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Blended AI Resources As Predictor Of Physics Teachers' Effectiveness In Secondary School Physics In Awka Education Zone

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ABSTRACT

Report from scholars indicated that Physics teachers have not been effective because they lack instructional materials which has resulted in the greater number of students engaging in examination malpractice. This report prompted the researcher to determine if Blended AI resources could be a possible instructional material that a Physics teacher may need since that these technology encompasses so many materials which may or may not be possible for a Physics teacher to see or come into Physics class with and this could have been affecting their effectiveness in Physics. The finding of this study can boost the confidence of the Physics teachers in Awka Education zone to use this emerging technologies (Blended AI resources). Thus, the researcher determined Blended AI resources as predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone. This study was guided by two (2) research questions and two (2) research hypotheses. The design of this study was predictive research design. The population for the study was 2185 SSS II Physics students in 22 schools in Awka Education zone. The sample size of the study was 312 SSS II students in the six (6) sampled public coeducational secondary schools in Awka Education zone. Purposive Sampling technique was used to sample six (6) coeducational schools. The instruments used for data collections were four, which were Blended AI Resources (AI-driven virtual classrooms) Utilization Questionnaire (BARVCUQ), Blended AI Resources (AI-based assessment system) Utilization Questionnaire (BARASUQ), Reformed Teaching Observation Protocol (RTOP) and Physics Achievement Test (PAT). The instruments were validated by experts in Physics Education and Computer Science Education of Faculty of Education, ESUT, Enugu. The instruments were found to be highly reliable with KR20 of 0.79 for PAT, Cronbach Alpha of 0.75, 0.74 and 0.82 for BARASUQ, BARVCUQ and RTOP respectively. Regression Analysis of Predictive values (which are the coefficient of Determination, R^2, adjusted coefficient of Determination, adjusted R^2), and Pearson Product Moment Correlation (R) were used to answer research questions while the Regression Analysis of Variance were used to test the research hypotheses. The hypotheses were further tested to determine the extent at which Blended AI resources would significantly predict the increase the teachers' effectiveness in Physics using Test of Regression Weights. The study discovered that (1) AI-based assessment system significantly predicts lowly and moderately on teachers' effectiveness in Physics by 6.3% as measured using RTOP and 20% as measured using PAT and any positive adjustment in the use of AI-based assessment system, the teachers' effectiveness (RTOP and PAT) in Physics would significantly be affected by 5.7% and 18.8%. Hence, AI-based assessment systems is a significant predictor of Teachers' Effectiveness in Secondary school Physics in Awka Education Zone; (2) AI-driven virtual classrooms lowly significantly predicts the teachers' effectiveness in Physics in terms of Physics teachers' Teaching Observation Protocol and any positive significant adjustment in the use of AI-driven virtual classrooms, the teachers' effectiveness (RTOP) in Physics will be affected by 8.2%. Hence, the study concludes that AI-driven virtual classrooms is a significant predictor of Teachers' Effectiveness in Secondary school Physics in terms of Physics teachers' Teaching Observation Protocol and is not a significant predictor of Teachers' Effectiveness in Secondary school Physics in terms of students' achievement in Physics. Thus, the study recommended that Federal and State Government should invest on Physics education by providing Physics teachers with various forms of Blended AI resources and incentives that will enable those Physics teachers to be able to power the use of Blended AI resources in combination with other innovative teaching strategies in teaching Physics as this act is likely to improve their effectiveness in Physics.

Keywords: Teaching, Physics, Artificial Intelligence, resources

INTRODUCTION

Science Education is the greatest tool for the development of a nation through human development. This is because Science Education embraces all processes by which a person acquires knowledge and skills, to live well in his society. Science Education enables humans respond to and interacts with the environment. In other words, Science Education liberates the students from ignorance, lack of awareness and high rate of docility. In realization of the importance of Science Education, the Federal Government of Nigeria made Science Education compulsory from primary school level to university level. In Secondary School level in Nigeria, there are about nine science education subjects that are offered by the students which are Mathematics (that's compulsory), Computer Studies, Biology, Physics, Chemistry, Forestry, Data Science, Information Technology (IT), Agriculture, and Agronomy. Apart from Mathematics that is compulsory, Physics is the second highest chosen science subjects that is optional.

From the statistics published by the West African Examination Council (WAEC, 2025) on the candidates' enrollment per subject, Physics had the second highest science optional subject and fourth highest in all by 54.6%. This showed that students sought for Physics because the knowledge of Physics facilitates the understanding of other disciplines (Udodi, 2017). Physics promotes the acquisition of specialized science skills and knowledge (Adeyemo, 2020). Physics studies matter that made up the universe, the motion and energy of matter, the cause effect relationship of matter and energy and, the application of natural phenomena (Ashi, 2017). Obasi (2017) reported that the knowledge of Physics can be enhanced if it is taught using modern technology as the modern technology enables to expose the knowledge of the universe, the motion and energy of matter, the cause effect relationship of matter and energy and, the application of natural phenomena to the students in a better perspective without being abstract and by so doing, enhances the Physics teachers' effectiveness in Physics. Thus, the success of achieving the objectives of Physics in Secondary School level in Nigeria depends on the Physics teachers' effectiveness in Physics.

