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TEACHERS' DIGITAL ASSESSMENT COMPETENCE, PARENTAL EXPECTATIONS, AND CURRICULUM IMPLEMENTATION AS PREDICTORS OF SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN MATHEMATICAL CONCEPTS IN PHYSICS IN ENUGU STATE, NIGERIA

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ABSTRACT
This study investigated teachers' digital assessment competence, parental expectations, and curriculum implementation as predictors of students' achievement in mathematical concepts in Physics in Enugu State. The study adopted a predictive correlational research design. The population comprised 12,879 Senior Secondary II Physics students in public secondary schools in Enugu State. The sample size of 389 was used for the study. Data were collected using the Teachers' Digital Assessment Competence Questionnaire (TDACQ), Parental Expectations Questionnaire (PEQ), Curriculum Implementation Questionnaire (CIQ), and Mathematical Concepts in Physics Achievement Test (MCPAT). The reliability coefficients of .91, .89, .87, and .93 were obtained for TDACQ, PEQ, CIQ, and MCPAT respectively. Data were analysed using simple and multiple linear regression. The findings revealed that teachers' digital assessment competence significantly and positively predicted students' achievement in mathematical concepts in Physics, accounting for 38.3% of the variance. Parental expectations also significantly and positively predicted students' achievement, accounting for 28.0% of the variance. Curriculum implementation significantly and positively predicted students' achievement, accounting for 40.0% of the variance. Furthermore, teachers' digital assessment competence, parental expectations and curriculum implementation jointly significantly predicted students' achievement, accounting for 60.7% of the variance. The study concluded that teachers' digital assessment competence, parental expectations and curriculum implementation were important predictors of students' achievement in mathematical concepts in Physics. It was recommended that education authorities should strengthen teachers' digital assessment competence, promote supportive parental academic expectations and improve the effective implementation of the Physics curriculum to enhance students' achievement.

KEYWORDS: Digital assessment competence, parental expectations, curriculum implementation, mathematical concepts, Physics achievement.

INTRODUCTION

Physics is a fundamental science subject that contributes substantially to scientific literacy, technological development and preparation for careers in science, technology, engineering and mathematics (STEM). At the secondary school level, Physics is expected to develop students' understanding of natural phenomena, quantitative reasoning, problem-solving skills and the ability to apply scientific principles to real-life situations. These expectations make students' achievement in Physics an important indicator of the effectiveness of science education. In Nigeria, the Senior Secondary School Physics curriculum is designed to provide learners with conceptual, practical and problem-solving competencies needed for further education and national development (NERDC, 2013; Adebule et al., 2023). However, concerns about students' persistent difficulties in Physics suggest that the desired curriculum outcomes are not always being achieved in classroom practice.

One important dimension of Physics achievement is students' ability to understand and apply mathematical concepts. Mathematics serves as an essential language for expressing many physical principles, relationships and laws. Students

are expected to manipulate equations, interpret graphs, use ratios and proportions, apply algebraic operations, work with vectors and trigonometric relationships, and perform numerical calculations when solving Physics problems. Consequently, weakness in mathematical reasoning can hinder students' understanding even when they possess some knowledge of the underlying physical concepts. Bowers et al. (2024) demonstrated that students employ a wide range of mathematical skills when solving Physics problems, while Maries and Singh (2023) emphasised the importance of systematic reasoning and problem-solving processes in Physics learning. This suggests that achievement in mathematical concepts in Physics requires an effective combination of conceptual understanding, mathematical competence and appropriate instructional support.

The challenge of learning mathematical concepts in Physics is particularly important because students are often required to move between physical and mathematical representations. For example, understanding motion may require students to interpret a graph, identify a relevant equation, substitute values and explain the physical meaning of the resulting answer. Similar mathematical demands occur in electricity, waves, heat, mechanics and modern Physics. Difficulties at any stage of this process can result in incorrect solutions even when students have memorised the relevant formulas. Research has therefore increasingly emphasised the importance of mathematical reasoning, representations and problem-solving skills in Physics achievement (Bowers et al., 2024; Singh et al., 2023). The quality of the learning environment within which these skills are developed consequently deserves closer attention.

One teacher-related factor that may influence students' achievement is teachers' digital assessment competence. The rapid integration of digital technologies into education has expanded opportunities for teachers to assess students, provide feedback, monitor learning progress and identify misconceptions. Digital assessment competence involves more than the ability to operate technological devices; it includes teachers' capacity to select appropriate digital assessment tools, design assessment tasks, interpret assessment evidence and use the results to improve instruction. The European Commission (2017), through the DigCompEdu framework, identifies digital assessment as an important component of teachers' professional digital competence, while Tzafilkou et al. (2023) argue that teachers' digital competence should incorporate both technological and pedagogical dimensions.

