and female students who were taught with AITS

3. There is no significant difference on the effect of AITS on academically higher-level learners and lower-level learners

2.1 Literature Review

2.2 Conceptual Framework

This section proposes a conceptual framework within which the concepts learning, traditional learning, and academic performance is treated in this work.

Concept of Learning

Learning is an active and dynamic process in which individuals make use of a variety of information and strategies modes of processing (Shekari, 2015). Marshal (2000) as cited in (Shekari, 2015) states that learning is imprinting of materials (memorization) of information, skills and abilities. He further explains that human minds are essentially selfish and therefore people act only to increase “pleasure and to avoid pain”. This utilitarian theory on conceptualization learning had it that human minds at birth are like clean slate, which is gradually filled up by sensation derived from their environment. Kadiri (2004) opined that learning is a process that an individual acquires as a result of maturation. The maturation theory explains further that the capacity of learning in an individual depends largely on his maturation level.

Concept of Traditional Learning

Traditional method of teaching and learning is when a teacher directs students to learn through memorization and recitation techniques thereby not developing their critical thinking problem solving and decision making skills while modern or constructivist approach to teaching involves a more interacting, student-based of teaching. Here, the students learn through group participation. Most of the higher institution of learning uses the lecture method which is also a traditional teaching and learning strategy.

Lecture method of teaching is the oldest teaching method applied in educational institution. This teaching method is one way

channel of communication of information. Students' involvement in this teaching method is just to listen and sometimes pen down some notes if necessary during the lecture, combine the information and organized it (Essays, 2018).

One of the problems in this method is to grab the attention of students in class room. Another big problem is that many students in the class cannot follow the theme. Learning has a strong influence on method of teaching.

Concept of Artificial Intelligence

Artificial intelligence is a part of computing science that focuses on creating intelligent machines and programs. The purpose of artificial intelligence is to try to mimic human consciousness and perform tasks such as human beings. In practice it means the ability of a machine or program to think and learn. Generally, the term artificial intelligence means a machine or program that tries to emulate human consciousness. AI has become a significant part of the technology industry. (Tekoäly 2018).

The most influential factors in the rise of AI now are computing ability and power, data and algorithms. The power and ability of processors have significantly increased. Today there is an enormous amount of data available of the weather, social media and medical science, and machines are finally able to exploit this data. At the same time, the storage costs for data management have fallen and the development with data storage have led to a faster way to analyze massive amounts of data. (Tekoäly 2018).