Physics teachers' effectiveness refers to the ability of the Physics teachers to achieve desired learning outcomes of Physics through efficient instructional delivery and classroom management. It involves the extent to which Physics teachers can motivate students, apply appropriate teaching methods, and assess learning progress accurately. Afe (2020) disclosed that effective Physics teachers possess Physics competence, dedication, and the capacity to influence students' behaviour and performance positively. Thus, Adediwura and Tayo (2017) disclosed that teacher effectiveness is measured by students' academic achievement in Physics and the teacher's ability to facilitate meaningful learning. A Physics teacher whose students perform poorly in Physics is said not to be effective. Report from Adaramola & Obomanu (2021) indicated that Physics teachers have not been effective which has resulted in the greater number of students engaging in examination malpractice. Lack of teachers' not been effective is because according to Anibueze (2021), the teachers still prefer using the old method and have refused to adopt the 21st century technology such as the Blended Artificial Intelligence Resources. Especially in this 21st century, where virtually, all the students use Artificial Intelligence (AI) to do school assignment and it would be nice if Physics teachers uses the AI to teach Physics as Sander (2021) reported that the students can learn best if the teacher uses the materials that they use mostly and George (2022) reported that in Nigeria, 74.3% of all the Nigerian students uses Artificial Intelligence (AI) for their educational purposes.

Artificial Intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems, to perform tasks that typically require human reasoning and learning. According to Russell and Norvig (2021), AI encompasses subfields such as machine learning, natural language processing, robotics, and computer vision aimed at creating intelligent systems. Therefore, AI serves as a transformative force in education, business, and technology by enhancing efficiency and problem-solving capabilities. When Artificial Intelligence is applied in education, it is called Blended Artificial Intelligence. Tang (2024) reported that AI-based blended courses improve students' theoretical understanding, practical competence, and learning attitudes. Park and Doo (2024) disclosed that AI applications in blended learning enhance flexibility and autonomy, especially in online learning environments. Blended Artificial Intelligence resources refer to educational tools and systems that merge Artificial Intelligence technologies with traditional and online teaching approaches to improve learning effectiveness. In Physics education, Tang (2024) revealed that Blended Artificial Intelligence resources provide personalized Physics learning experiences by adjusting

instructional materials used to teach Physics to match individual students' needs and progress in Physics. Park and Doo (2024) revealed that there are nine (9) most popular Blended Artificial Intelligence Resources that can be used in teaching Physics and there are; AI-powered Learning Management Systems, adaptive learning platforms, **AI-driven assessment tools,** AI-based data analytics dashboards, **intelligent tutoring systems**, AI-powered chatbots, speech and language recognition tools, **AI-driven virtual classrooms**, predictive learning analytics tools and AI-based content creation tools.

Among the nine (9) most popular Blended AI resources as enumerated by Park and Doo, Ndubisi (2024) recommended that four (4) of them are highly needed for the improvement of Physics education in Nigeria which are AI-driven assessment tools, intelligent tutoring systems, AI-driven virtual classrooms and AI-powered chatbots, speech and language recognition tools. This is because of the nature of Nigerian educational and economic system that may not give the Physics teacher the required time and chance to effectively integrate the others into the teaching of Physics, but with Nigerian system, it is easier for the Physics teacher to integrate use Blended AI resources in teaching Physics effectively. However, this study will focus on AI-driven assessment tools and AI-driven virtual classrooms. This is based on Ndubisi (2024)'s above assertion and the fact that it involves students a lot as the students can take the teaching of Physics to their various homes even without the Physics teacher and still their academic performance in Physics will still improve.

For AI-driven assessment tools, they use machine learning algorithms to automate grading, generate feedback, and analyze student performance with high precision. They help the students to identify their knowledge gaps in the Physics taught, predict their possible Physics outcomes and provide them personalized feedback. They enable the students to evaluate themselves in high precision with or without the Physics teacher. According to Taylor and Brown (2024), integrating AI into assessment enhances fairness, accuracy, and efficiency in grading systems. Likewise, Green and O'Connor (2023) highlighted that AI-based assessment systems promote formative assessment practices that support continuous learning improvement. Whereas for AI-driven virtual classrooms, they use machine learning algorithms to teach students Physics using a visual robotic Physics teacher. They provide the students the opportunity to ask questions pertaining to the Physics topic taught without feeling shy or being embarrass by their colleagues and/or by their teacher. AI-driven virtual classrooms are considered one of the most important techniques of e-learning, as they enable both teachers and students to achieve the educational goals of Physics. This is done by facilitating the application of the curriculum at any time and place without any form of restrictions.

AI-driven virtual classrooms help the Physics teacher to cover all aspects of the Physics curriculum with or without practical applications and help the students understand all the points of the Physics curriculum; which is difficult to provide in the case of limited equipment and funding. AI-driven virtual classrooms provide the synchronization between the process of explaining the theoretical ideas and practical application and help the students and teachers' study and prepare Physics topics at any time and place. They satisfy the scientific passion of students, allowing them to access the various topics in Physics including Physics experiments easily regardless of time or place, and this increase their understanding of Physics. Despite the importance of Blended AI resources, scholars like Ndubisi (2024) reported that the Blended AI resources are not been integrated in the teaching of Physics in Nigeria.

