ISSN: 1118-5872

FOS

MULTI-DISCIPLINARY JOURNAL

(Alvan Ikoku Federal University of Education)

CONSEQUENCE OF INTELLIGENT TUTORING SYSTEM ON THE ACHIEVEMENT OF MATHEMATICS STUDENTS IN OWERRI MUNICIAL COUNCIL OF IMO STATE

[1]OGOKE, Chinemeze James, [2]ANYANWU, Anthony, [3]ACHUGAMONU, Pius, C, [4]OKOLIE, Alfred & [5]UGURU NDUBUISI OKON
james4justics@gmail.com, 08069817174; aanyanwu29@gmail.com,07038923949; piuschukwuma2000@gmail.com, 08035640390; okoliealfred@gmail.com, 08039254130 , ugurundubuisi1202@gmail.com.07037248887
1, 2, 3, 4 Department of Mathematics, Alvan Ikoku Federal University of Education, Owerri, Imo State
5 Department of Mathematics, Federal College Of Education Eha- Amufu

Abstract

The technological improvement like artificial intelligence (AI) provides an opportunity to help teachers and students solve and improve teaching and learning performances, especially in mathematics. The aim of this study centers on the application of intelligent tutoring system as artificial intelligence tool in the teaching and learning of mathematics: implication for achievement. The researcher adopted a pure experimental design, specifically; pre-test, post-test randomized control group was used. The area of the study is Owerri municipal council of Imo State. The population comprised 4200 students in private secondary in Owerri Municipal Council of Imo state. The sample size was 72 students selected through purposive sampling technique. One instrument was used for collection of data namely; Geometry Achievement Test (GAT). Three experts validated the instrument. The reliability co-efficient value of 0.74 was gotten which was calculated using the Kuder – Richardson Formula 20. Experimental group was taught using the application of AI tool while the control group was taught without the application of AI tool. Mean and standard deviation were used to answer the research questions while the hypotheses were tested using Analysis of covariance (ANCOVA). The null hypothesis (Ho) is rejected at p value less than 0.05. In conclusion, students taught Geometry with AI did not achieved more than those taught without AI. There are no significant differences in the mean achievement scores of male and female students taught Geometry using AI. It was therefore recommended that improved technologies be provided for both teacher and students for effective application of AI.

Keywords: Artificial Intelligence, Intelligent tutoring system, mathematics, achievement and gender.

Introduction

Education has displayed a vital role in the development of human civilization. The method of learning is constantly evolving and undergoing numerous changes due to technological development. As a result, the traditional ways of learning where education is imparted within the walls of classrooms to a group of students is facing out. With the intervention of the internet and digital technology, the online platform is trending slowly and surely taking the place of classrooms. Thus, the modern education system has completely eradicated the space limitation of a classroom by encouraging the participation of more students from every corner of the world. By providing knowledge through online platforms or websites, the modern education system has been able to attract a variety of students and teachers to participate in technology-based learning, especially in science and mathematics.

Today, other fields of knowledge are dependent on mathematics as a science for solving problem, stating theories and predicting outcome. According to Ogoke (2016), mathematics is the backbone of science and technology and no nation can hope to achieve any measure of scientific and technological advancement without proper foundation in school mathematics. Mathematics as a science subject is all encompassing for

there is hardly any subject that does not need mathematics for proper functioning (Ogoke, 2016). The role of mathematics education in the lives of individuals and the society is very crucial. It is the gateway to achieving scientific and technological advancement and economic survival. The Federal Republic of Nigeria (2013) in the National Policy on Education made mathematics one of the compulsory subjects for secondary school education.

Mathematics refers to learning content which uses symbolic language to represent concepts such as number, quantity, space and structure. According to (Orhani, 2021), mathematics has been identified as a complex and challenging task that aims to enhance students' competence in problem solving. Notwithstanding, students generally find it difficult to complete math tasks, especially those that need to be solved in multiple steps. Therefore, researchers have made efforts to develop different learning strategies and tools to improve learning outcomes in mathematics. They have also noted the importance of identifying factors that affect student performance in learning mathematics, such as insufficient prior knowledge and lack of personalized support for students in the individual form. Meanwhile, the advancement of artificial intelligence (AI) has provided a tool to address these problems (Orhani, 2021).