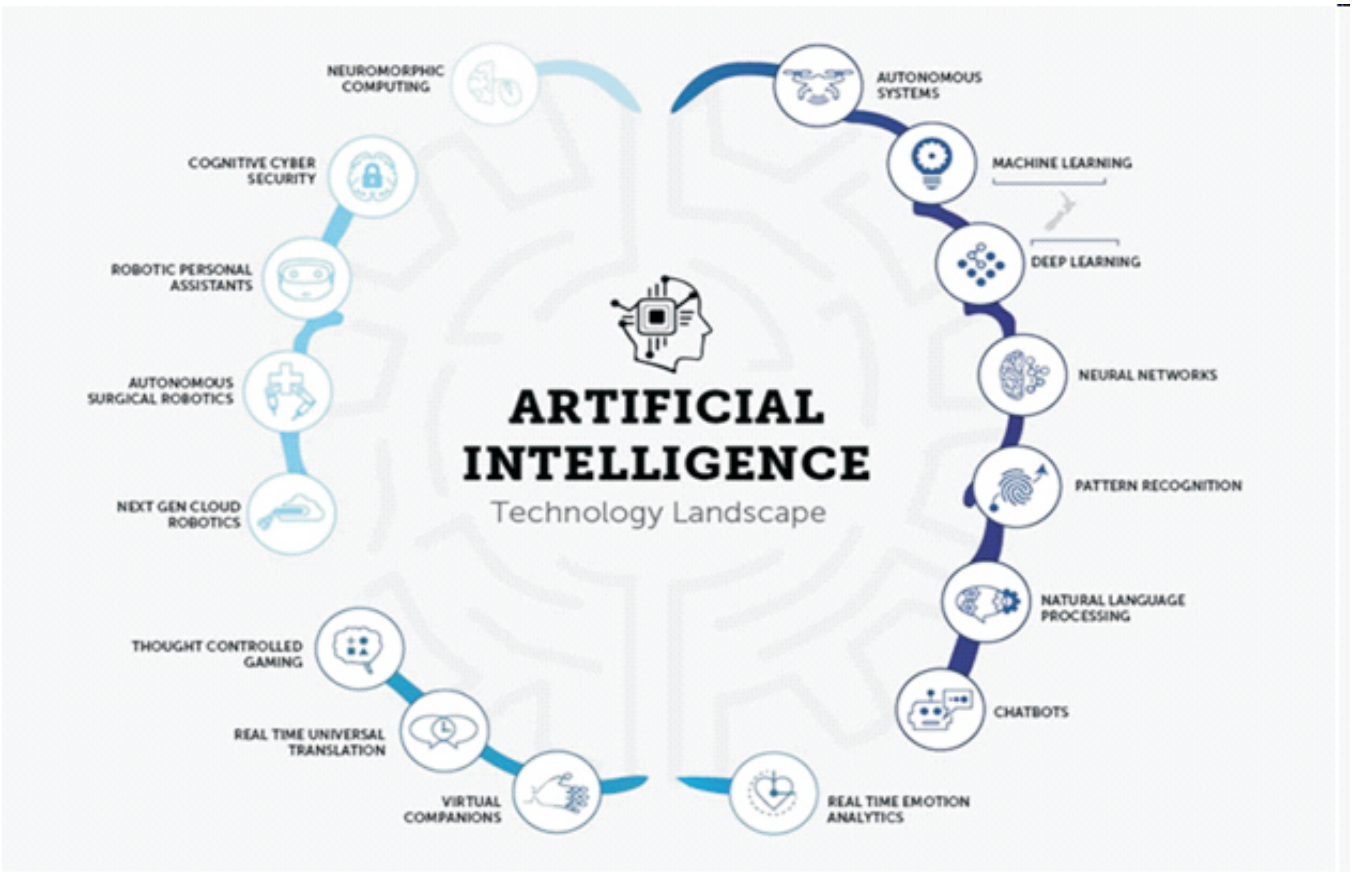

Plate 1: Artificial Intelligence (Source: Pottala, 2018)

Concept of Intelligent Tutoring System

Intelligent Tutoring System is a computer program designed to simulate the behavior and guidance of a human teacher. These systems help students study a variety of topics by asking questions, analyzing responses, and providing customized instructions and feedback. This type of system can alter the behaviour of private lessons in real time, after differences in individual student strategies or modify their knowledge base to interact more effectively with all students. For an intelligent teacher, the goal is not only to know that the answer is incorrect but that the student knows why this response is wrong. To achieve this, the system monitors responses through several intermediate steps to determine what is most accurate and why the student thought wrong (Akkila, & Abu Naser, 2017).

Concept of Academic Performance

Academic performance of a child could be defined as the learning outcomes of the child. This includes the knowledge, skills and ideas, acquired and obtained through their course of study within and outside the classroom situation (Okorie, 2014). It is the outcome of determination, hard work, of student in academic pursuit. Pandey, (2008) defined academic achievement as the performance of the pupils in the subjects they study in the school. This determines the pupils' status in the class. This gives children an opportunity to develop their talents, improve their grades and prepare for future academic challenges. Academic performance refers to a person's performance in a given academic area (e.g. reading or language arts, mathematics, science and other areas of human learning. Academic performance relates to academic subjects a child studies in school and the skills the child is expected to master in each (Kathryn, 2010).

Artificial Intelligence (AI) Technologies that Supports Teachers and Students

The last decades have observed a large number of AI based tools and applications that primarily focus on the student interaction or learning strategies centered on the student. They include.

2.3 Intelligent Tutoring Systems (ITS)

This is a term commonly known on the literature related to applications of AI systems on EdTech. Starting from a general point of view, an Intelligent Tutoring System (ITS) is an "interdisciplinary field that investigates how to devise educational systems that provide instruction tailored to the needs of individual learners, as many good teachers do" (Schoksey, 2004). In other terms, ITS is a computing technological instrument which purpose is to provide an individualized learning experience to the student. During the years, ITS has been studying some relevant characteristics needed to increase the quality of the service, as the value of communication on user's interaction with the system, mostly through conversational dialogue technologies, or the denominated Chat-bots (influenced by Artificial Intelligence systems). Usually, ITS includes four main components that interact during its performance to achieve the desired result, their connection can be evidenced on the figures 1 and 2. Likewise on figure 1 and 2, it is possible to observe the general structure of an ITS, which allow us to recognize the specific moment where the user is situated and the interactions of the elements when the input goes inside the system, processing the information and providing an output to the user as well.