From the reports of Ndubisi (2024), scholars like Eze (2022) was quoted to have reported that Nigerian teachers are afraid that it will affect their teachers' effectiveness and cause confusion in the classroom. Adeoye & Ajiboye (2022) reported that Artificial intelligence is not being integrated in blended learning for secondary education. Egbo (2024) reported that there are many factors that may have caused it, one of them is lack of innovative technology in schools but Onasanya, Adebisi and Effiong (2023) disclosed that most of all the Urban schools in Lagos, 80% of them have their senior secondary school students use mobile phones and this report means that it is very possible for the Physics teachers to integrate Blended AI resources in teaching Physics but are afraid that it may affect their effectiveness in Physics. Thus, there is need to determine Blended AI resources as predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone. The essence of this study is to determine if Blended AI resources can effectively predict Physics Teachers' Effectiveness in Secondary School Physics in Awka Education zone.

The finding of this study can boost the confidence of the Physics teachers in Awka Education zone to use this emerging technologies (Blended AI resources). Since that scholars have reported that they enhances students' performance in Physics and the major parameters needed for this emerging technology to be used by the students have been met by the students naturally using the reports of Onasanya, Adebisi and Effiong (2023), it then becomes imperative for the researcher to embark on this study. Specifically, the study was limited to determine AI-driven virtual classrooms and AI-based assessment systems were the as predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone. The essence of limiting them to AI-driven virtual classrooms and AI-based assessment systems were because they can easily be implemented by the Physics teachers if they are found to have high predictive level to teachers' effectiveness since that the Physics teachers use their conventional methods in the everyday teaching of Physics. In every Physics lesson, a Physics teacher enter class to teach Physics so it won't be difficult for the Physics teacher to use AI-driven virtual classrooms to teach Physics and use to evaluate the students in Physics without necessary protocol. The adoption of the Blended AI resources may likely enhance Physics teachers' professional development and instructional competence in Physics.

Purpose of the Study

The aim of this study was to determine Blended AI resources as predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone. Specifically, the study determined;

1. AI-based assessment systems as predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone.
2. AI-driven virtual classrooms as predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone.

Research Questions

The following research questions guided the study

1. To what extent does AI-based assessment systems predict the Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone?
2. To what extent does AI-driven virtual classrooms predict the Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone?

Research Hypotheses

The following research hypotheses which were tested at 0.05 levels of significance guided the study.

H0 1: AI-based assessment systems is not a significant predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone.

H0 2: AI-driven virtual classrooms is not a significant predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone.

RESEARCH METHODS

The design of this study was predictive research design. According to Anibueze (2021), a predictive research seeks to establish if one or two variables can forecast the other variable. This research goes beyond the Correlational research that establishes relationship between two or more variables being investigated. This study seeks to identify relationships between the variables which are the Blended AI resources and the teachers' effectiveness in Physics in Awka Education zone, and then use one or more variables (that's the Blended AI resources) to predict the value/outcome of another variable (that's the teachers' effectiveness in Physics). This study forecasted an outcome based on an observed data. This study didn't manipulate variables unlike the Quasi-experimental research to determine its effect but to determine the predictive level of one variable on another variable. The population for the study was 2185 SSS II Physics students in 22 schools in Awka Education zone as at 2024/2025 academic session (Post Primary Schools Service Commission, PPSSC, Awka zone).

The sample size of the study was 312 SSS II students in the six (6) sampled public coeducational secondary schools in Awka Education zone. Purposive Sampling technique was used to sample six (6) coeducational schools. The essence of selecting coeducational schools was because the researcher wanted to ensure that there was gender interaction. In each of the six (6) sampled schools, simple sampling technique was sampled to sample two (2) physics classes. The number of the students in each of the sampled intact classes were the

sample size of this study. Thus, the study sampled 109 male and 203 female SSS II Physics students. The sampled students were placed in two groups; 159 (58male and 101 female) students in AI-driven virtual classrooms group (that's Group 1) and 153 (51male and 102 female) students in AI-based assessment system group (that's Group 2).

The instruments used for data collections were four, which were Blended AI Resources (AI-driven virtual classrooms) Utilization Questionnaire (BARVCUQ), Blended AI Resources (AI-based assessment system) Utilization Questionnaire (BARASUQ), Reformed Teaching Observation Protocol (RTOP) and Physics Achievement Test (PAT). All the instruments have two sections; Section A and B. The Section A of PAT, BARVCUQ and BARASUQ contained the personal information of the respondents like the Name of the Student, Gender, Class and the Name of the School, while their Section B differed. The Section B of PAT contained the 40-multiple choice (A – D) Physics questions in line with the PAT table of Specification. The table of Specification is structured in six (6) cognitive domains; Knowledge (20%), Comprehension (20%), Application (30%), Analysis (15%), Synthesis (10%) and Evaluation (5%) on the following topics heat energy; Heat definition as regards to Heat and temperature, Sources of heat, Effects of heat, Kinetic molecular theory, Thermal expansivity, Change of state, and Transfer of heat: conduction, convection and radiation. The choice of these contents is because these contents are taught at Senior Secondary School II (SSS II) and it is a topic that is taught first term scheme of work. PAT was scored by 0 mark for the wrong option and 1 mark for the correct option. The maximum score was 40 while the minimum score was 0. Their scores were converted to percentage for analysis as shown as: $P\% = \frac{Score}{40} \times \frac{100}{1}$. The result from the percentage was interpreted as:

0.00 – 39.00	=	Fail
40.00 – 49.00	=	Pass
50.00 – 59.00	=	Average/Moderate
60.00 – 69.00	=	Very Good
70.00 – 99.99	=	Excellent

The Section B of BARVCUQ contained 15 structured items that determines the extent at which the respondents agree on the Utilization of Blended Artificial Intelligence Resources of AI-driven virtual classrooms. The items has four (4) response options of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The Section B of BARASUQ contained 15 structured items that determines the extent at which the respondents agree on the Utilization of Blended Artificial Intelligence Resources of AI-based assessment system. The items has four (4) response options of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). Section B of BARVCUQ and BARASUQ were developed in line with the one developed by Mishra and Koehler (2006)'s Technological Pedagogical Content Knowledge (TPACK). Both instruments' Section B contains three parts; Part 1 centers on Content Knowledge (CK) (that's items 1 – 5), Part 2 centers on Pedagogical Knowledge (PK) (that's items 6 – 10) and Part 3 centers on Technological Knowledge [that's Knowledge of AI-driven virtual classrooms for **BARVCUQ** and Knowledge of AI-based assessment system for **BARASUQ**] (TK) (that's items 11 – 15).

The interpretation of the scoring scale is stated as follows:

Strongly Agree (SA)	=	4
Agree (A)	=	3
Disagree (D)	=	2
Strongly Disagree (SD)	=	1

The scores obtained from the respondents on BARASUQ and BARVCUQ were interpreted as

1.00 – 1.99	=	Strongly Disagree (SD)
2.00 – 2.49	=	Disagree (D)
2.50 – 2.99	=	Agree (A)
3.00 – 3.99	=	Strongly Agree (SA)

RTOP was developed by the researcher. RTOP contains both Sections A and B. Section B of the RTOP was developed in line with the one developed by the original authors; Dr. Andrew E. Sawada and Dr. Richard C. Piburn in 1990 (Sawada, et al 2002). However, the Section A contained the respondent's code number which is assigned by the Senior Research Assistant while the Section B contains 25 items which are subdivided into

five (5) parts that are structured in 0 – 4 scale. Each part contains 5 items. Part 1 centers on Lesson Implementation (items 1 – 5), Part 2 centers on Content Knowledge of Physics (items 6 – 10), Part 3 centers on Content-Procedural Knowledge of Physics (items 11 – 15), Part 4 centers on Classroom Culture-Communicative Interaction (items 16 – 20) and Part 5 centers on Classroom Culture- Student/Teacher Relationships (items 21 – 25). The interpretation of the scoring scale is stated as follows:

0 = Never occurred
1 = Very Little Evidence
2 = Some Evidence
3 = Strong Evidence
4 = Very Strong Evidence

The scores obtained from the respondents on RTOP was interpreted as

0 – 30 = Traditional/Lecture dominated
31 – 50 = Transitional
51 – 70 = Moderately Reformed
71 – 100= Highly Reformed/Student-centered

The instruments were validated by experts in Physics Education and Computer Science Education of Faculty of Education, ESUT, Enugu. The four research instruments were found to be highly reliable. The instruments were administered to 40 SSS II Physics students in Onitsha Education zone. Different statistical tools were used to analyze their reliability. For PAT, K-R 20 was used which revealed 0.79, while for BARASUQ and BARVCUQ, Cronbach Alpha was used to determine their reliabilities with the Alpha levels of 0.75 and 0.74 respectively whereas, Cronbach Alpha was used to determine inter-rater reliability of RTOP which gave an estimate value of 0.82.

The researcher trained five (5) Physics teachers from the three (3) sampled coeducational schools on the use of AI-driven virtual classrooms in teaching Physics for three weeks together with their (3) Vice Principals. At the end of the training, the five (5) Physics teachers became the study's Research Assistant for Group 1 and the three (3) Vice Principals became the Study's Senior Research Assistants for Group 1 while the researcher trained another five (5) Physics teachers from the three (3) sampled coeducational schools on the use of AI-based assessment system in teaching Physics for three weeks together with their (3) Vice Principals. At the end of the training, the five (5) Physics teachers became the study's Research Assistant for Group 2 and the three (3) Vice Principals became the Study's Senior Research Assistants for Group 2. The research assistants for Group 1 taught Physics to their sampled class in AI-driven virtual classrooms group for four (4) weeks using the AI-driven virtual classrooms after administering pre-PAT to the students while their counterparts in Group 2 taught Physics to their sampled class in AI-based assessment system group for four (4) weeks using the AI-based assessment system after administering pre-PAT to the students.