Meanwhile, secondary school students make use of modern technologies such laptops, android phones, etc, without exploring the benefits of such technologies. For instance, artificial intelligence can be integrated into online learning platforms, allowing content and activities to be customized according to the needs and knowledge level of each student. Learning management systems can use artificial intelligence to provide personalized recommendations, automatic feedback and monitor student progress (Mahendra, 2023). Science education researchers such as Mathematics Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN), amongst others have come up with many techniques, strategies and methods for teaching and monitoring science and mathematics; namely problem-solving method, inquiry-based teaching/learning approach, mathematical games, cooperative learning and analogies as advance organizers among others.

According to (Orhani, 2021), the purpose of artificial intelligence is to represent human intelligence, to support communication between the user and the system during problem solving. The goal of intelligent systems is to create content that effectively adapts to the learner's learning knowledge and skills to optimize learning. It is universally known that AI would be the source and cause of the improvement of the classroom teaching methodology (Intel, 2020). Modern AI techniques involve the concepts of teaching and learning, as some systems are required to teach models and concepts, either autonomously or supervised through some form of instruction (Xie, & Zou, 2020). The main contribution of Artificial Intelligence in the subject of mathematics is the provision of concepts, methods and tools for the design of flexible and relevant computer-based systems for teaching and learning purposes (Bray & Tangney, 2017).

In line with views of (Davadas & Lay, 2017), Artificial intelligence (AI) has the practical objective of designing and implementing systems whose behaviours seem intelligent to the eyes of human observers, seeing the system, one can legitimately assume that its behaviour is due to some kind of reasoning. This implies a clear identification of what knowledge consists of and the ways in which it can be represented. (Hwang, Xie, Wah, & Gasevic, 2020), have identified the roles of AI in education, as an intelligent teacher,

caregiver, learning tool and partner, as well as educational policy-making advisor Regarding the role of the intelligent teacher, the use of AI technologies helps to simulate the intelligence of teachers to provide personalized guidance, feedback or support to students during the learning process, has been demonstrated by several researchers.

Artificial intelligence is being successfully applied in some educational cases and is improving student learning and development as well as teacher performance (Sennar, 2019). Learning mathematics is considered a great challenge for many students. The advancement of computer technologies, in particular, artificial intelligence (AI), is providing an opportunity to tackle this problem by diagnosing students' learning problems individually and providing personalized support to maximize their learning performance. For the sake of this study, Intelligent tutoring system as one of the models of AI was used. Mathematics education has been a longstanding concern globally, with many students struggling to achieve proficiency in math (Kilpatrick, Swafford, & Findell, 2001; National Mathematics Advisory Panel, 2008). In recent years, Intelligent Tutoring Systems (ITS) have emerged as a promising solution to support math learning (Woolf, 2010; Dziuban et al., 2018).

Intelligent Tutoring Systems (ITS) are computer-based systems that provide personalized instruction and feedback to students. ITS are designed to simulate the behavior of a human tutor, adapting to the individual needs and abilities of each student. Over the years, ITS have evolved to incorporate more advanced technologies, such as artificial intelligence, machine learning, and natural language processing. It provides domain-specific knowledge and expertise, tracks student progress, identifies knowledge gaps, and adapts instruction, delivers personalized instruction, feedback, and assessment and facilitates user interaction, communication, and engagement (Woolf, 2009). ITS have been widely used in mathematics education to provide personalized instruction and feedback It has also been used in science education to support inquiry-based learning and experimentation. Also, ITS have been used to support language learning, providing personalized feedback and instruction. Moreover, studies have demonstrated that ITS can provide personalized learning experiences, adapt to individual students' needs, and offer real-time feedback (Koedinger et al., 2013; Aleven et al., 2016).

