INVESTIGATING THE RELATIONSHIP BETWEEN SCIENCE SELF-EFFICACY AND PHYSICS ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS IN DELTA STATE

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Abstract: *This study investigated the relationship between science self-efficacy and physics achievement among secondary school students in Delta State, Nigeria. A quantitative analytic correlational survey design was employed with a sample of 176 students from 12 schools. Data were collected using the Physics Self-Efficacy Questionnaire (PSE-Q), a Physics Achievement Test (PAT), and a Questionnaire on Instructional Practices and Environmental Factors (QIPEF). Results revealed a non-significant relationship between self-efficacy and achievement (r = .046, p > .05), challenging Social Cognitive Theory predictions in this context. However, teacher-centered instructional practices and environmental/psychological factors significantly predicted self-efficacy (R² = .284 and R² = .522 respectively), suggesting that self-efficacy is highly malleable and responsive to contextual improvements. No significant sex differences in self-efficacy were observed. The findings indicate a 'confidence-competence' paradox wherein students possess adequate self-efficacy that is not translated into academic performance, highlighting the critical role of instructional and environmental interventions. Implications for physics education policy and practice are discussed.*

Keywords: *science self-efficacy; physics achievement; secondary school; teacher-centered instruction; instructional practices.*

Introduction
The attainment of sustainable technological advancement and economic prosperity in the twenty-first century has necessitated unprecedented emphasis on achieving excellence in Science, Technology, Engineering, and Mathematics (STEM) education across

the globe. International policy frameworks, particularly those advanced by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Organisation for Economic Co-operation and Development (OECD), have consistently established that a nation's competitive advantage and economic resilience are inextricably linked to both the quality and quantity of STEM graduates it produces (Potvin & Hasni, 2014; Martin et al., 2016). Within this multidisciplinary scientific framework, physics assumes a foundational role, providing the essential conceptual and mathematical architecture required to interpret natural phenomena across scales ranging from quantum mechanics to astrophysics (Bao & Kathleen, 2019). Furthermore, physics education serves as a critical determinant of workforce preparedness in an increasingly technology-driven global economy, underpinning professional competencies in engineering, medicine, and applied sciences (National Research Council, 2012). The practical applications of physics are foundational to contemporary technological infrastructure, including renewable energy systems, advanced telecommunications, medical imaging technologies, and aerospace engineering innovations (Hofstein & Mamlok-Naaman, 2007).

Nigeria, as a developing nation with significant strategic aspirations toward industrialization and technological self-reliance, has explicitly positioned physics as a cornerstone subject within the senior secondary school curriculum. The National Policy on Education (Federal Republic of Nigeria, 2013) mandates physics as a compulsory subject for students pursuing science-related careers, directly aligning with the country's Vision 2030 agenda, which emphasizes technological advancement and sustainable economic development. However, despite this policy commitment, Nigerian secondary school students continue to demonstrate persistently poor performance in physics, presenting a substantial challenge to the nation's educational objectives.

Longitudinal examination of examination records from the West African Examinations Council (WAEC) and the National Examinations Council (NECO) spanning 2015 to 2024 reveal a troubling pattern of chronic underachievement. Ogunleye (2019) documented that physics consistently ranks among the subjects with the highest failure rates nationally, with pass rates at the credit level frequently falling below 40%, substantially undermining access to tertiary STEM programs. Within Delta State specifically located in Nigeria's South-South geopolitical zone, this trend has intensified. Ovuworie and Ajaja (2024) reported that average physics performance in the state declined by 12 percentage points between 2015 and 2023,

with female students exhibiting disproportionately lower achievement levels. Furthermore, Akinsolu (2010) found that merely 14% of secondary schools in southwestern Nigeria produced candidates meeting the fundamental requirement of five credits for university admission, while Adesoji (2008) documented that fewer than 30% of physics candidates achieved grades sufficient for entry into science and engineering programs.