Digital assessment may be particularly useful in Physics because many mathematical concepts can be represented through graphs, simulations, interactive tasks and computer-based problem-solving activities. A teacher with adequate digital assessment competence can use students' responses to identify whether errors result from conceptual misunderstanding, inappropriate formula selection, algebraic manipulation, substitution or interpretation of graphical information. Such evidence can facilitate timely feedback and targeted remediation. UNESCO (2023) similarly stresses that the educational value of technology depends largely on how effectively teachers integrate it into teaching and assessment rather than on technology availability alone. Thus, teachers' digital assessment competence may contribute to students' achievement by strengthening the assessment-feedback-instruction cycle.

A second factor of interest is parental expectations. Parents influence students' educational experiences through the academic standards, aspirations and expectations they communicate. Positive and realistic expectations can encourage students to value academic achievement, devote more time to study and persist when confronted with difficult learning tasks. Meta-analytic evidence indicates that parental educational expectations are positively associated with students' academic achievement, even after accounting for several background factors (Pinquart & Ebeling, 2020). Similarly, Jeynes (2024) found a significant relationship between parental expectations and students' academic outcomes across a wide range of studies. These findings indicate that the home environment can complement classroom experiences in shaping students' academic development. The relevance of parental expectations may be particularly strong in mathematical learning because students often require sustained effort and repeated practice to master quantitative concepts. Parents who communicate the importance of Mathematics and Physics may encourage students to complete assignments, seek additional assistance and persevere when confronted with difficult problems. However, expectations are not necessarily beneficial when they become excessive pressure. Wang et al. (2021) found that parental expectations are related to students' mathematics beliefs and perceived achievement, suggesting that the way expectations are communicated can influence their educational consequences. Thus, constructive parental expectations may provide motivational support, whereas unrealistic expectations may have unintended negative effects on students' engagement and confidence.

The third predictor is curriculum implementation. A curriculum provides the intended content, learning objectives, instructional experiences and assessment requirements through which educational goals are expected to be achieved. Curriculum implementation concerns the extent to which these provisions are translated into actual classroom experiences. Effective implementation involves adequate content coverage, appropriate instructional strategies, effective use of learning resources, sufficient instructional time, practical activities and assessment practices that correspond with curriculum objectives. The quality of implementation is therefore important because a well-designed curriculum may have limited influence on achievement if its essential components are not adequately delivered.

Curriculum implementation is particularly significant in Physics because meaningful learning requires students to combine conceptual, mathematical and practical experiences. Students need opportunities to interpret physical phenomena, conduct experiments, analyse data, construct and interpret graphs, manipulate equations and apply

principles to unfamiliar situations. When implementation focuses mainly on memorisation of formulas or incomplete coverage of content, students may struggle to develop the mathematical reasoning required for problem solving. Nigerian studies have reported concerns about incomplete implementation of the secondary school Physics curriculum, inadequate instructional resources, large class sizes and limitations in teachers' instructional practices (Adebule et al., 2023; Mankilik & Mailafiya, 2024). Such challenges may restrict students' opportunities to develop the mathematical and conceptual competencies expected from the Physics curriculum. Teachers' digital assessment competence, parental expectations and curriculum implementation can therefore be viewed as complementary influences on students' achievement in mathematical concepts in Physics. Digital assessment competence represents the teacher's capacity to obtain and use evidence of students' learning; parental expectations represent an important home-based influence on students' motivation and persistence; while curriculum implementation represents the extent to which intended learning opportunities are provided in the classroom. Considered together, these variables provide a broader explanation of achievement than approaches that focus exclusively on students' individual characteristics or teaching methods.

Despite the relevance of these factors, existing studies have largely examined them independently. Research on digital competence has frequently focused on teachers' general technology skills rather than the specific competence required for digital assessment and feedback (European Commission, 2017; Tzafilkou et al., 2023). Studies on parental expectations have largely examined general academic or mathematics achievement rather than achievement in the mathematical aspects of Physics (Pinquart & Ebeling, 2020; Hascoët et al., 2021). Similarly, Nigerian studies on Physics curriculum implementation have focused mainly on general curriculum delivery, resources and students' overall Physics performance (Adebule et al., 2023; Mankilik & Mailafiya, 2024). There is consequently limited empirical evidence on the combined predictive contribution of teachers' digital assessment competence, parental expectations and curriculum implementation to students' achievement in mathematical concepts in Physics. The present study is therefore designed to examine teachers' digital assessment competence, parental expectations and curriculum implementation as predictors of students' achievement in mathematical concepts in Physics in Enugu State Nigeria.