One week before the end of the treatment, the Senior Research Assistant educate the whole students on the need to fill RTOP with the aim to make their teachers better. They administered RTOP on the students for all the subjects and guide the students on how to fill them. This was to train the students who are the respondents on how to fill RTOP and to remove bias from the students in filling the RTOP. On the last day of the treatment, the researcher assistants administered RTOP, BARVCUQ and RTOP on the students in Group 1 while the research assistants in Group 2 administered RTOP, BARASUQ and RTOP on the students in Group 2. The research assistants handled over the research instruments to the researcher for marking and analyzing. However, the research assistants for Group 1 handed a total of 143 copies (that's a total of 48 copies from the males and 95 from the female) of BARVCUQ, post-PAT and RTOP were handed over to the researcher while those ones for Group 2 handed a total of 145 copies (that's a total of 47 copies from the males and 98 from the female) of BARASUQ, post-PAT and RTOP were handed over to the researcher, which means that 92.31% return rate. BARVCUQ/ BARASUQ were used to measure the utilization of Blended AI resources while the RTOP and students' scores from PAT were used to measure the teachers' effectiveness in Physics. The researcher decided to use the Quasi-experimental method to determine their predictive level of AI-based assessment systems and AI-driven virtual classrooms because the researcher wanted to reduce or eliminate extraneous variables that may affect the result of this study.

Regression Analysis of Predictive values (which are the coefficient of Determination, R^2, adjusted coefficient of Determination, adjusted R^2), and Pearson Product Moment Correlation (R) were used to answer research questions while the Regression Analysis of Variance were used to test the research hypotheses. The hypotheses were further tested to determine the extent at which Blended AI resources would significantly predict the increase the teachers' effectiveness in Physics using Test of Regression Weights. In answering the research questions using the Pearson Product Moment Correlation (R), the R tells how much of the relationship between the predictor (the Blended AI resources) and the dependent variable (the teachers' effectiveness in Physics). Thus, the interpretation of the relationship was based on the Nwana (2011)'s assertions which is as follow

Correlation values from 0.80 – 1.00 = Very High positive Relationship;
Correlation values from 0.60 – 0.79 = High positive Relationship;
Correlation values from 0.40 – 0.59 = Average positive Relationship;
Correlation values from 0.20 – 0.39 = Low positive Relationship;
Correlation values from 0.00 – 0.19 = Very Low positive Relationship;
Correlation values from 0.00 – -0.19 = Very Low negative Relationship;
Correlation values from -0.20 – -0.39 = Low negative Relationship;
Correlation values from -0.40 – -0.59 = Average negative Relationship;
Correlation values from -0.60 – -0.79 = High negative Relationship;
Correlation values from -0.80 – -1.00 = Very High negative Relationship.

In answering the research questions using the Coefficient of Determination, R^2, R^2 tells how much of the variation the predictor (Blended AI resources) has in the dependent variable (teachers' effectiveness in Physics) and if the variation is between 0.01 and 0.09, then the variation is said to be ***small/low/weak prediction***, but if the variation is between 0.10 and 0.29, then the variation is said to be ***moderate/averagely prediction***, and if the variation is more than 0.30, then the variation is said to be ***strong/high prediction***. In testing the research hypotheses using Regression ANOVA, the null hypothesis (H_0) was rejected when the significance of F (value of the test statistics) is less than 0.05. Otherwise do not reject at 0.05.

RESULTS

Question 1: *To what extent does AI-based assessment systems predict the Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone?*

Table 1: Regression Analysis of AI-based Assessment Systems and Teachers' Effectiveness in Secondary School Physics

Predictor	Criterion	N	PAT	RTOP	BARASUQ	R	R^2	Adj. R^2	Std Error	Sig. (2-tailed)	Interpretation
BARASUQ	RTOP	145	52.14	58.15	2.91	.252[a]	.063	.057	4.01271	.002	LPR, LP
BARASUQ, RTOP	PAT					.447[c]	.200	.188	5.05417	.000	APR, MP
DECISION			M	MR	A						

a. Predictors: (Constant), BARASUQ
b. Dependent Variable: RTOP
c. Predictors: (Constant), RTOP, BARASUQ

*** M= Moderate; MR = Moderately Reformed; A = Agreed; LPR = Low Positive Relationship; LP = Low Prediction

****APR = Average Positive Relationship; MP = Moderate Prediction

The Table 1 shows that when the Physics teachers uses Artificial Intelligence Resources of AI-based assessment system to teach students Physics, their effectiveness in students' achievement score in Physics (PAT) is moderate/average with the mean score of 52.14, while their Physics teachers' Teaching Observation Protocol is moderately reformed with the mean rating score of 58.15. The table further shows that the respondents uniformly agreed that their physics teachers utilized the AI-based assessment system with the mean rating score of 2.91. From the Pearson Correlation analysis (r) in Table 1 indicated that there is a

significant ***low positive relationship*** between the Artificial Intelligence Resources of AI-based assessment system and the Physics teachers' effectiveness as measured using RTOP ($r = .252$, $p < .002$) and also, Artificial Intelligence Resources of AI-based assessment system ***moderately and positively correlated*** with the teachers' effectiveness as measured using PAT, and the correlation is significant at $r = .447$ and $p = .000$. Lastly, the study shows that there is a significant ***weak variation prediction*** of the Artificial Intelligence Resources of AI-based assessment system as measured using BARASUQ on the Physics teachers' effectiveness in Physics using RTOP ($R^2 = .063$, $p < .002$) and there is a ***moderate/average variation prediction*** of the Artificial Intelligence Resources of AI-based assessment system as measured using BARASUQ on the Physics teachers' effectiveness in Physics using PAT ($R^2 = .200$, $p < .000$). This means that AI-based assessment system significantly predicts lowly and moderately on teachers' effectiveness in Physics by 6.3% as measured using RTOP and 20% as measured using PAT and any positive adjustment in the use of AI-based assessment system, the teachers' effectiveness (RTOP and PAT) in Physics will be affected by 5.7% and 18.8% (adj $R^2 = .057, .188$).