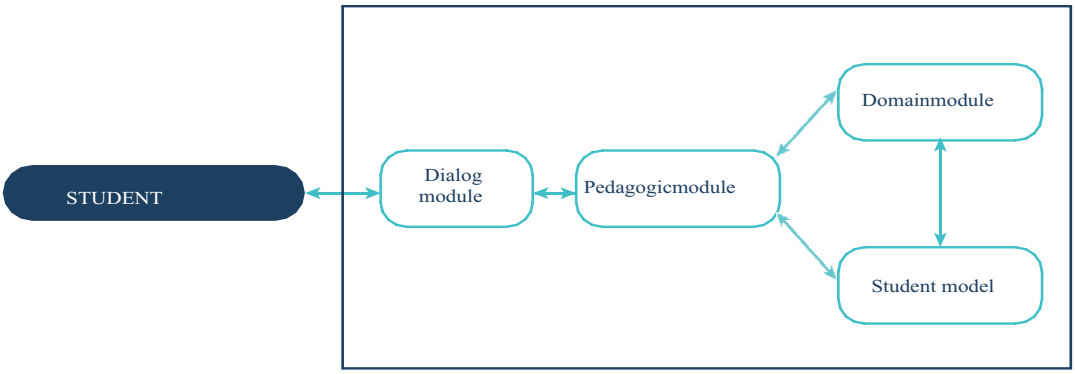

Figure 1: Main components of an Intelligent Tutoring System (ITS) Tutoring System (ITS)