Purpose of the Study

The main purpose of this study is to examine teachers' digital assessment competence, parental expectations, and curriculum implementation as predictors of students' achievement in mathematical concepts in Physics in Enugu State, Nigeria. Specifically, the study sought to determine the:

1. extent to which teachers' digital assessment competence predicts students' achievement in mathematical concepts in Physics in Enugu State;
2. extent to which parental expectations predict students' achievement in mathematical concepts in Physics in Enugu State;
3. extent to which curriculum implementation predicts students' achievement in mathematical concepts in Physics in Enugu State; and
4. extent to which teachers' digital assessment competence, parental expectations, and curriculum implementation jointly predict students' achievement in mathematical concepts in Physics in Enugu State.

Research Questions

The study was guided by the following research questions;

1. To what extent does teachers' digital assessment competence predicts students' achievement in mathematical concepts in Physics in Enugu State?
2. To what extent do parental expectations predict students' achievement in mathematical concepts in Physics in Enugu State?
3. To what extent does curriculum implementation predicts students' achievement in mathematical concepts in Physics in Enugu State?
4. To what extent do teachers' digital assessment competence, parental expectations, and curriculum implementation jointly predict students' achievement in mathematical concepts in Physics in Enugu State?

Hypotheses

The following null hypotheses were formulated and tested at the 0.05 level of significance:

1. Teachers' digital assessment competence does not significantly predict students' achievement in mathematical concepts in Physics in Enugu State.
2. Parental expectations do not significantly predict students' achievement in mathematical concepts in Physics in Enugu State.
3. Curriculum implementation does not significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

4. Teachers' digital assessment competence, parental expectations, and curriculum implementation do not jointly significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

METHODOLOGY

The study adopted a correlational research design, specifically a predictive correlational design. The design was considered appropriate because the study examined the extent to which teachers' digital assessment competence, parental expectations and curriculum implementation predicted students' achievement in mathematical concepts in Physics without manipulating any of the variables. The design enabled the researchers to determine both the individual and joint predictive contributions of the three independent variables to students' achievement in mathematical concepts in Physics.

The study was conducted in Enugu State, Nigeria. Enugu State is located in the South-East geopolitical zone of Nigeria and has a well-established system of secondary education. Physics was offered as a science subject at the senior secondary school level, particularly for students preparing for tertiary programmes in science, engineering, medicine, technology and related disciplines. The state provided an appropriate setting for the study because secondary schools operated under varying conditions relating to teachers' professional competencies, curriculum implementation, digital technology use, instructional resources and parental support.

The population of the study comprised 12,879 Senior Secondary II (SS II) students offering Physics in the 297 public secondary schools in Enugu State. The choice of SS II students was considered appropriate because they had been exposed to substantial portions of the secondary school Physics curriculum and were not yet involved in the terminal Senior Secondary School Certificate Examination. A sample size of 388 SS II students offering Physics was used for the study. A multistage sampling procedure was used to select the sample for the study. In the first stage, simple random sampling technique, balloting with replacement was used to sample three education zones out of the zones in Enugu state. At the second stage, simple random sampling technique, balloting with replacement was used to sample two local government areas from the three education zones sampled. At the third stage, SS II students offering Physics were sampled from the sampled schools using proportionate sampling. The sampling procedure ensured that respondents from the different educational zones were adequately represented in the study.

Four instruments were used for data collection: Teachers' Digital Assessment Competence Questionnaire (TDACQ), Parental Expectations Questionnaire (PEQ), Curriculum Implementation Questionnaire (CIQ), and Mathematical Concepts in Physics Achievement Test (MCPAT). The Teachers' Digital Assessment Competence Questionnaire (TDACQ) was a researchers'-developed instrument used to measure Physics teachers' competence in using digital technologies for assessment purposes. The instrument was developed with reference to the Assessment Area of the European Framework for the Digital Competence of Educators (DigCompEdu), which identifies assessment strategies, analysing evidence and feedback and planning as major dimensions of teachers' digital assessment competence. The TDACQ consisted of 30 item instrument. The items were structured on a four-point rating scale of Very High Competence (4), High Competence (3), Low Competence (2), and Very Low Competence (1).

The Parental Expectations Questionnaire (PEQ) was designed by the researchers to measure the level of academic expectations perceived by students from their parents or guardians. The PEQ consisted of 30 items structured on a four-point Likert-type scale of Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1).