These patterns extend beyond individual student outcomes to systemic constraints. Many Nigerian universities report that fewer than 20% of admitted students possess adequate foundational knowledge in physics, creating a critical skills gap that constrains the nation's capacity to train the engineers and physicists necessary for infrastructure development and industrialization (Federal Ministry of Education, 2018). International comparative assessments corroborate these concerns; the Trends in International Mathematics and Science Study (TIMSS) consistently ranks Nigerian students significantly below global averages in science achievement (Martin et al., 2016; Mullis et al., 2016).

Existing research has identified multiple structural and pedagogical factors contributing to physics underachievement in Nigeria. Inadequate teaching resources, incomplete syllabus coverage, and the predominance of teacher-centered instructional strategies have been highlighted as primary constraints (Abamba & Chukwuka, 2021; Ogbiku & Ajaja, 2024). Evidence suggests that more than 80% of physics teachers in Nigerian secondary schools employ predominantly teacher-centered strategies, offering minimal opportunities for student interaction or practical experimentation (Ogunleye, 2007, as cited in Ajaja & Ogbiku, 2024). Such pedagogical approaches stand in stark contrast to internationally recommended best practices emphasizing active learning and collaborative problem-solving, and are consistently associated with low motivation and poor academic performance (Freeman et al., 2014; Deslauriers et al., 2011).

Infrastructural deficiencies further constrain effective physics instruction. A national survey conducted by the Education Sector Analysis Unit (2005) found that 65% of Nigerian secondary schools lacked functional science laboratories, while 78% reported critical shortages of qualified physics teachers. Recent assessments in Delta State confirm that these deficiencies persist largely unabated (Bawan, Kamgba, & Obi, 2024). The shortage of qualified teachers is particularly acute, with studies documenting that up to 40% of physics teachers hold only the minimum teaching qualification (National Certificate in Education), while 16% lack formal teaching certification entirely (Ossai et al., 2019), creating conditions at odds with national

policy requiring at least a bachelor's degree with pedagogical training. These structural limitations deny students critical opportunities to engage with physical phenomena directly, test hypotheses, and develop procedural knowledge—experiences identified by international research as foundational to deep learning (Hofstein & Lunetta, 2004).

While these structural and pedagogical factors are undeniably critical, emerging evidence suggests that cognitive and affective variables particularly science self-efficacy, play an equally vital role in determining students' physics achievement (Bandura, 1997; Aslam & Alam, 2017; Okokon, Etor, and Uko, 2023). Self-efficacy, as conceptualized within Albert Bandura's Social Cognitive Theory (SCT), represents an individual's belief in their capability to organize and execute actions necessary to achieve specific performance outcomes within a particular domain (Bandura, 1997). Unlike generalized self-esteem, self-efficacy is domain-specific and task-specific, reflecting perceived rather than actual ability (Usher & Pajares, 2008). This distinction is empirically significant because self-efficacy beliefs frequently predict academic performance more powerfully than actual ability measures; they directly shape the degree of effort invested, persistence in the face of difficulty, and resilience following setbacks (Schunk & DiBenedetto, 2020).

Meta-analytic syntheses confirm moderate to strong positive correlations between academic self-efficacy and performance outcomes across subject areas and educational contexts. Honicke and Broadbent (2016) conducted a systematic review of 49 studies and found that academic self-efficacy consistently demonstrated one of the strongest relationships with academic performance, with effect sizes ranging from small to large across contexts. Students with strong self-efficacy exhibit greater motivation, set more challenging goals, employ more effective learning strategies, and demonstrate superior problem-solving persistence (Schunk & DiBenedetto, 2020; Richardson et al., 2012). Conversely, those with weak self-efficacy typically avoid challenging assignments, attribute poor outcomes to personal shortcomings rather than insufficient effort, and exhibit reduced academic engagement (Owoduni, 2019).