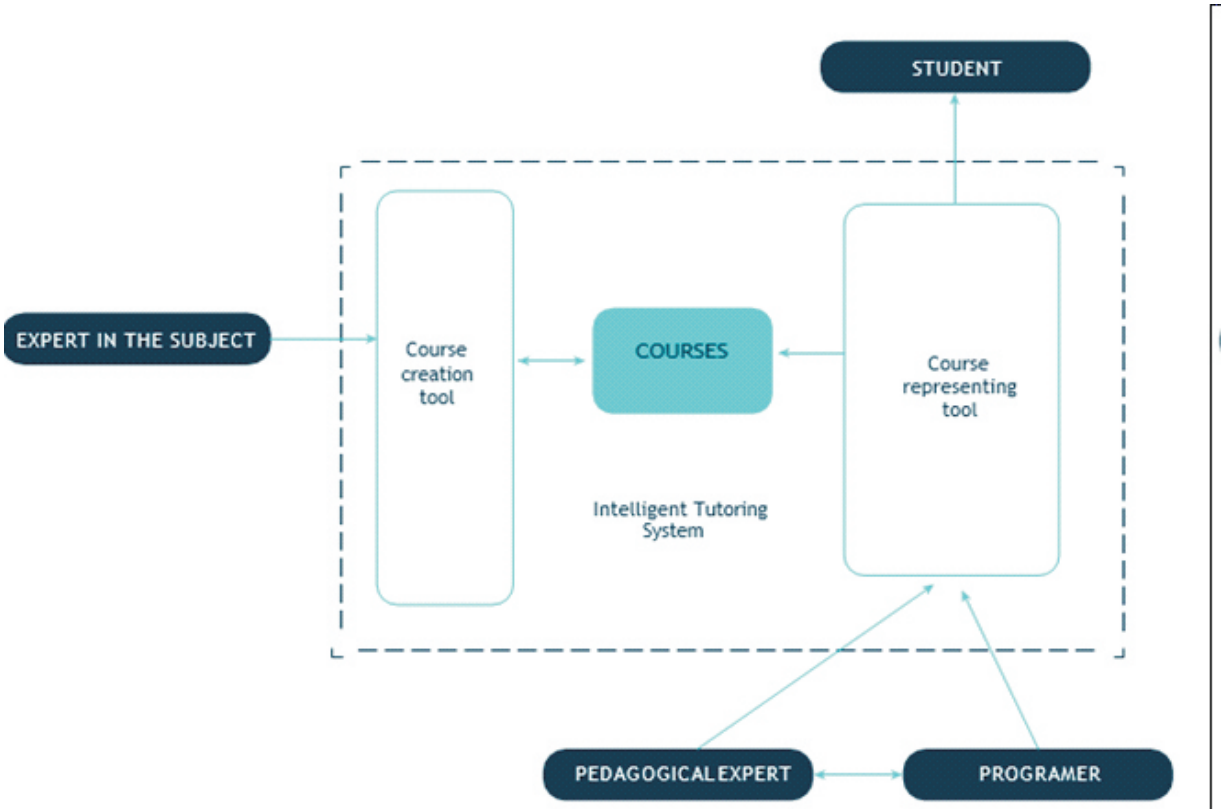

Figure 2: The general structure of the Intelligent Tutoring System (ITS)

Content-Oriented Learning Systems

The term of Content-Oriented Learning Systems (COLA), borns on experimental research from a team of students, professors of Politecnico di Torino and Politecnico di Milano, besides the support of experts on AI technology from IBM Milan. This type of system was created to "build learning conversations using modern AI approaches based on a good and well-organized body of content" (Akcora et al, 2018) and the guidelines of the project are the ones evidenced on the figure 3. The experiment was done with the contents of the course of 8th grade of school in mathematics.

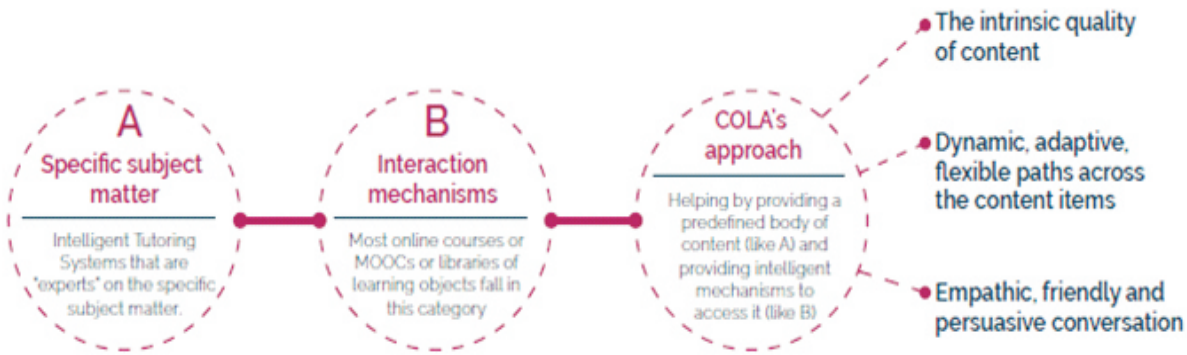

Figure 3: Main directions for an application supporting learning, COLA system

2.4 Impact of AI on Education

AI technology has been explored and applied in a variety of industries to progress in term of data and information management, its collection and process to create more efficient systems inside machinery, services, products, and production processes. From this perspective, the education industry is also immersed on those who are implementing the power of AI as a computer system looking to achieve benefits on the teaching and learning processes to improve the quality of the education systems. Particularly, AI can modify educational resources, providing supportive tools to educators, connecting students and teachers all over the world, getting better solutions to people with some special difficulties; all of these through the construction of intelligent platforms and the ability of mixing realities that enable the users to experience the things around them in ways that was not even thinkable before (Diaz, 2019).

Consequently, a large variety of research and studies on this field has established some benefits of using AI technology on EdTech, however, it has not been clear what are the limits of the technology and even if is a powerful processor of information and a technology able to learn, it cannot be put at the same level as the human intelligence. For this reason, the inclusion of AI in education need to be accompanied by the right establishment of functions that it is capable of developing and the big difference between providing information and constructing knowledge. In other words, developers of AI on education need to clarify the role of the technology as a supportive tool not as a replacing element of teachers role in learning environments, because is them who necessarily need to be behind the technology to achieve valuable results on the process of learning of the students (Diaz, 2019). Therefore, the key element to keep in mind with the introduction of this new technology on education, is the challenge that the teachers must face and, as the technology might help with some of their work at the same is going to test and ask for an intensification of their role as tutors and as drivers for the construction of knowledge and critical thinking of students, based on the recognition of the environment and the elements that move around them, which can only be recognized under their own experiences as human beings through social interaction and personal analysis.