The Curriculum Implementation Questionnaire (CIQ) was designed by the researcher to measure the degree to which the prescribed Senior Secondary School Physics curriculum was implemented in classroom practice. The instrument was a 30 item instrument designed to assess the extent to which students were exposed to the content, instructional experiences, practical activities, mathematical applications, instructional resources and assessment practices specified or implied by the Physics curriculum. The questionnaire was administered to students because they directly experienced the classroom practices through which the curriculum was implemented. The items were structured on a four-point rating scale of Very High Extent (4), High Extent (3), Low Extent (2), and Very Low Extent (1).

The Mathematical Concepts in Physics Achievement Test (MCPAT) was developed by the resaerchers. It was developed to measure students' achievement in mathematical concepts applied to Physics. The test was developed from the relevant Senior Secondary School II Physics curriculum and focused on students' ability to apply mathematical reasoning and procedures in solving Physics problems. The MCPAT covered algebraic manipulation and formulae, numerical calculations and proportional reasoning, measurement and unit conversions, graphs and mathematical interpretation, vectors and basic trigonometric applications, and quantitative problem solving in areas such as Mechanics and Electricity. The MCPAT consisted of 40 multiple-choice items with four response options (A–D). The items were distributed across the identified content areas to ensure adequate representation of the mathematical concepts assessed. A table of specifications was prepared to guide the distribution of items across the content areas and cognitive levels. Each correctly answered item attracted three marks, while an incorrect or unanswered item attracted zero. The maximum obtainable score was therefore 120 and the minimum score was zero. The total score obtained by each student represented the student's level of achievement in mathematical concepts in Physics, with higher scores indicating higher achievement.

The instruments were subjected to face validation. To do this, copies of the TDACQ, PEQ, CIQ and MCPAT, together with the objectives, research questions and hypotheses of the study, were presented to experts in Physics Education, Measurement and Evaluation, and Educational Technology. The experts were asked to examine the instruments in terms of relevance, clarity, appropriateness of language, adequacy of content coverage and alignment with the constructs being measured. Their observations and recommendations were used to modify the instruments before the final administration. Particular attention was given to the MCPAT to ensure that the items adequately represented the mathematical aspects of the Physics curriculum and measured students' ability to apply mathematical concepts in solving Physics problems. This was done through the use of table of specification

The reliability of the instruments was established through a pilot study involving 30 SS II students offering Physics in Anambra State who were similar to, but were not included in, the main study. Cronbach's alpha was used to determine the internal consistency of the TDACQ, PEQ and CIQ because the instruments employed Likert-type response scales. The reliability coefficients of .91, .89 and .87 were obtained for TDACQ, PEQ and CIQ respectively. However, the reliability of the MCPAT was determined using the Kuder-Richardson Formula 20 (KR-20) because the achievement-test items were scored dichotomously as correct or incorrect. The reliability coefficient of .93 was obtained indicated that the test had adequate internal consistency for measuring students' achievement in mathematical concepts in Physics.

Before data collection, the researchers obtained the necessary permission from the relevant educational authorities and the principals of the selected schools. Research assistants were briefed on the purpose of the study, administration procedures and ethical requirements before they participated in the data collection. The questionnaires were administered to the respondents in the sampled schools during school hours. The MCPAT was administered under standardised examination conditions. The researchers and research assistants supervised the administration and retrieval of the instruments to minimize loss and ensure that the required procedures were followed. Respondents were informed that the information obtained would be used strictly for research purposes and that their responses would be treated confidentially.

The data collected were analysed using regression analysis. Specifically, simple linear regression analysis was used to answer research questions 1–3, while multiple regression analysis was used to answer research question 4. The coefficient of determination (R^2) was used to determine the proportion of variance in students' achievement explained by each predictor. Hypotheses 1-3 was tested using regression t-test, while regression ANOVA was used to test hypothesis 4. The four null hypotheses were tested at the 0.05 level of significance. A null hypothesis was rejected when the probability value was less than 0.05; otherwise, it was not rejected.

RESULTS

Research Question One

To what extent does teachers' digital assessment competence predict students' achievement in mathematical concepts in Physics in Enugu State?

Table 1: Linear regression analysis of the extent to which teachers' digital assessment competence predict students' achievement in mathematical concepts in Physics in Enugu State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.619[a]	.383	.381	2.90238

(R^2) = Coefficient of Determination

Result in Table 1 presents the linear regression analysis of the extent to which teachers' digital assessment competence predict students' achievement in mathematical concepts in Physics in Enugu State. The result shows a correlation coefficient (R) of 0.619, indicating a moderate positive relationship between teachers' digital assessment competence and students' achievement in mathematical concepts in Physics. The R Square value of 0.383 indicates that teachers' digital assessment competence account for 38.3% of the variance in students' achievement in mathematical concepts in Physics in Enugu State. The remaining 61.7% of the variance may be attributed to other factors not included in the regression model.