Within science education specifically, domain-specific science self-efficacy represents confidence in one's ability to successfully perform science-related tasks and understand scientific concepts. This construct significantly influences a learner's willingness to engage in complex problem-solving, predict course enrollment decisions, and shape career aspirations (Nissen, 2019; Marshman et al., 2018). Successful performance experiences enhance self-efficacy, creating positive feedback loops of achievement and engagement, while repeated

failures engender vicious cycles of disengagement and declining achievement (Bandura, 1997). Critically, research conducted within Nigerian contexts uniformly demonstrates that self-efficacy functions as a key determinant of student performance in physics. For instance, Okokon, Etor, and Uko (2023) found that science self-efficacy accounted for 34% of the variance in physics achievement among secondary students in Cross River State, Nigeria.

Despite the robust international evidence linking self-efficacy to achievement, and despite growing recognition of self-efficacy's importance within the Nigerian educational context, a critical gap persists in empirical research examining the relationship between science self-efficacy and physics achievement specifically within Delta State. While existing Nigerian studies have largely emphasized infrastructural and instructional challenges (Bawan et al., 2024; Ogbiku & Ajaja, 2024), the psychological dimensions of learning particularly science self-efficacy and its interaction with environmental and pedagogical factors, have been substantially underexplored. This research gap represents a significant impediment to designing effective, evidence-based interventions that simultaneously address both the environmental and psychological dimensions of physics learning.

Moreover, while large-scale infrastructural and pedagogical reforms demand considerable financial resources and extended implementation periods, interventions targeting students' self-efficacy beliefs offer more readily accessible and economically viable approaches to enhancing academic performance within existing resource constraints (Margolis & McCabe, 2006). Bandura (1997) identified four primary sources through which self-efficacy develops: mastery experiences (genuine success in performing tasks), vicarious experiences (observing similar others succeed), social persuasion (encouragement and feedback from credible sources), and physiological/affective states (emotional responses to performance situations). Notably, mastery experiences emerge as the most potent source of self-efficacy development. In the Delta State context, the prevailing teacher-centered pedagogy and inadequate laboratory practices systematically undermine opportunities for students to accumulate mastery experiences, thereby constraining the development of robust physics self-efficacy.

The present study addresses this critical gap by investigating the relationship between science self-efficacy and physics achievement among secondary school students in Delta State, Nigeria. Specifically, this research examines: (1) the correlation between science self-efficacy and physics achievement; (2) the predictive power of self-

efficacy for physics performance; (3) gender differences in self-efficacy levels; (4) the influence of teacher-centered instructional practices on self-efficacy development when controlling for sex; (5) the major psychological and environmental factors influencing students' science self-efficacy; and (6) the potential contribution of enhanced self-efficacy to improvements in student motivation, persistence, and achievement.

This investigation is grounded in Albert Bandura's Social Cognitive Theory (SCT), which posits that human learning and development result from dynamic, bidirectional interactions among personal cognitive factors, behavioral patterns, and environmental influences (Bandura, 1997). Central to SCT is the construct of self-efficacy, which operates as a task-specific confidence belief that directly influences motivation, effort, perseverance, and resilience—thereby functioning as an indispensable psychological predictor of academic achievement, particularly in cognitively demanding disciplines such as physics (Artino, 2012; Nissen, 2019).

The "triadic reciprocal causation" model proposed by Bandura elucidates how personal cognitive appraisals (including self-efficacy beliefs), behavioral actions, and environmental contexts continuously interact. For physics students, personal cognitive appraisals of capability, mediated by motivational and emotional states, influence behavioral engagement in problem-solving and inquiry, which in turn affects educational outcomes within specific social and physical environments such as classrooms equipped (or not equipped) with laboratory resources and supportive instructional climates (Zee et al., 2016; Okokon et al., 2023).

Furthermore, this theoretical framework integrates these mechanisms within an ecological perspective, acknowledging that self-efficacy development is modulated by contextual variables including socioeconomic background, gender, prior academic performance, instructional quality, and resource availability (Ajadi & Amoo, 2014; Biri, 2020; Ntsayakgosi et al., 2024). This conceptual integration positions self-efficacy as a pivotal mediating construct linking internal psychological dispositions with external academic outcomes, a perspective particularly salient for resource-constrained educational settings such as that characteristic of Nigerian secondary schools in Delta State.