On the other hand, is not a secret that behind every industry there is a group of people trying to reach a profit or a monetary benefit from the development of this type of technology, which means, the idea of AI can be sold to governments or institutions leaders as the solution for reducing the human capital (teachers). For this reason, and from the ethical point of view, developers need to recognize, design and share the right

information about AI, because in the majority of the studies taken into account for this thesis, developers tend to focus on the features of the technology but forget about the most important element of the design of a product, the user requirements, profile, and its value on the project, in other words looking to obtain a human centred approach. Hence, "it is certainly true that we need to engage a more diverse population in acquiring the skills to design and develop the future of our artificial intelligence" (Luckin, 2018).

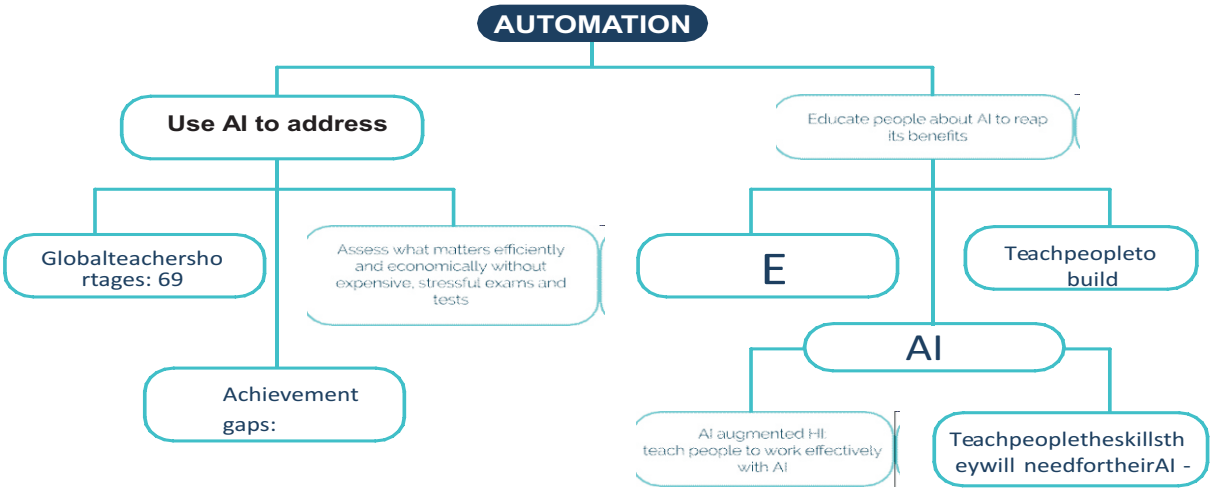

Figure 4: The AI and education knowledge tree with its two dimensions Ethics: help everyone to achieve their potential

2.5 Academic Library Services and AI

Academic libraries are crucial parts of education establishments because they give lecturers and students access to a wealth of knowledge resources. Akinyemi (2023) examined how artificial intelligence can change academic libraries and raise technical calibre of librarians for effectiveness of service delivery in reference, circulation, cataloguing an classification, cataloguing and classification to meet technology changing needs of library users. It is recommended that academic libraries embrace artificial intelligence (AI) as a vital tool in their service delivery as technology develops, ultimately improving technological academic experience in general. Additionally, the management of the library should work to educate and train staff members to use AI effectively for library services.

3.1 Research Methodology

The design for this study was quasi–experimental design. The quasi experimental design is chosen because it controls the internal validity threats of the initial group equivalence and researcher's selection bias, since there was no randomization of the subjects into groups. Specifically, pre-test–post-test of equivalent control group design was used. The experimental group learnt using the developed AITS method while the control group was taught using the traditional method. The schematic representation of the design is as shown below;

O1 X O2 : AITS

O3 * O4 : Traditional Method

Where X = Treatment, O = Observation, * = No treatment.

O1 and O3 are the pre-test for experimental and control groups respectively.

O2 and O4 are post-test for experimental

group and control group respectively.

The population of the study was all 91 first year undergraduate student in the Faculty of Science, Department of Mathematics of the Federal University Lafia and the Faculty of Natural and Applied Science, Department of Mathematics of Nasarawa State University Keffi. A sample of 40 (20 males and 20 females) students was selected using multistage sampling technique. Multistage sampling technique was used for the study because different sampling techniques would be applied at different stages of the research. For this research work, Mathematics Achievement Test (MAT) was used. The MAT is a test instrument that covers all the areas of Polynomial that was taught in this study. The Table of Specification was designed such that 25% of the questions representing ten (10) questions were Lower Order Questions while 75% of the questions representing thirty (30) questions were Higher Order Questions. The researcher computed the reliability for multi-item opinion questions using SPSS, computer software. The pre-MAT and post-MAT were tested using Kuder-Richardson formula 20 and it gave a reliability figure of 0.79 and 0.73 respectively, which is above the recommended reliability of 0.7 (Kaplan and Saccuz, 1993).