Hypothesis One

Teachers' digital assessment competence does not significantly predict students' achievement in mathematical concepts in Physics in Enugu State

Table 2: Regression coefficient for the prediction of teachers' digital assessment competence towards students' achievement in mathematical concepts in Physics in Enugu State

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	19.555	1.312		14.903	.000

	TDAC	.498	.032	.619	15.488	.000

The result in Table 2 shows that t-value of 15.488 with associated exact probability value of .000 was obtained. This probability value of 0.000 was compared with 0.05 set as level of significance for testing the hypothesis and it was found to be significant since the obtained probability value of 0.000 is less than 0.05. Thus, the null hypothesis which stated that teachers' digital assessment competence does not significantly predict students' achievement in mathematical concepts in Physics in Enugu State was rejected. The researchers therefore, conclude that teachers' digital assessment competence significantly predicts students' achievement in mathematical concepts in Physics in Enugu State.

Research Question Two

To what extent do parental expectations predict students' achievement in mathematical concepts in Physics in Enugu State?

Table 3: Linear regression analysis of the extent to which parental expectations predict students' achievement in mathematical concepts in Physics in Enugu State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.529[a]	.280	.278	3.13513

(R^2) = Coefficient of Determination

Result in Table 3 presents the linear regression analysis of the extent to which parental expectations predict students' achievement in mathematical concepts in Physics in Enugu State. The result shows a correlation coefficient (R) of 0.529, indicating a moderate positive relationship between parental expectations and students' achievement in mathematical concepts in Physics. The R Square value of 0.280 indicates that parental expectations account for 28% of the variance in students' achievement in mathematical concepts in Physics in Enugu State. The remaining 72% of the variance may be attributed to other factors not included in the regression model.

Hypothesis Two

Parental expectations do not significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

Table 4: Regression coefficient for the prediction of parental expectations towards students' achievement in mathematical concepts in Physics in Enugu State

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	25.726	1.155		22.272	.000
	PE	.336	.027	.529	12.258	.000

The result in Table 4 shows that t-value of 12.258 with associated exact probability value of .000 was obtained. This probability value of 0.000 was compared with 0.05 set as level of significance for testing the hypothesis and it was found to be significant since the obtained probability value of 0.000 is less than 0.05. Thus, the null hypothesis which stated that parental expectations do not significantly predict students' achievement in mathematical concepts in Physics in Enugu State was rejected. The researchers therefore, conclude that parental expectations significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

Research Question Three

To what extent does curriculum implementation predicts students' achievement in mathematical concepts in Physics in Enugu State?

Table 5: Linear regression analysis of the extent to which curriculum implementation predicts students' achievement in mathematical concepts in Physics in Enugu State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.632[a]	.400	.398	2.86161

(R^2) = Coefficient of Determination

Result in Table 5 presents the linear regression analysis of the extent to which curriculum implementation predicts students' achievement in mathematical concepts in Physics in Enugu State. The result shows a correlation coefficient (R) of 0.632, indicating a moderate positive relationship between curriculum implementation and students'

achievement in mathematical concepts in Physics. The R Square value of 0.400 indicates that curriculum implementation account for 40% of the variance in students' achievement in mathematical concepts in Physics in Enugu State. The remaining 60% of the variance may be attributed to other factors not included in the regression model.

Hypothesis Three

Curriculum implementation does not significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

Table 6: Regression coefficient for the prediction of curriculum implementation towards students' achievement in mathematical concepts in Physics in Enugu State

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	22.772	1.067		21.338	.000
	CI	.445	.028	.632	16.059	.000

The result in Table 6 shows that t-value of 16.059 with associated exact probability value of .000 was obtained. This probability value of 0.000 was compared1 with 0.05 set as level of significance for testing the hypothesis and it was found to be significant since the obtained probability value of 0.000 is less than 0.05. Thus, the null hypothesis which stated that curriculum implementation does not significantly predict students' achievement in mathematical concepts in Physics in Enugu State was rejected. The researchers therefore, conclude that curriculum implementation significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

Research Question Four

To what extent do teachers' digital assessment competence, parental expectations, and curriculum implementation jointly predict students' achievement in mathematical concepts in Physics in Enugu State?