The present investigation contributes to the literature in several important ways. First, it addresses a critical empirical gap in the Nigerian educational research literature, providing context-specific evidence on how science self-efficacy operates within the unique educational realities of Delta State. Second, by examining the

interaction between psychological factors (self-efficacy) and environmental/instructional factors (laboratory resources, teaching methods), this study elucidates the multifactorial determinants of physics achievement in resource-constrained settings. Third, the research extends the application of Social Cognitive Theory to physics education within a non-Western educational context, enhancing the cross-cultural generalizability of this psychological framework. Finally, by identifying actionable levers for improving self-efficacy within existing resource constraints, this study provides evidence-based guidance for policy makers, curriculum developers, and practitioners seeking to enhance physics education and student outcomes in Nigeria and similar contexts.

Literature Review
At the core of academic persistence in rigorous disciplines lies Bandura's (1997) Social Cognitive Theory (SCT), which posits that learning is not a passive receipt of information but a dynamic, reciprocal interaction between personal cognition, behavior, and the environment. Central to this triadic reciprocity is self-efficacy, which is defined as the internal conviction in one's capacity to execute tasks (Bandura, 1997). In the context of secondary school physics, this construct transcends mere confidence; it acts as the primary mediator for motivation, resilience, and cognitive engagement (Artino, 2012; Nissen, 2019). Because physics is inherently cognitively demanding, students' beliefs about their capabilities determine whether they meet challenges with increased effort or withdrawal (Talsma et al., 2018).

While Bandura identifies mastery experiences as the most potent source of self-efficacy, the literature suggests that these experiences are not created in a vacuum. In the Nigerian educational landscape, particularly within Delta State, the path to mastery is frequently obstructed. Traditional teacher-centered instruction and a chronic lack of functional laboratories, as evidenced by reports indicating that up to 65% of schools lack basic facilities (Bawan et al., 2024), systematically deny students the successful task completion necessary to build robust efficacy. When instructional climates are characterized by high-stakes assessment anxiety rather than scaffolded inquiry, the physiological and emotional states of students shift from excitement to avoidance (Gale et al., 2021; Iwuanyanwu, 2022). This suggests that self-efficacy in Nigerian physics classrooms is not merely a psychological trait but an ecological product shaped by resource availability and pedagogical quality.

The argument for self-efficacy as a predictor of achievement is further complicated by persistent demographic disparities. Research

consistently reveals a "confidence gap": female students often report lower physics self-efficacy even when their objective performance matches or exceeds that of their male peers (Marshman et al., 2018). This disparity is exacerbated in Nigerian contexts where social stereotypes and a lack of female STEM role models reinforce the perception of physics as a male domain (Biri, 2020). Furthermore, socioeconomic constraints act as a "ceiling" on efficacy development. While interventions like cognitive attributional retraining can help students reframe failure (Smith & Capuzzi, 2019), such psychological shifts are often neutralized by systemic inequities, such as the shortage of qualified teachers and instructional materials (Udeh-Aloysius & Achufusi, 2024).

Despite the wealth of global evidence confirming the link between science self-efficacy and physics achievement, and the documented success of localized studies in states like Cross River (Okokon et al., 2023), a significant empirical void remains. Current literature has extensively mapped the *theoretical* importance of Bandura's sources, yet there is a dearth of localized data specifically examining how the unique socio-educational infrastructure of Delta State influences these efficacy-achievement pathways. While national pass rates languish below 40%, existing studies have failed to provide a multi-dimensional analysis that simultaneously accounts for the specific instructional practices and resource limitations unique to Delta State's secondary schools. Consequently, it remains unclear whether the underperformance in this region is primarily a failure of psychological agency or a direct consequence of an environment that suppresses the very sources of self-efficacy required for STEM success. This study seeks to bridge this gap by investigating these multifaceted relationships to inform a more localized, context-sensitive pedagogical framework.