H0 1: AI-based assessment systems is not a significant predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone.

Table 2: Regression Analysis of the Predictive Variable (AI-based assessment systems) on Physics Teachers' Effectiveness in Secondary school Physics

Model		Sum of Squares	Df	Mean Square	F	Sig.	Dec.
1	Regression	156.104	1	156.104	9.695	.002[b]	S
	Residual	2302.558	143	16.102			
	Total	2458.662	144				
2	Regression	904.627	2	452.314	17.707	.000[b]	S
	Residual	3627.331	142	25.545			
	Total	4531.959	144				

[1]a. Dependent Variable: RTOP

b. Predictors: (Constant), BARASUQ

[2]a. Dependent Variable: PAT

b. Predictors: (Constant), RTOP, BARASUQ

The Analysis of Variance (ANOVA) for the regression (predication) shows that F-ratio is 9.695 and is significant at 0.002. Since 0.002 is less than 0.05, the null hypothesis 1 is rejected as stated. Also, model 2 shows that that F-ratio is 17.707 and is significant at 0.000. Since 0.000 is less than 0.05, the null hypothesis 1 is rejected as stated. Hence, the study concludes that AI-based assessment systems is a significant predictor of Teachers' Effectiveness in Secondary school Physics in Awka Education Zone. This implies that AI-based assessment systems significantly predicts teachers' effectiveness in Physics.

Table 3: Test of Regression Weights for the Contribution of AI-based assessment systems on Teachers' Effectiveness in Secondary school Physics

Model	Unstandardized Coefficients		Standardized Coefficients	t-ratio	Sig.	Decision
	B	Std. Error	Beta			
(Constant)	46.772	3.670		12.745	.000	S
BARASUQ	3.911	1.256	.252	3.114	.002	S
(Constant)	12.463	6.755		1.845	.067	NS
BARASUQ	3.320	1.635	.158	2.031	.044	S
RTOP	.516	.105	.380	4.901	.000	S

[1]a. Dependent Variable: RTOP

[2]a. Dependent Variable: PAT

From the result in Table 3, it is revealed that Teachers' Effectiveness in Secondary school Physics which is constant has a t-statistic value of t=12.745 and is significant at 0.000. On the other hand, AI-based assessment systems has a t-statistic value of t=3.114 which is significant at 0.002 as regards to Teachers' Effectiveness in Secondary school Physics measured using RTOP. This implies that AI-based assessment systems significantly contributed to the Teachers' Effectiveness in Secondary school Physics as measured using RTOP since that their significant values are less than 0.05. In model 2, it is revealed that Teachers' Effectiveness in Secondary school Physics which is constant has a t-statistic value of t=1.845 and is not significant at 0.067. On the other hand, AI-based assessment systems has a t-statistic value of t=2.031 which is significant at 0.044 as regards to Teachers' Effectiveness in Secondary school Physics measured using RTOP and a t-statistic value of t=4.901 which is significant at 0.000 as regards to Teachers' Effectiveness in Secondary school Physics measured using PAT. This implies that AI-based assessment systems significantly contributed to the Teachers' Effectiveness in Secondary school Physics as measured using RTOP and PAT since that their significant values are less than 0.05.

From the Table 3, it implies that for any significant increase of additional unit use of AI-based assessment systems by 3.911% (Beta=3.911), the teachers' effectiveness in Secondary School Physics as measured by RTOP is predicted to increase by 46.772% (Beta=46.772) and for any significant increase of additional unit use of AI-based assessment systems by 3.320% (Beta=3.320), the teachers' effectiveness in Secondary School Physics as measured by PAT and RTOP is predicted to increase by 12.463% (Beta=12.463) and 0.516% (Beta=.516).

Question 2: To what extent does AI-driven virtual classrooms predict the Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone?

Table 4: The Mean Scores of AI-driven virtual classrooms and Teachers' Effectiveness in Secondary school Physics

Predictor	Criterion	N	PAT	RTOP	BARVCUQ	R	R^2	Adj. R^2	Std Error	Sig. (2-tailed)	Interpretation
BARVCUQ	RTOP	143	62.10	60.08	2.93	.298[a]	.089	.082	3.62863	.000	LPR, LP
BARVCUQ, RTOP	PAT					.134[c]	.018	.004	6.65962	.281	VLPR, LP
DECISION			M	MR	A						