Table 7: Multiple regression analysis of the extent to which teachers' digital assessment competence, parental expectations, and curriculum implementation jointly predict students' achievement in mathematical concepts in Physics in Enugu State

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.779[a]	.607	.604	2.32044

(R^2) = Coefficient of Determination

Result in Table 7 presents the multiple regression analysis of the extent to which teachers' digital assessment competence, parental expectations and curriculum implementation jointly predicted students' achievement in mathematical concepts in Physics in Enugu State. The result showed a multiple correlation coefficient (R) of .779, indicating a strong positive relationship between the three predictor variables jointly and students' achievement in mathematical concepts in Physics. This suggests that when teachers' digital assessment competence, parental expectations and curriculum implementation were considered together, they were strongly associated with students' achievement in mathematical concepts in Physics. The coefficient of determination (R^2) was .607, indicating that teachers' digital assessment competence, parental expectations and curriculum implementation jointly accounted for 60.7% of the variance in students' achievement in mathematical concepts in Physics. The remaining 39.3% of the variance could be attributed to other factors not included in the regression model.

Hypothesis Four

Teachers' digital assessment competence, parental expectations, and curriculum implementation do not jointly significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

Table 8: Regression ANOVA for the joint prediction of students' achievement in mathematical concepts in Physics by teachers' digital assessment competence, parental expectations, and curriculum implementation

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3207.747	3	1069.249	198.582	.000[b]
	Residual	2073.005	385	5.384		
	Total	5280.752	388			

Result in Table 8 shows that F-ratio of 198.582 with associated exact probability value of .000 was obtained. This probability value of .000 was compared with 0.05 set as level of significance for testing the hypothesis and it was found to be significant since the obtained probability value of .000 is less than 0.05. Thus, the null hypothesis which

stated that teachers' digital assessment competence, parental expectations, and curriculum implementation do not jointly significantly predict students' achievement in mathematical concepts in Physics in Enugu State was rejected. The researchers therefore, conclude that teachers' digital assessment competence, parental expectations, and curriculum implementation jointly and significantly predict students' achievement in mathematical concepts in Physics in Enugu State.

CONCLUSION

Extent to which teachers' digital assessment competence predicts students' achievement in mathematical concepts in Physics in Enugu State

The finding of the study revealed that teachers' digital assessment competence significantly and positively predicted 38.3% of students' achievement in mathematical concepts in Physics. This finding suggests that teachers who possessed greater competence in using digital technologies for assessment were better positioned to identify students' strengths and weaknesses, provide timely feedback, monitor learning progress and adjust instruction to address identified difficulties. In the context of mathematical concepts in Physics, digital assessment can provide opportunities for students to receive immediate feedback on numerical calculations, formula manipulation, graphical interpretation and problem-solving procedures. The finding may therefore be attributed to the capacity of digitally supported assessment to provide teachers with timely evidence of students' learning, enabling them to identify misconceptions and provide appropriate corrective instruction. This result supports the position of the European Commission (2017) that teachers' digital assessment competence involves the effective use of digital technologies to employ diverse assessment strategies, analyse evidence of learners' performance and provide feedback that informs subsequent teaching.

The finding is also consistent with the broader literature on technology-supported assessment and learning. Digital assessment can make assessment more continuous and interactive by enabling teachers to administer formative assessments, analyse students' responses and provide personalised feedback. Such practices are particularly relevant to Physics, where students often experience difficulties connecting mathematical procedures with physical concepts. When teachers are competent in using digital assessment tools, they can more readily detect specific errors, such as incorrect substitution, inappropriate use of formulae, errors in units and misinterpretation of graphs, and respond to these difficulties during instruction. This can enable assessment to function not merely as a means of assigning scores but as a continuous process for improving teaching and learning.

The positive prediction found in the present study therefore suggests that digital assessment competence represented more than the ability to operate technological tools; it constituted an important pedagogical competence that could support improved learning outcomes. Teachers who effectively integrate digital assessment into instruction can obtain immediate information about students' understanding and use such information to differentiate instruction, provide corrective explanations and create additional learning opportunities for students who experience difficulties. This interpretation is consistent with Redecker (2017), who identified assessment, analysis of learner evidence, feedback and instructional adaptation as important dimensions of teachers' digital competence. Falloon (2020) similarly emphasised that teachers' digital competence becomes educationally meaningful when technology is integrated with sound pedagogical practices and used to enhance learners' engagement and achievement.