It is an AI-based teaching tool for higher education students who feel overlooked in the classroom by educators. The app is guided by each student's unique learning process, keeps them aware of their daily progress, and helps teachers tailor lessons to meet each student's specifics. Freed from any kind of limitations of time, space or number of students, the popularity of online learning is increasing day by day (Couture, 2018). Hence, the aim of this study centers on the application of artificial intelligence in the teaching and learning of mathematics: implication for achievement and retention.

Achievement is the feeling of getting things done as we desired or getting things that we expected. Okafor (2011) described achievement as the act of accomplishing or finishing something, something accomplished successfully, especially by means of exertion, skill, practice or perseverance. Academic achievement is determined by the level of accomplishment of a given task evaluated by the teacher through achievement test, assignment, etc. Adeyemi (2008) describes academic achievement as the scholastic standing of a student at a given moment which states individual intellectual abilities. Achievement in

mathematics therefore identifies how well or bad students have accomplished a given mathematics task or test. Thus, achievement in mathematics may not necessarily take place unless teachers form solid foundation for solid instruction through effectively planned lesson and activity- oriented techniques (Ogoke and Okigbo, 2021).

Nevertheless, research has also demonstrated that the use of technology, such as ITS, can help narrow the gender gap in math achievement (Wang & Lee, 2011; Chao et al., 2018). Gender issue in science education has been a subject of discourse and concern to science educators. According to Okereke (2006), Mathematics teachers also come to class loaded with a high dosage of sex related stereotypes, which make them treat boys and girls differently. Due to sex role stereotyping, it is generally believed that mathematics is suitable for boys and not for girls. On the contrary, Etsu and Ahmad (2018) reported that there is no significant difference in the academic achievement and retention of students' mathematics when taught with laboratory-based approach. The result agreed with Nwoke (2007), Ogoke (2018) and Shafi (2018), who reported no significant difference in the academic achievement and retention of students in mathematics. However, there is a need to explore the impact of ITS on-math achievement among students, taking into account individual differences such as gender.

Statement of Problem

The performance of secondary school students in mathematics in external examination bodies like West African Senior School Certificate Examination (WASSCE), NECO has improved slightly but needs more efforts in some areas like Geometry to attain its full heights. This has remained a source of concern to researchers, parents and the society at large. Meanwhile, secondary school students make use of modern technologies such laptops, android phones, etc, without exploring the benefits of such technologies. For instance, artificial intelligence can be integrated into online learning platforms, allowing content and activities to be customized according to the needs and knowledge level of each student. Learning management systems can use artificial intelligence to provide personalized recommendations, automatic feedback and monitor student progress. Science education researchers such as Mathematics Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN), amongst others have come up with many techniques, strategies and methods for teaching and monitoring science and mathematics; namely problem-solving method, inquiry-based teaching/learning approach, mathematical games, cooperative learning and analogies as advance organizers among others. Despite all these efforts, the problem of fluctuation in performance in mathematics has continued to be noticed in the public examinations and students are using technologies in the negative ways. Based on this premise, the researcher deemed it fit to find out the application **of intelligent tutoring system as AI tool** in the teaching and learning of mathematics, implication for achievement.

Based on the problem of this study, the study determined the application of intelligent tutoring system as AI tool in the teaching and learning of mathematics, implication for achievement. Specifically, this study was designed to determine the:

1. Differences in the mean achievement scores of students taught mathematics with the application of Intelligent tutoring system (AI) and those taught without the application of Intelligent tutoring system (AI).
2. Differences between the mean achievement scores of male and female students taught mathematics with the application of Intelligent tutoring system (AI)

Based on the purpose of the study, the following research question were stated to guide the study

1. What is the difference in the mean achievement scores of students taught mathematics with the application of Intelligent tutoring system (AI) and those taught without the application of Intelligent tutoring system (AI)?
2. What is the difference in the mean achievement scores of male and female students taught mathematics with the application of Intelligent tutoring system (AI)?

Based on the research question, the following hypotheses were stated to guide the study.