Methodology
Research Design and Sampling
This study adopted a quantitative analytic correlational survey design to examine the relationships between naturally occurring variables without experimental intervention. The target population included all senior secondary students (SS2 and SS3) enrolled in physics across public and private schools in Delta State's three senatorial districts for the 2024/2025 academic session.

A multi-stage probability sampling technique was employed to ensure regional representation. First, two Local Government Areas (LGAs) were purposively selected from each senatorial district. Second, one public and one private school were randomly sampled from each LGA,

totaling 12 institutions. Finally, students were stratified by class level and sex, resulting in a final sample of N = 176 (n = 107 males, n = 69 females; $Mean_{age}$ = 16.3 years, SD = 0.8).

Instrumentation and Validation

The study utilized three validated instruments to measure the primary variables. First, the Physics Self-Efficacy Questionnaire (PSE-Q), a 40-item scale adapted from Lindstrøm and Sharma (2011), assessed five dimensions of self-efficacy: problem-solving, goal persistence, exam confidence, academic beliefs, and peer efficacy. Responses were recorded on a 5-point Likert scale, with established reliability coefficients (α) between .78 and .92.

Second, a 50-item Physics Achievement Test (PAT), specifically aligned with the Nigerian Senior Secondary Certificate Examination (SSCE) curriculum, measured cognitive performance and conceptual application. Finally, a researcher-developed Questionnaire on Instructional Practices and Environmental Factors (QIPEF) evaluated classroom variables, including teacher-centered methods, laboratory resources, and psychological drivers such as intrinsic motivation and persistence.

Content validity for the researcher-developed tools was confirmed via expert review (CVI ≤.80), while pilot testing (n = 50) ensured internal consistency and psychometric adequacy for the Delta State educational context.

Procedure and Data Analysis

Following institutional ethical approval and administrative clearance, research instruments were administered in supervised settings by independent researchers to mitigate social desirability bias. To ensure that performance outcomes did not confound efficacy perceptions, the Physics Self-Efficacy Questionnaire (PSE-Q) and the Questionnaire on Instructional Practices and Environmental Factors (QIPEF) were administered prior to the Physics Achievement Test (PAT). All participants provided informed consent, with rigorous protocols in place to guarantee anonymity and data confidentiality.

Quantitative data were processed using SPSS Version 23. After verifying fundamental statistical assumptions including normality, linearity, and homoscedasticity, inferential analyses were conducted at a 0.05 level of significance. The analytical framework comprised:

(1) Pearson Product-Moment Correlation: To examine the relationship between science self-efficacy and physics achievement (H_1).
(2) Simple Linear Regression: To determine the predictive power of self-efficacy on academic outcomes (H_2).

(3) Independent Samples t-test: To assess sex-based differences in self-efficacy levels (H_3).

(4) Multiple Regression Analysis: To evaluate the collective influence of instructional practices, environmental factors, and psychological variables on self-efficacy while statistically controlling for sex (H_4 and H_5).

(5) Descriptive Statistics: To establish baseline benchmarks for student motivation and persistence (H_6).

Results

Descriptive Statistics

Descriptive statistics indicated that students demonstrated moderate levels of science self-efficacy (M = 55.09, SD = 12.34, range = 28-89), while physics achievement scores were substantially lower (M = 48.67%, SD = 18.42%, range = 12%-96%). Male students reported marginally higher self-efficacy (M = 55.49, SD = 11.66) than female students (M = 54.49, SD = 13.01), though this difference was negligible. Data distributions approximated normality (skewness and kurtosis values within acceptable ranges), satisfying assumptions for parametric testing. Table 1 presents the descriptive statistics for all study variables.

Table 1: *Descriptive Statistics for Study Variables*

Variable	M	SD	Range
Science Self-Efficacy (total score)	55.09	12.34	28-89
Physics Achievement (%)	48.67	18.42	12-96
Male Self-Efficacy	55.49	11.66	—
Female Self-Efficacy	54.49	13.01	—

Note. N = 176 (Male n = 107, Female n = 69).