Extent to which parental expectations predict students' achievement in mathematical concepts in Physics in Enugu State

The finding of the study revealed that parental expectations significantly and positively predicted 28% of students' achievement in mathematical concepts in Physics. This finding suggests that the academic expectations communicated by parents may have played an important role in shaping students' commitment to learning and achievement. Parents who expected their children to perform well academically may have encouraged regular study, persistence with difficult tasks, completion of assignments and greater attention to Mathematics and Physics. Such expectations can communicate to students that academic achievement is valued within the family, thereby strengthening students' motivation and willingness to invest effort in challenging learning activities. In mathematical aspects of Physics, where students are often required to persist through complex calculations and multi-step problems, sustained parental encouragement and expectations may be particularly beneficial.

The finding may further be explained by the role of parental expectations in developing students' persistence when confronted with challenging academic tasks. Students whose parents consistently expected them to succeed may have been more likely to perceive difficult mathematical and Physics problems as tasks requiring additional effort rather than as reasons to give up. This is particularly relevant to mathematical concepts in Physics, where successful problem solving often requires several stages of reasoning, calculation and verification. Parental expectations may also encourage students to devote additional time to difficult topics, seek assistance when necessary and maintain aspirations for further education in science-related fields. However, the positive influence of parental expectations is likely to depend on whether such expectations are realistic and accompanied by appropriate encouragement and

support. Excessive or unrealistic expectations may instead create pressure and anxiety. The present finding therefore suggests that supportive parental expectations constituted a meaningful factor in students' achievement in mathematical concepts in Physics and that the home environment can complement effective classroom instruction in promoting students' academic success.

The finding is in agreement with the findings of Pinquart and Ebeling (2020), who, in a meta-analytic study, found a positive association between parents' educational expectations and children's academic achievement. Their findings suggested that parental expectations could influence students' educational outcomes by shaping their academic motivation, aspirations and engagement with schoolwork. The present finding is also in agreement with Benner et al. (2016), who reported that parental expectations were associated with adolescents' educational outcomes through pathways involving academic motivation, engagement and educational aspirations. These findings provide support for the present result because students who perceived strong and supportive academic expectations from their parents may have been more likely to establish higher academic goals and devote greater effort to achieving them.

Extent to which curriculum implementation predicts students' achievement in mathematical concepts in Physics in Enugu State

The finding of the study revealed that curriculum implementation significantly and positively predicted 40% of students' achievement in mathematical concepts in Physics. This finding suggests that effective translation of the prescribed Physics curriculum into actual classroom practice was an important factor in students' achievement. Effective curriculum implementation provides students with adequate exposure to relevant Physics content, appropriate instructional strategies, practical activities, mathematical problem-solving experiences, instructional resources and curriculum-based assessment. These experiences are particularly important in Physics because students are expected not only to understand physical principles but also to apply mathematical operations, formulae, graphs and quantitative relationships in solving problems. When the curriculum is implemented effectively, students are more likely to receive systematic and meaningful learning experiences that enable them to connect theoretical knowledge with mathematical applications.

The finding is in agreement with Anugwo et al. (2023), who examined the implementation of the secondary school science core curriculum in Nigeria and considered curriculum content, instructional materials and evaluation procedures as important components of curriculum implementation. Their findings revealed weaknesses in the provision of instructional materials and the use of prescribed evaluation procedures, suggesting that effective curriculum implementation requires adequate attention to the different components through which curriculum objectives are translated into classroom learning. The present finding is also in agreement with Mankilik and Mailafiya (2024), who investigated the implementation of the Senior Secondary School Physics curriculum and students' performance in Bauchi Education Zone. Their study drew attention to factors associated with the implementation of the Physics curriculum and students' learning experiences. These findings support the present study because they indicate that the successful implementation of the Physics curriculum depends on the extent to which teachers are able to provide students with the content, instructional experiences and learning opportunities required to attain the intended educational outcomes.

The finding is further supported by Kemka et al. (2026), who investigated factors affecting the implementation of the Senior Secondary School Physics curriculum in government-owned schools in Ikeduru Local Government Area of Imo State. The study identified interactive teaching methods, teacher availability and practical activities as important factors influencing effective Physics curriculum implementation. This finding is in agreement with the present study because mathematical concepts in Physics are better understood when students are actively involved in learning activities that require them to apply concepts, perform calculations, interpret results and relate mathematical expressions to physical phenomena. Effective curriculum implementation therefore creates opportunities for teachers to move beyond theoretical explanations and engage students in practical and problem-solving activities. The present finding consequently implies that improving curriculum implementation in secondary schools could be an important strategy for enhancing students' achievement in mathematical concepts in Physics, particularly through adequate content coverage, appropriate instructional approaches, practical activities, relevant instructional resources and sufficient instructional time.