1. There is no significant difference in the mean achievement scores of students taught mathematics with the application of Intelligent tutoring system (AI) and those taught without the application of Intelligent tutoring system (AI).
2. There is no significant difference in the mean achievement scores of male and female students taught mathematics with the application of Intelligent tutoring system (AI).

METHOD

The researcher adopted a pure experimental design, specifically; pre-test, post-test randomized control group was used. The area of the study is Owerri municipal council of Imo State. The population comprised 4200 students in senior secondary three in Owerri Munipal Council of Imo state. The sample size was 72 students selected through a stratified simple random sampling and purposive sampling. Stratified sampling was used to select the school among the schools in Owerri Musical council of Imo Nigeria while purposive sampling, a non-probability sampling was used to select students that have access to Android phones or computers into the experimental group. Stratified simple random sampling is a probability sampling method that involves dividing the population into distinct subgroups or strata, and then selecting a simple random sample from each stratum. This approach ensures that each subgroup is represented in the sample, allowing for more accurate and reliable estimates. Purposive sampling techniques based on proximity and accessibility. Purposive sampling according to Nkwocha (2014) has the merit of selecting sample by arbitrary method to satisfy predetermined criteria. One instrument was used for collection of data namely; Mathematics Achievement Test (MAT). The Mathematics Achievement Test (MAT) is a standardized test designed to assess students' understanding and application of geometric concepts. The test consists of 40 multiple-choice questions, divided into four sections: Points, Lines, and Planes (10 questions), angles and Measurements (10 questions), properties of Shapes (10 questions), Geometric Transformations (10 questions). The MAT is scored based on the number of correct responses. Each correct answer is worth 2 points, and each incorrect answer is worth 0 points. The maximum possible score is 80 points. Three experts validated the instrument. The reliability co-efficient value of 0.74 was gotten which was calculated using the Kuder – Richardson Formula 20. Experimental group was taught using the application of AI for assignments and further studies while the control group was taught with the traditional teaching method (TTM) only. Mean and standard

deviation were used to answer the research questions while the hypotheses were tested using Analysis of covariance (ANCOVA). The null hypothesis (Ho) was rejected at p value less than 0.05.

Instructional Procedure

Selection of Participants

A randomized controlled trial design was employed to select participants. This approach ensures that participants are randomly assigned to either the control or experimental group, minimizing bias and ensuring comparability between groups.

Seventy-two (72) SS3 students from a single classroom were recruited for the study. The students were randomly assigned to either the control group (n = 48) or the experimental group (n = 24). Both groups were in the same class, but the experimental group received instruction with AI integration, while the control group received traditional instruction without AI. The experimental group was asked to use their Android phones or computers daily and respond to messages on a private platform created by the researchers. Intelligent Tutoring System (ITS) - an AI instrument that provides personalized learning experiences - was utilized to support students in overcoming mathematical challenges. By setting it up with the support team, integrating it into a blended learning approach, training students on its navigation, and providing academic support and resources, ITS effectively facilitated student learning and success.

The experimental group consisted of 24 students, while the control group had 48 students. The disparity in group sizes was primarily due to the challenges in recruiting students with access to devices or AI software. In many Nigerian secondary schools, students are restricted from using Android phones or computers due to concerns about the negative impact of these devices on morality. Consequently, only 24 students with parental permission were able to participate in the experimental group, which utilized AI software. Despite the unequal group sizes, the study aimed to provide valuable insights into the impact of AI on mathematics learning outcomes.

Teaching Participants: Researchers who chose to teach part-time in private schools (because some students in the school had access to Android phones and computers) taught male and female students. The control group did not use AI and relied primarily on classroom training. Researchers in the experimental group taught students to use the skills they had learned in homework and extracurricular activities. Teachers use Intelligent Tutoring System (ITS) tools to guide student learning and provide immediate feedback on areas that need attention.

Conduct post-test: After teaching, participants (control and experimental groups) were administered a post-test to determine whether they had acquired knowledge. The researcher evaluated the articles and recorded the scores.