a. Predictors: (Constant), BARVCUQ

b. Dependent Variable: RTOP

c. Predictors: (Constant), RTOP, BARVCUQ

*** M= Moderate; MR = Moderately Reformed; A = Agreed; LPR = Low Positive Relationship; LP = Low Prediction

****VLPR = Very Low Positive Relationship

Table 4 shows that when the Physics teachers uses AI-driven virtual classrooms to teach students Physics, the effect in students' achievement score in Physics (PAT) is ***very good*** with the mean score of 62.10, while their Physics teachers' Teaching Observation Protocol is moderately reformed with the mean rating score of 60.08. The table further shows that the respondents uniformly agreed that their physics teachers utilized the AI-driven virtual classrooms with the mean rating score of 2.93. From the Pearson Correlation analysis (r) in Table 4 indicated that there is a significant ***low positive relationship*** between the Artificial Intelligence Resources of AI-driven virtual classrooms and the Physics teachers' effectiveness as measured using RTOP ($r = .298$, $p < .000$) and also, Artificial Intelligence Resources of AI-driven virtual classrooms ***low positive relationship*** with the teachers' effectiveness as measured using PAT, and the correlation is not significant at $r = .134$ and $p = .281$. Lastly, the study shows that there is a significant ***weak variation prediction*** of the Artificial Intelligence Resources of AI-driven virtual classrooms as measured using BARVCUQ on the Physics teachers' effectiveness in Physics using RTOP ($R^2 = .089$, $p < .000$) and there is a ***weak variation prediction*** of the Artificial Intelligence Resources of AI-driven virtual classrooms as measured using BARVCUQ on the Physics teachers' effectiveness in Physics using PAT ($R^2 = .018$, $p < .281$), which is not significant. This means that AI-driven virtual classrooms lowly significantly predicts the teachers' effectiveness in Physics in terms of Physics teachers' Teaching Observation Protocol by 8.9% and any positive significant adjustment in the use of AI-driven virtual classrooms, the teachers' effectiveness (RTOP) in Physics will be affected by 8.2% (adj $R^2 = .082$).

H0 2: AI-driven virtual classrooms is not a significant predictor of Physics Teachers' Effectiveness in Secondary school Physics in Awka Education Zone.

Table 5: Regression Analysis of the Predictive Variable (AI-driven virtual classrooms) on Physics Teachers' Effectiveness in Secondary school Physics

Model		Sum of Squares	Df	Mean Square	F	Sig.	Dec.
1	Regression	180.457	1	180.457	13.705	.000[b]	S
	Residual	1856.536	141	13.167			
	Total	2036.993	142				
2	Regression	113.557	2	56.778	1.280	.281[b]	NS
	Residual	6209.072	140	44.351			
	Total	6322.629	142				

[1]a. Dependent Variable: RTOP

b. Predictors: (Constant), BARVCUQ

[2]a. Dependent Variable: PAT

b. Predictors: (Constant), RTOP, BARVCUQ

The Analysis of Variance (ANOVA) for the regression (predication) shows that F-ratio is 13.705 and is significant at 0.000. Since 0.000 is less than 0.05, the null hypothesis 2 is rejected as stated. In Model 2, F-ratio is 1.280 and is not significant at 0.281. Since 0.281 is more than 0.05, the null hypothesis 2 is accepted as stated. Hence, the study concludes that AI-driven virtual classrooms is a significant predictor of Teachers' Effectiveness in Secondary school Physics in terms of Physics teachers' Teaching Observation Protocol and is not a significant predictor of Teachers' Effectiveness in Secondary school Physics in terms of students' achievement in Physics.

Table 6: Test of Regression Weights for the Contribution of AI-driven virtual classrooms on Teachers' Effectiveness in Secondary school Physics

Model	Unstandardized Coefficients		Standardized Coefficients	t-ratio	Sig.	Decision
	B	Std. Error	Beta			
(Constant)	46.950	3.561		13.185	.000	S
BARVCUQ	4.476	1.209	.298	3.702	.000	S
(Constant)	48.389	9.765		4.955	.000	S

BARVCUQ	-.254	2.324	-.010	-.109	.913	NS
RTOP	.241	.155	.137	1.557	.122	NS

[1]a. Dependent Variable: RTOP

[2]a. Dependent Variable: PAT

From the result in Table 6, it is revealed that Teachers' Effectiveness in Secondary school Physics which is constant has a t-statistic value of t=13.185 and is significant at 0.000. On the other hand, AI-driven virtual classrooms has a t-statistic value of t=3.702 which is significant at 0.000 as regards to Teachers' Effectiveness in Secondary school Physics measured using RTOP. This implies that AI-driven virtual classrooms significantly contributes to the Teachers' Effectiveness in Secondary school Physics as measured using RTOP since that their significant values are less than 0.05. It implies that for any significant increase of additional unit use of AI-driven virtual classrooms by 3.911% (Beta=46.950), the teachers' effectiveness in Secondary School Physics is predicted to increase by 46.950% (Beta=4.476). In Model 2, the Table 6 discloses that the Teachers' Effectiveness in Secondary school Physics as measured using PAT which is constant has a t-statistic value of t=4.955 and is significant at 0.000. On the other hand, AI-driven virtual classrooms has a t-statistic value of t=-0.109 which is not significant at 0.913 and the Teachers' Effectiveness in Secondary school Physics measured using RTOP has t-statistic value of t=1.557 which is significant not at 0.122. This implies that AI-driven virtual classrooms significantly did not contribute to the Teachers' Effectiveness in Secondary school Physics as measured using RTOP and PAT since that their significant values are more than 0.05.