Extent to which teachers' digital assessment competence, parental expectations, and curriculum implementation jointly predict students' achievement in mathematical concepts in Physics in Enugu State

The finding of the study revealed that teachers' digital assessment competence, parental expectations and curriculum implementation jointly significantly predicted students' achievement in mathematical concepts in Physics, with the three variables jointly explaining 60.7% of the variance in students' achievement. This finding indicates that students' achievement in mathematical concepts in Physics was influenced by a combination of factors operating at the classroom, home and curriculum levels. Teachers' digital assessment competence may provide timely information about students' learning difficulties and enable teachers to give appropriate feedback, while parental expectations may

encourage students' commitment, persistence and academic engagement. At the same time, effective curriculum implementation may ensure that students are adequately exposed to relevant content, mathematical problem-solving activities, practical experiences, instructional resources and appropriate assessment. The substantial proportion of variance explained by the three predictors suggests that achievement in mathematical concepts in Physics is better understood as the outcome of interacting educational influences rather than the effect of a single factor.

The finding may further be explained by the interconnected nature of the three predictors. Digital assessment competence enables teachers to obtain evidence of students' understanding and use such evidence to improve instruction; parental expectations can reinforce students' commitment to learning beyond the classroom; and effective curriculum implementation provides the content, learning experiences and instructional structure within which teaching and learning take place. When these conditions operate together, students may receive consistent academic support from the classroom, home and school curriculum. This is particularly important in mathematical concepts in Physics, where achievement requires conceptual understanding, mathematical reasoning, regular practice, appropriate feedback and opportunities to apply knowledge to physical situations. The finding therefore suggests that interventions aimed at improving students' achievement should not focus exclusively on teachers or students but should also strengthen parents' academic support and the quality of curriculum implementation. The combined predictive effect observed in the present study consequently underscores the importance of adopting a comprehensive approach to improving students' achievement in mathematical concepts in Physics in Enugu State.

The finding is in agreement with the findings of studies which have emphasised the complementary influence of teachers, parents and curriculum-related factors on students' academic outcomes. Redecker (2017) and Falloon (2020) emphasised that teachers' digital competence becomes more educationally meaningful when digital technologies are integrated into assessment, feedback and instructional decision-making. Similarly, Pinquart and Ebeling (2020) found a positive association between parents' educational expectations and children's academic achievement, indicating that parental expectations can contribute to students' motivation, aspirations and academic engagement. In relation to curriculum implementation, Anugwo et al. (2023) highlighted the importance of curriculum content, instructional materials and evaluation procedures in the implementation of the secondary school science curriculum, while Mankilik and Mailafiya (2024) reported issues relating to the implementation of the Senior Secondary School Physics curriculum and students' performance. These findings are in agreement with the present study because they collectively demonstrate that effective teaching practices, supportive parental expectations and appropriate curriculum implementation can provide complementary conditions for improving students' learning outcomes.

CONCLUSION

The study concluded that teachers' digital assessment competence, parental expectations and curriculum implementation significantly and positively predicted students' achievement in mathematical concepts in Physics in Enugu State. Individually, each variable made a meaningful contribution to students' achievement, with curriculum implementation emerging as the strongest predictor. When combined, the three variables jointly explained 60.7% of the variance in students' achievement. The study therefore concluded that improving students' achievement in mathematical concepts in Physics requires a coordinated focus on teachers' digital assessment competence, supportive parental expectations and effective implementation of the Physics curriculum.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Physics teachers should participate regularly in professional development programmes focused on digital assessment competence. Such programmes should equip teachers with practical skills in designing digital assessments, analysing students' responses, providing timely feedback and using assessment results to improve instruction.
2. School administrators and relevant education authorities should encourage parents to maintain realistic and supportive academic expectations for their children. Parent–school programmes should emphasise the importance of encouraging students' effort, persistence, regular study and interest in Physics rather than placing excessive pressure on them.
3. The Ministry of Education and school administrators should strengthen the implementation of the Senior Secondary School Physics curriculum by ensuring adequate instructional time, appropriate teaching strategies, relevant instructional materials, practical activities and effective curriculum-based assessment.
4. Physics teachers should make greater use of practical and mathematical problem-solving activities during instruction. Students should be given regular opportunities to apply Physics formulae, interpret graphs, perform calculations and relate mathematical concepts to real-life physical situations.
5. Education authorities should provide schools with adequate digital devices, reliable internet facilities and appropriate digital assessment platforms to enable teachers to effectively integrate technology into Physics assessment and instruction.

6. School administrators should strengthen collaboration among Physics teachers, parents and other relevant stakeholders to provide coordinated academic support for students. Such collaboration should focus particularly on students experiencing difficulties with mathematical concepts in Physics.

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