Results

Table 1: Mean Achievement Scores and standard deviation of Students taught Geomtry with AI and without AI.

Subject	N	Pre-test Mean score	SD Pretest Score	Posttest Mean	SD Posttest	Mean difference
AI	24	31.67	9.45	50.37	12.05	7.53
WithoutAI	48	32.41	8.75	57.90	10.66	

From Table 1, the mean score in achievement of students taught mathematics with the application of AI (50.37) is lesser than the mean achievement score of students taught mathematics without the application of AI (57.90) leaving a mean difference of 7.53 in favour of those taught without AI. Table 1 further reveals that students taught mathematics with AI had higher standard deviation (SD) score than their counterparts taught without AI. In general, students taught without the application of AI achieved higher than their counterparts that were taught with AI.

Table 2: Mean Achievement Scores and standard deviation of male and female Students taught mathematics with AI

AI	N	Pre-test Mean	SD Pretest	Posttest Mean	SD Posttest	Mean difference
Male	10	32.00	8.24	55.16	10.66	4.72
Female	14	31.46	9.35	50.44	12.62	

From Table 2, the mean score in achievement of male students (55.16) is higher than the mean achievement score of their female (50.44) counterparts taught mathematics with AI with mean difference of 4.72. Table 3 further reveals that female students had higher standard deviation (SD) score than their male counterparts in the use of AI. In general, male students achieved higher than their female counterparts when taught with the application of AI.

Null Hypotheses Tested at 0.05 alpha levels

Table 3: ***Summary of Analysis of Covariance (ANCOVA) of Students Achievement Scores in mathematics using AI and without AI***

Source	Type III sum of Squares	Df	Mean Square	F	Sig.	
Corrected Model	19474.814[a]	8	2434.352	34.707	.000	.778
Intercept	17812.611	1	17812.611	253.957	.000	.763
Pretest	4277.127	1	4277.127	60.980	.000	.436
Strategy	44.318	1	44.318	.632	.042	.008
Gender	265.747	1	265.747	3.789	.061	.046
Achievlevel	2049.403	1	2049.403	29.219	.039	.270
Strategy * Gender	26.136	1	26.136	.373	.643	.005
Error	5541.084	63	70.140			
Total	295745.000	72				
Corrected Total	25015.898	71				

R Squared = .778 (Adjusted R Squared = .756)
Significant at $P < 0.05$

Table 3 revealed a significant main effect of the teaching strategies on the mean achievement scores of students in mathematics, F (1,63) = 0.632, p = 0.042, η_p^2= 0.008. In keeping with the decision rule therefore, the null hypothesis is rejected. Thus; the achievement scores in mathematics of students taught with AI and those taught without AI differ significantly. This means that students taught without AI appeared favourable for the students in the teaching and learning of mathematics.

Hypothesis 2 was tested with ANCOVA and the result of the test is summarized in Table Three. The ANCOVA revealed no significant main effect of gender on the mean achievement scores of students in mathematics, F (1, 63) = 3.789, p = 0.061, ηp2= 0.046. The decision therefore is that the null hypothesis is not rejected. Thus; the achievement scores of male and female students' taught mathematics with AI do not differ significantly. This shows that achievement in mathematics is not influenced by gender with the use of AI.

Discussion

The result of the study revealed that students taught mathematics without the application of AI achieved and retained higher than those taught with the application of AI; showing that classroom-based learning is still effective on students' achievement in mathematics. Table 5 revealed a significant main effect of the teaching strategies on the mean achievement scores of students in mathematics, F(1,63) = 0.632,p = 0.042,η_p^2= 0.008. Thus; the achievement scores in mathematics of students taught with AI and those taught without AI differ significantly. This means that students taught without AI appeared favourable for the students in the teaching and learning of mathematics.