Relationship Between Self-Efficacy and Achievement

Pearson correlation analysis revealed a weak, non-significant relationship between science self-efficacy and physics achievement (r = .046, p = .549, 95% CI = [-.042, .131]). Table 2 presents the correlation results. Together with the regression findings, these results indicate that, within this sample, students' confidence in their physics capabilities did not meaningfully translate into academic performance—a pattern contrary to well-established theory.

Table 2: *Correlation Between Science Self-Efficacy and Physics Achievement*

Variables	R	p-value	95% CI	N
Self-Efficacy × Achievement	.046	.549	[-.042, .131]	176

Note. r = Pearson correlation coefficient; CI = Confidence Interval.
Simple linear regression confirmed that self-efficacy did not significantly predict achievement (B = .016, β = .046, t = .600, p = .549), as shown in Table 3.

Table 3: *Simple Linear Regression: Self-Efficacy Predicting Physics Achievement*

Predictor	B	β	T	p	R²
Self-Efficacy	.016	.046	.600	.549	.002

Note. B = unstandardized coefficient; β = standardized coefficient.

Sex Differences in Self-Efficacy
An independent samples t-test indicated no statistically significant difference in science self-efficacy between male and female students (t(174) = .527, p = .599). Levene's test confirmed equal variances (F = .595, p = .442). This finding suggests sex parity in self-efficacy beliefs in this sample, differing from the sex gap traditionally reported in STEM contexts. Table 4 presents the complete results.

Table 4: *Independent Samples t-Test: Sex Differences in Science Self-Efficacy*

Sex	N	M	SD	t	Df	P
Male	107	55.49	11.66	.527	174	.599
Female	69	54.49	13.01			

Note. Levene's test for equality of variances: F = .595, p = .442.

Instructional Practices and Self-Efficacy
Multiple regression analysis demonstrated that teacher-centered instructional practices significantly predicted science self-efficacy when controlling for sex. In Block 1, sex alone explained 4.5% of variance (ΔR² = .045, p = .004). Adding instructional practice in Block 2 yielded a substantial increase in explained variance (ΔR² = .239, p < .001), with the final model accounting for 28.4% of variance (R² = .284). Standardized coefficients revealed that instructional practice (β

= .48, p < .001) was a substantially stronger predictor than sex (β = -.16, p = .003). Table 5 presents the hierarchical regression results.

Table 5: *Hierarchical Regression: Instructional Practices Predicting Self-Efficacy (Controlling for Sex)*

Model/Predictor	B	Β	t	p	R²	ΔR²
Block 1					.045***	.045
Sex	—	—	—	.004		
Block 2					.284***	.239
Sex	—	-.16	—	.003		
Instructional Practice	—	.48	—	< .001		

Note. *** p < .001. B = unstandardized coefficient; β = standardized coefficient.

A two-way factorial ANOVA confirmed significant main effects for both sex (F = 5.66, p = .018) and achievement proxy (F = 26.29, p < .001), plus a significant interaction effect (F = 5.17, p = .007), suggesting differential impacts on male and female students. Results are presented in Table 6.

Table 6: *Two-Way Factorial ANOVA: Effects of Sex and Achievement on Self-Efficacy*

Source	Df	F	p	η²
Sex	1	5.66	.018*	—
Achievement Proxy	1	26.29	< .001***	—
Sex × Achievement	1	5.17	.007**	—

Note. * p < .05, ** p < .01, *** p < .001.

Environmental and Psychological Factors Predicting Self-Efficacy

Multiple regression analysis examined the combined predictive power of environmental and psychological factors. Environmental factors alone explained 33.7% of variance in self-efficacy (R^2 = .337, $F(1, 174)$ = 88.22, p < .001). When psychological factors were added in Block 2, the model explained 52.2% of variance (R^2 = .522, $F(1, 173)$ = 66.83, p < .001), with psychological factors contributing an additional 18.4% (ΔR^2 = .184, p < .001). Standardized coefficients in the final model indicated that both environmental factors (β = .412, p <

.001) and psychological factors (β = .499, p < .001) significantly predicted self-efficacy, with psychological factors showing slightly greater relative influence. Complete results are presented in Table 7.