The researcher administer the instruments with the help of research assistants and collect the data for analysis after the students had responded to them. The MAT was collected after the assigned time for the achievement test elapsed. The scores for both the experimental and control group were recorded accordingly. The test items in both the pre-MAT and post-MAT test were scored one mark each. The maximum mark was twenty (40) while the lowest mark was zero (0). Data collated was analyzed using descriptive statistics of mean and standard deviation to answer the research questions asked while the hypotheses was tested at 0.05 significance level using the analysis of covariance (ANCOVA). The choice of ANCOVA is to control differences across the groups, to increase the precision of data and to remove bias which results from using intact groups.

4.1 Results of Findings

The research survey presents the following: Statistical analysis of data collected, sequential presentation of results as well as relevant interpretations based on the research questions and the tested hypotheses.

Result from Research Question

Research Question 1: What are the mean achievement scores of students who were taught with AITS as tutor and those who were taught with the traditional method?

Table 2: Mean Achievement Scores and Standard Deviation of Students who were taught with AITS and without AITS (traditional method)

Group		Pretest	posttest	Mean gain
AITS Group	N	20	20	
	Mean	17.15	36.20	19.05
	Std. Deviation	2.16	4.92	
Control	N	20	20	
	Mean	16.35	27.50	11.15
	Std. Deviation	2.54	6.79	

Table 2 shows the mean achievement score of students who were taught with AITS as tutor and tool and those who were taught without AITS (traditional method). Students who were taught with AITS as tutor had a mean of 36.20 in the posttest and standard deviation of 4.92 while students who were taught without AITS (traditional method) had a mean of 27.50 and standard deviation of 6.79. The mean achievement scores of students taught with AITS as tutor were higher than the mean achievement score of students taught without AITS (traditional method). For the pre-test, the mean achievement scores of students taught with AITS as tutor and control were respectively 17.15 and 16.35. This indicates that the students were at the same level before the experiment.

Research Question 2: What are the mean achievement scores of male and female students who were taught with AITS as tutor?

Table 3: Mean Achievement Scores and standard Deviation of male and female students who were taught with AITS

Group	Sex		Pretest	Posttest
AITS Group	Male	N	10	10
		Mean	17.20	36.40
		Std. Deviation	2.53	4.85
	Female	N	10	10
		Mean	17.10	36.00
		Std. Deviation	1.85	5.21
	Total	N	20	20
		Mean	17.15	36.20
		Std. Deviation	2.16	4.92

Table 3 shows the mean achievement scores and standard deviation of male and female students who were taught with AITS as tutor and also those that were taught without AITS (traditional method). For AITS Group, male students had a mean of 36.40 with standard deviation of 4.85 while female students had a mean of 36.00 with standard deviation of 5.21 in the posttest. This indicated that no significant difference is noticed in the achievement male and female students taught with AITS as tutor.

Research Question 3: Does the AITS cater for both academically higher-level learners and lower-level learners?

Table 4: Mean Achievement score of academically higher-level learners and lower-level learners

Group		Pretest	posttest
High Learn	N	7	7
	Mean	19.00	37.86
	Std. Deviation	1.00	3.39
Low Learn	N	13	13
	Mean	16.15	35.31
	Std. Deviation	1.95	5.48

Table 4 revealed that the academically higher-level students who were taught with AITS as tutor had a pretest score of 19.00 and standard deviation of 1.00; posttest score of 37.86 and standard deviation of 3.39 respectively while the academically lower-level students who were taught without AITS as tutor had a pretest score of 16.15 and standard deviation of 1.95; posttest score of 35.31 and standard deviation of 5.48 respectively. This result indicated that AITS cater for both academically higher-level learners and lower-level learners.

4.2 Result from Research Hypothesis

Research Hypothesis 1

There is no significant difference between the mean achievement scores of students who were taught with AITS and those who were taught without AITS (traditional method).