The ANCOVA results revealed no significant main effect of gender on the mean achievement scores of students in mathematics, F (1, 63) = 3.789, p = 0.061, ηp2= 0.046. The decision therefore is that the null hypothesis is not rejected. Thus; the achievement scores of male and female students' taught mathematics with AI do not differ significantly. This shows that achievement in mathematics is not influenced by gender with the use of AI. This means that retention in mathematics has no influence on the achievement of students in mathematics. Thus, AI brings benefits and opportunities to education by facilitating personalization of learning, providing instant feedback and improving efficiency in the assessment process. In line with the findings of the study, the students taught with the application of AI believed much in the personalized learning and as a result did not see need for classroom learning.

Also, frequent notifications, social media, and games can distract students from their studies. Supporting the effectiveness of the use of AI, Wu (2021) found that through the teaching of AI, students' mathematics scores are about 30% higher than the traditional teaching methods. The integration of Artificial Intelligence (AI) in mathematics education has sparked intense debate among researchers. While AI-powered learning tools offer numerous benefits, such as enhanced engagement and personalized feedback, some argue that over-reliance on technology can undermine critical thinking and problem-solving skills, Zengin (2017). Moreover, concerns surrounding equity and access have been raised, as not all students have equal access to AI-powered learning tools, potentially exacerbating existing inequalities in education (Warschauer & Matuchniak, 2010).

In furtherance, the achievement scores of male and female students' taught mathematics with AI do not differ significantly. This shows that achievement in mathematics is not influenced by gender with the use of AI. Interestingly, research suggests that the use of AI in mathematics education does not significantly impact achievement scores based on gender. However, studies have revealed differences in how male and female students interact with AI-powered learning tools. For instance, male students tend to perform better in mathematics when using AI-powered tools, as they are more likely to engage with the technology (Chai , Koh, & Tsai, 2010). Conversely, female students may be less likely to engage with AI-powered tools due to factors such as lack of confidence or stereotypes (Kaplan et al., 2019). Nevertheless, when female students do engage with AI-powered tools, they tend to perform equally well as their male counterparts and may even benefit more from the personalized feedback and support provided by the technology (Dziuban et al., 2018)

Conclusion

Based on the findings, the researcher concluded that students taught mathematics without the application of AI achieved higher than those taught mathematics with the application of AI. Also, the use of AI in the teaching and learning of mathematics is gender friendly.

Recommendations

Based on the findings, the following recommendations were made;

1. The researcher recommended that activity-based classroom should be encouraged in the teaching and learning of mathematics.
2. The use of AI in the teaching and learning of mathematics in secondary schools should be done under closed monitoring, otherwise should be applied in higher education.
3. Improved technologies should be provided for both teacher and students for effective application of AI.

REFERENCES

Adeyemi, T. O. (2008). Predicting student's achievement in junior certificate examination in Ondo State, Nigeria. *Humanity and social Sciences Journals, 3* (1), 26-36.

Aleven, V., McLaren, B. M., & Sewall, J. (2016). Scaling up vocational education through intelligent tutoring systems. Journal of Educational Data Mining, 8(1), 1-27.

Anusiem, A.U (2006). *Processes of human learning* (Revived edition) Divine Mercy publishers,

Baker, R. S., Inventado, P. S., & Ocumpaugh, J. (2018). Differences in accuracy and reliability when comparing student responses to multiple-choice and open-ended questions. Journal of Educational Data Mining, 10(1), 1-27.

Bray, A., & Tangney, B. (2017). Technology usage in mathematics education research. A systematic review of recent trends, Computer Education, 114, 255–273.

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2010). Facilitating Preservice Teachers' Development of Technological, Pedagogical, and Content Knowledge (TPACK). Educational Technology & Society, 13(4), 63-73.

Chao, C. A., Chen, G. D., & Chu, H. C. (2018). Exploring the impact of intelligent tutoring systems on math achievement and motivation. Journal of Educational Computing Research, 56(4), 419-435.

Couture, W. (2018). How AI is disrupting education. Disruptor Daily.