Table 7: *Hierarchical Regression: Environmental and Psychological Factors Predicting Self-Efficacy*

Model/Predictor	B	B	t	p	R²	ΔR²
Block 1					.337***	.337
Environmental Factors	—	—	—	< .001		
Block 2					.522***	.184
Environmental Factors	—	.412	—	< .001		
Psychological Factors	—	.499	—	< .001		

Note. *** p < .001. B = unstandardized coefficient; β = standardized coefficient. Block 1: F(1, 174) = 88.22; Block 2: F(1, 173) = 66.83.

Discussion of Findings

The findings of this study offer a critical expansion of Social Cognitive Theory within a resource-constrained, non-Western context. First, the non-significant relationship between science self-efficacy and physics achievement (r = .046, p > .05) contradicts established international trends, revealing a "contextual decoupling" phenomenon. This suggests a state of "illusory efficacy," where students maintain high self-confidence that is disconnected from conceptual mastery: a likely byproduct of the rote memorization and instructional rigidity prevalent in Nigerian secondary schools. Without rigorous formative feedback or authentic problem-solving, students may sustain inflated self-assessments that mask a lack of academic competence.

Second, the absence of significant sex differences in self-efficacy (p = .599) supports the "Sex Similarities Hypothesis" (Hyde, 2005). This indicates that STEM advocacy in Delta State may be successfully narrowing historical gaps in confidence; however, this parity has not yet translated into improved competence for either sex, reinforcing the identified "confidence-competence paradox."

Most significantly, the data demonstrate that self-efficacy is a highly responsive construct shaped by external factors, with teacher-centered practices and environmental variables explaining a substantial portion

of its variance R^2= .522). The finding that instructional methods explain 23.9% of the variance in efficacy, far exceeding the influence of sex, suggests that pedagogical reform is a more powerful lever for student development than addressing demographic factors alone. Furthermore, the substantial impact of environmental factors (R^2 = .337) highlights that functional laboratories and classroom climate are not mere amenities but central mechanisms for constructing self-efficacy through "mastery experiences" (Bandura, 1997). In conclusion, bridging the gap between student confidence and academic success requires moving beyond rote instruction toward resource-rich, inquiry-based environments that ground psychological self-belief in genuine academic proficiency.

Implications and Conclusions
The findings offer critical insights for physics education reform in Delta State and similar resource-constrained environments. First, the tenuous link between efficacy and achievement suggests that psychological interventions are insufficient in isolation; enhancing student confidence must be integrated with structural improvements in laboratory facilities and a pedagogical transition toward inquiry-based instruction that provides scaffolded "mastery experiences". Second, the significant influence of instructional practices on self-efficacy (R^2 = .284) justifies institutional investment in teacher professional development. Training educators in active learning and formative assessment is a cost-effective strategy to displace the teacher-centered "chalk and talk" methods that currently dominate 80% of Nigerian classrooms (Akpokiniovo & Akudolu, 2023).

Third, the explanatory power of environmental factors underscores that functional laboratories and instructional materials are essential for grounded efficacy development (Oluwasegun, Ohwofosirai & Emagbetere, 2015). Without these, students' scientific self-belief remains abstract and disconnected from authentic practice. Finally, the observed sex-neutrality in efficacy levels must be sustained through inclusive pedagogies that continue to reinforce female students' perceptions of their scientific capabilities.

In conclusion, science self-efficacy in Delta State is a malleable construct significantly shaped by the instructional climate and school environment. While a "confidence-competence" paradox currently exists, where moderate self-belief does not yield high achievement, the data indicates this gap can be bridged through systematic pedagogical innovation and environmental support. Future research should utilize longitudinal designs to track efficacy trajectories during instructional shifts and qualitative methods to further unpack the mechanisms of the

efficacy-achievement paradox. Ultimately, by aligning psychological support with environmental and instructional reform, secondary schools can transform self-efficacy into a genuine catalyst for STEM achievement and career persistence.

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