Table 5: ANCOVA Table of Students' scores in the Mathematics Achievement Test (MAT)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	770.765[a]	2	385.382	10.800	.000	.369
Intercept	964.728	1	964.728	27.035	.000	.422
PreMAT	13.865	1	13.865	.389	.537	.010
Group	769.660	1	769.660	21.568	.000	.368
Error	1320.335	37	35.685			
Total	42668.000	40				
Corrected Total	2091.100	39				

a. R Squared = .369 (Adjusted R Squared = .334)

Table 5 indicated that the use of AITS in teaching Polynomials is a significant factor in the mean achievement scores of students who were taught with AITS and without AITS (traditional method). This is because with the 95% confidence interval of difference, the value of F, its degree of freedom and its P- value is significant, the value of F is 21.568, and the result of the test is significant beyond the .05 level of significant as .000 is less than 0.05. Therefore the null hypothesis of no significant difference is hereby rejected. This means that there is a significant difference in the mean achievement scores of students taught with AITS and those taught without AITS (traditional method).

Table 6: ANCOVA table of students who were taught with AITS as tutor and without AITS on achievement for Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Correctedmodel	12.226[a]	2	6.113	.233	.795	.027
Intercept	531.974	1	531.974	20.233	.000	.543
PreMAT	11.426	1	11.426	.435	.519	.025
Gender	.950	1	.950	.036	.852	.002
Error	446.974	17	26.293			
Total	26668.000	20				
Corrected Total	459.200	19				

a. R Squared = .027 (Adjusted R Squared = -.088)

Table 6 indicated that the across gender there is no significant difference in the treatment and therefore using AITS, gender is not a significant factor in the mean achievement scores of students in the Mathematics Achievement Test. This is because with the 95% confidence interval of difference, the value of f, its degree of freedom and its P-value significant, the value of F is 0.036 and the result of the f-test is non-significant beyond the 0.05 level of significant as .852 is greater than 0.05. This hypothesis of no significant difference in the mean achievement scores is therefore accepted. This means that there is no significant difference in the mean achievement scores of male and female students taught with AITS as tutor. This therefore implies that AITS for teaching Mathematics can reduce gender gap in achievement of students.

Hypothesis 3

There is no significant difference on the effect of AITS on academically higher-level learners and lower-level learners

Table 7: ANCOVA Table of Students who academically higher learners and lower learners

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	110.343[a]	2	55.171	2.689	.097	.240
Intercept	568.424	1	568.424	27.700	.000	.620
PreMAT	80.769	1	80.769	3.936	.064	.188
Learners	99.066	1	99.066	4.828	.042	.221
Error	348.857	17	20.521			
Total	26668.000	20				
Corrected Total	459.200	19				

a. R Squared = .240 (Adjusted R Squared = .151)

Table 7 shows that there is no significant difference between the scores of the academically higher learners and the academically lower students who were taught with AITS as tutor. This is because with the 95% confidence interval of difference, the value of F, its degree of freedom and its P-value significant, the value of F is 4.828, and the result of F test is significant beyond the 0.05 level as .097 (as in corrected model) is greater than .05. Therefore hypothesis of no significant difference is accepted. The result indicated that both academically higher learners and lower learners gained significantly meaning that the AITS cater for both kind of learners.

5.1 Discussion of Findings

Based on the results of the analysis of data presented in this chapter, the following major findings came up. The discussion is presented under the following captions:

(i) Effect of AITS on students achievement
(ii) Effect of AITS on gender
(iii) Effect of AITS on Type of leaners

Effect of AITS on students' achievement

Results presented on Table 2 and Table 5 showed that students taught with AITS performed significantly better in the Mathematics Achievement Test than their counterparts who were taught using the traditional method. This result is in agreement with the result of earlier studies carried out by Gambari et al (2014), John (1999) and Ozofor (2001), who found in their separate studies, that the use of computer software was more effective than the traditional methods in enhancing students' achievement. The relative superiority of the AITS over the

lecture method in enhancing students' achievement in Mathematics could be attributed to the fact that, it is student – centered and ensures active participation of students in the teaching learning process more than the lecture method. The lecture method often subjects the learner to the position of the passive recipient of the facts as handed down to him by the teacher. Moreover, the activities in the AITS were carried out by the students themselves, at their own pace during and after the school periods; which is in contrast to the lecture method where the teacher did most of the work for the students. The active participation of the students involving the use of several sense organs, invariably should arouse greater students' interest going by psychological theories (Blair and Stone, 1975). Given, these prevailing circumstances under which the AITS and the lecture method are employed in the classroom instruction, it is not surprising that the treatment group (AITS) out – performed the control group in the MAT. The above result on the effect of AITS on achievement of students, does not, however, agree with Michael (2002) who found that the use of CAI in teaching of Mathematics did not show any significant difference when compared to the traditional lecturing method.