Davadas, S. D., & Lay, Y. F. (2017). Factors affecting students' attitude toward mathematics: A structural equation modeling approach

Dziuban, C. D., Moskal, P. D., Williams, R. L., & Moskal, P. (2018). Situated cognition and the culture of learning in blended and online environments. Journal of Educational Computing Research, 56(4), 439-455.

Federal Republic of Nigeria (2013). *National policy on education (5th ed.*). Lagos: NERDC

Hwang, G. J., Xie, H., Wah, B. W., &Gasevic, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Artificial Intelligence Integducation.Comput. Educ. Artif. Intell., 1, 100001.
Intel. (2020). ration in Mathematics. Department of School Education and Literacy, Ministry of Education, Government of India.
Kilpatrick, J., Swafford, J., & Findell, B. (2001). Adding it up: Helping children understand math. Washington, DC: National Academy Press.
Koedinger, K. R., Corbett, A. T., & Perfetti, C. (2013). The Knowledge-Learning-Instruction (KLI) framework: Toward a unified science of learning. Journal of Educational Psychology, 105(2), 261-275.
Kaplan, A. M., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest AI of them all? Business Horizons, 62(1), 15-25.
Nkwocha, P. C. (2014*). Measurement and evaluation in the field of education.* Owerri Versatile Publishers Ltd.
Nwoke, B.I. (2010). Effect of Computer Assisted Instruction on Senior Secondary School Students' Performance in Mathematics. *Journal of Issues on Mathematics 13(4), 19-24.*
Ogoke and Okigbo (2021). Effects of planned and modified lesson study techniques on secondary school students' academic achievement and retention in mathematics. *South Eastern Journal of Research and Sustainable Development, 5(2),* 50-74.
Ogoke, C.J, Anyanwu, A, Osuji, N (2018). Effect of immediate reinforcement learning strategy on the senior secondary school students' achievement in mathematics. *Journal of the Mathematical Association of Nigeria, 43*(1), 202- 209.
Ogoke, C.J. (2016). *Effect of cooperative and competitive learning strategies on the achievement of secondary school students' in mathematics.*Unpublished master thesis, Nnamdi Azikiwe, Univeristy, Awka. *.Retrieved from: http://www.naulibraary.org*.
Okafor (2011). *Effects of cooperative and individualized system of instruction on the senior secondary school students' achievement in mathematics.*Unpublished Doctorate Dissertation.NnamdiAzikiwe University, Awka.Retrieved from:*www.naulibrary.com.*
Okereke, S.C. (2006). Effect of Prior knowledge of implementing of mathematics tasks concepts to career types and gender on students Achievement, interest and re-function. *Nzewi proceeding of the 47th Annual conference*, 253-259.
Orhani, S. (2021). Artificial Intelligence in Teaching and Learning Mathematics. *Kosovo Educational Research Journal, 2(3),* 29-38.
Sennar, K. (2019). The artificial intelligence tutor: the current possibilities of smart virtual learning. Emerj.
Shafi, A (2010). The Effect of Improvised Instructional Materials on Students' Performance in Solid Geometry.*ABACUS. The Journal of the Mathematical Association of Nigeria, 35* (1), 46-52.
Wang, X., & Lee, J. (2011). The impact of technology on math education: A review of the literature. Journal of Educational Computing Research, 45(3), 347-361.
Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. Review of Research in Education, 34(1), 179-225.
Woolf, B. P. (2009). Building intelligent tutoring systems. San Francisco, CA: Morgan Kaufmann Publishers.
Woolf, B. P. (2010). Building intelligent tutoring systems. San Francisco, CA: Morgan Kaufmann Publishers.
Wu, R. (2021). Visualization of basic mathematics teaching based on artificial intelligence. *Journal of Physics*: 2(1), 42-65.
Xie, H., &Zou, D. (2020). Application and theory gaps during the rise of Artificial Intelligence in Education. Computer Education, Artificial Intelligence, 1, 100002.
Zengin, Y. (2017). Investigating the effects of technology-enhanced instruction on student mathematics anxiety. Journal of Educational Computing Research, 55(6), 761-779.