Major Findings

From the results in Tables 1 to 6, the study discovers the followings;

1. AI-based assessment system significantly predicts lowly and moderately on teachers' effectiveness in Physics by 6.3% as measured using RTOP and 20% as measured using PAT and any positive adjustment in the use of AI-based assessment system, the teachers' effectiveness (RTOP and PAT) in Physics will be affected by 5.7% and 18.8%. This means that AI-based assessment systems is a significant predictor of Teachers' Effectiveness in Secondary school Physics in Awka Education Zone.
2. AI-driven virtual classrooms lowly significantly predicts the teachers' effectiveness in Physics in terms of Physics teachers' Teaching Observation Protocol and any positive significant adjustment in the use of AI-driven virtual classrooms, the teachers' effectiveness (RTOP) in Physics will be affected by 8.2%. Hence, the study concludes that AI-driven virtual classrooms is a significant predictor of Teachers' Effectiveness in Secondary school Physics in terms of Physics teachers' Teaching Observation Protocol and is not a significant predictor of Teachers' Effectiveness in Secondary school Physics in terms of students' achievement in Physics.

DISCUSSION OF THE FINDINGS

The findings of this study tally with the assertions of scholars like Olatunji and Ahmed (2021) found that AI integration with traditional instruction enhances lesson engagement and classroom interactivity. This assertion was discovered in the study as the study was able to reveal that Blended AI resources significantly predicted teachers' effectiveness in terms of RTOP. In support of this finding, Chukwu and Iwu (2023) disclosed that blended AI teaching tools increase teachers' efficiency by automating administrative and assessment tasks. Adebayo and Ojo (2024) revealed that teachers using AI-assisted instructional designs report improved confidence and classroom management. In the context of Physics, blending AI enhances students' problem-solving, digital literacy, and participation. Physics Teachers benefit from real-time insights and feedback that guide lesson planning and evaluation.

In terms of measuring Physics teachers' effectiveness in Physics using the students' achievement scores in Physics, the study discovers that the type of Blended AI resources determines the type of prediction on teachers' effectiveness if measured using students' achievement scores in Physics as AI-driven virtual classrooms was not able to predict teachers' effectiveness in terms of students' achievement in Physics while AI-based assessment system significantly and moderately predicts the teachers' effectiveness in terms of students' achievement in Physics. This finding is in consonance with the findings of Okon and Udo (2021) who reported that Blended AI resources gives a teacher an AI-generated insights and teaching strategies but

the success of the teaching lies solely on the teacher's teaching strategies both in the classroom and outside of the classroom. In the same vein, Ojo and Adeyemi (2022) noted that AI learning platforms support teacher mentoring programs by providing performance data and professional feedback but its effect on the students depends on the AI resource being used, the students' nature and the type of teacher. Adeola and Bello (2024) pointed out that AI-enhanced blended platforms expose teachers to global best practices in digital pedagogy. Thus, blended AI resources not only improve Physics teachers' effectiveness in Physics but also strengthen teachers' adaptability to technological changes in education.

Finally, the study discovers that blended AI resources significantly predicted the teachers' effectiveness in Physics in terms of RTOP at a low extent. This implies that there are other factors that may possibly affects the teachers' effectiveness and that the Physics teachers should not solely lie on the use of blended AI resources without combination with other innovative teaching methods if the Physics teacher wants his/her effectiveness in Physics to improve. This finding tally with the assertions of Nwachukwu and Okafor (2023) and Adeola and Bello (2024) who in their separate studies revealed that the integration of AI-driven technologies with other forms of instruction into traditional instruction equips the teachers with tools to analyze, adapt, and optimize their teaching. These resources improve instructional delivery, streamline assessment processes, and foster effective communication between teachers and students. The emphasis of using Blended AI resources with other forms of instructions as highlighted by Nwachukwu and Okafor (2023) and Adeola and Bello (2024) implies that for optimal effectiveness of Physics teacher in Physics, other forms of innovative instructions are needed.

CONCLUSION

The study concludes that the Blended AI resources significantly predict the Physics teachers' effectiveness in Physics at a low extent and that the type of prediction of Blended AI resources on the teachers' effectiveness in terms of students' achievement scores in Physics depends on the type of the Blended AI resources as AI-based assessment system significantly predicts the teachers' effectiveness in Physics as measured using PAT at moderate extent of 20% while the other Blended AI resources could not significantly predicts the teachers' effectiveness in Physics as measured using PAT.

RECOMMENDATIONS

Considering the findings in this study, the following recommendations are made:

1. Parents should continue to invest on their children/students' academics especially in Physics if they want their children/students to continue to improve on the knowledge of Physics by providing their children/students with the different blended AI resources.
2. Physics teachers should use Blended AI resources with other forms of instructions in teaching students Physics.
3. Federal and State Government should invest on Physics education by providing Physics teachers with various forms of Blended AI resources and incentives that will enable those Physics teachers to be power the use of Blended AI resources and could motivate them to improve on their effectiveness in Physics.
4. Federal and State Government should make polices that could prompt Physics teachers to be using blended AI resources especially the AI-based assessment system.
5. Federal and State Ministries of Education with other government agencies and organizations like Mathematics Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN) etc should organize seminars, workshops and symposia for teachers and students on the importance of Blended AI resources in teaching students Physics and the need to use them in collaboration with other innovative forms of teaching strategies.

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