Effect of AITS on Gender

Results from Table 3 and Table 6 showed that there is no significant difference in the achievement of male and female students taught using the AITS. Although, the result from the Table 3 showed that the mean achievement of the male was slightly higher than the females. The result is in agreement with the finds of Gambari et al (2014), Etukudo (2002), Aruwa (2015), Ezeugo and Agwuagah (2000) and Ozofor (1993) who discovered in their independent studies that there is no significant difference between the achievement of boys and that of girls, in Mathematics using different instructional strategies. This could be attributed to the fact that the activities in the AITS are carried out by the students themselves and at their own pace during and after the school period, so this has given both the male and female students' chances of performing equally. On the other hand, the mean achievements score of male students being slightly better than their female counterparts can be associated with social attachment that males are more mathematically incline than female. Nevertheless, the finding of this study disagrees with the findings of Nnadi (2001), Erinsho (2005) and Ugwu (2007), who found significant difference in achievement in their independent studies.

Effect of AITS on Type of Learner

Results from Table 4 and Table 7 showed that the AITS caters for both the academically higher and lower leaners. Although, from Table 4 the mean achievement score for the higher learners were significantly higher than that of the lower learners, nevertheless there was significant improvement in the achievement scores of both type of learners. It is expected that as a result of the combination of genetic and environmental factors, the academically higher students are cognitively ready for learning than the academically lower students. Perhaps, this situation arises because higher students requires less effort and time to process and learn a given task than their lower counterparts. In addition the AITS, because it facilitate individuality in learning, the higher learner group may prefer working and learning on their own and moving at his own pace. This may account for the significant higher achievement of the academically higher students than their academically lower counterparts. The result of this study aligns with that of Ezeh (1992) whose findings indicated that there is no significant difference between the low and high ability groupings with regards to their

interest level but there is a significant difference between the high and low ability levels with regards to their levels of performance, with the high ability groups performing better.

5.1 Summary of Findings

The research was on the effectiveness of personalized learning using an Artificially Intelligent Tutoring System (AITS) as the tutor in teaching and learning of Polynomials.

Results showed that students who were taught with AITS as tutor outperformed those who were taught using the traditional method. It equally revealed that students that both the academically higher and academically lower learners improved significantly after interaction with the AITS. The result also showed that the male and female students achievement were not statistically significant after exposure to the AITS.

Conclusion

The following conclusions are made based on the findings of this study. The results of this study provided the empirical evidence that the use of an Intelligent Tutoring System as a tutor enhanced students' achievement in polynomial than the traditional lecturing method of delivering instruction.

Secondly, there was no significant difference between the mean achievement male and female students that were taught with AITS as tutor. Thus the computer did not recognize whether a male or a female student was using it. This implies that gender has no significant effect on achievement. Also, the use of AITS reduces gender gap.

Finally, the AITS software was seen to enhance the achievement of both the academically higher and lower learners. This means that the use of ITS in education caters for all kinds of learners. In general, the use of Artificial Intelligent Tutoring System (AITS) has proved to be viable in enhancing the meaningful teaching and learning of polynomials.

Recommendations

The following recommendations were made based on the findings of the research

1. Since the use of computer as a tool enhances achievement in mathematics, the mathematics teacher should use it as one of the strategies to be employed in classroom. Workshops / Seminars should be organized by the Government for Mathematics teachers to enable teachers learn how to use AITS module and other software in teaching Mathematics.
2. Computers should be made available in schools, by the Government so that every student will have access to computers and make use of them in learning. Parents should equally be encouraged to buy computers for students to use at home after normal classes. This will help students to practice what they have learnt in school and equally discourage them from engaging in unnecessary ventures after school.
3. Programmers and software producers should be encouraged to use mathematics curriculum in the production of software and equally arrange them according to classes
4. Academic Libraries and Librarians should acquaint themselves with relevant AI tools in order to enhance their library services delivery especially to the Gen Zs.

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