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Modelling the Impacts of Teachers' Access, Motivation, Attitude, and Self-Efficacy on Mathematics Teachers' Effective ICT Utilization in Classrooms in Enugu, Nigeria

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ABSTRACT

Effective classroom use of information and communication technology (ICT) remains uneven among secondary-school mathematics teachers in Enugu State, Nigeria, even as state and federal policy frameworks expand digital infrastructure through Smart Green Schools and the National Policy on ICT in Education. This article models the joint and mediated effects of four teacher-level factors, access to ICT resources, ICT motivation, ICT attitude, and ICT self-efficacy, on mathematics teachers' effective ICT utilization. Drawing on the Technology Acceptance Model, the Will, Skill, Tool framework, social-cognitive self-efficacy theory, and Technological Pedagogical Content Knowledge, the study integrates published correlational and structural-equation evidence from Enugu and wider Nigerian mathematics-education research. The core empirical structure is the partial least squares structural equation model estimated by Ogbu (2025) among 322 public secondary-school mathematics teachers in Enugu metropolis. That model showed that access, motivation, attitude, and self-efficacy each predicted classroom ICT utilization ($R^2 = .44$), that access strongly predicted attitude ($\beta = .77$), and that attitude exerted a complementary partial mediation between access and utilization. Complementary Enugu studies document persistent first-order barriers (power, laboratories, training) and second-order barriers (confidence, pedagogical beliefs). Policy implications include pairing hardware provision with motivation- and efficacy-building professional development, especially as Enugu scales interactive boards, connectivity, and teacher tablets.

Keywords: *ICT utilization, mathematics teachers, access, motivation, attitude, self-efficacy, PLS-SEM, Enugu, Nigeria*

1. INTRODUCTION

Mathematics remains a gatekeeping subject in Nigerian secondary education. Persistent underachievement in public examinations has been linked, among other factors, to instructional methods that rarely exploit dynamic visualization, multiple representations, immediate feedback, or data-rich problem contexts that digital tools can support (Ejoh, 2020; Ugwu et al., 2024). ICT, including computers, projectors, graphing and dynamic-geometry environments, spreadsheets, virtual laboratories, learning-management systems, and generative artificial intelligence, can make abstract

mathematical objects inspectable. Yet availability of devices does not automatically produce pedagogically productive use (Ertmer, 2005; Ogbu, 2025).

Enugu State is a strategically important case. The state's education transformation agenda has invested in Smart Green Schools equipped with interactive boards, ICT centres, robotics and artificial-intelligence spaces, teacher and learner devices, and improved connectivity (Enugu State Ministry of Education, 2024). Parallel studies continue to report ICT illiteracy among many teachers, under-use relative to ISTE standards, inadequate laboratories, unstable electricity, vandalism of installed devices, and limited in-service training (Anaeche et al., 2016; Nneji & Nsude, 2022; Okeke et al., 2024). Teachers who can physically reach a computer laboratory or a smart board may still avoid high-level integration if they doubt their competence, if they see little professional payoff, or if they hold unfavourable beliefs about technology's contribution to mathematics learning.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Reviews of technology in mathematics education emphasize that tools matter only when they are coupled to worthwhile mathematical tasks and to teachers' pedagogical content knowledge (Mishra & Koehler, 2006). In Nigerian secondary schools, the applications actually used by mathematics teachers tend to be lower-threshold tools: word processing, spreadsheets, drill-and-practice tutorials, and basic graphics (Anaeche et al., 2016). Ertmer (2005) distinguished first-order barriers (access, time, training, technical support) from second-order barriers (beliefs, attitudes, and pedagogical philosophy). Access includes physical presence of devices, reliability of power and connectivity, permission to use shared laboratories, personal ownership, and mathematics-relevant software.

Motivation refers to the energy and direction of teachers' effort toward ICT-supported mathematics teaching. In Enugu public secondary schools, teacher motivation exerted a strong direct effect on job

performance and mediated instructional supervision (Ezeugo, 2026). Attitude is an evaluative predisposition toward using ICT in mathematics teaching and is a core mediator in TAM (Davis, 1989; Scherer et al., 2019; Teo, 2009). Self-efficacy is the belief that one can operate relevant tools and recover from breakdowns in authentic classroom conditions (Bandura, 1997; Compeau & Higgins, 1995). In Nsukka Education Zone, science teachers' technology self-efficacy significantly predicted virtual-learning adoption (Nsude & Onyegegbu, 2024). Effective utilization denotes regular, curriculum-aligned use of ICT to support mathematical thinking, rather than merely typing notes or showing a static slide.

TAM proposes that perceived usefulness and perceived ease of use shape attitude, which shapes intention and use (Davis, 1989). The Will, Skill, Tool model states that technology integration is a function of will (motivation and attitude), skill (including self-efficacy) and tool (access and institutional support) (Knezek & Christensen, 2016). TPACK specifies the knowledge needed to make utilization effective rather than merely frequent (Mishra & Koehler, 2006). The conceptual model places access as an exogenous resource variable that influences attitude, motivation and self-efficacy, and that also retains a direct path to utilization.

3. METHOD

The article adopts an integrative correlational modelling design. Primary structural estimates are taken from the published PLS-SEM of Ogbu (2025), which surveyed public secondary-school mathematics teachers in Enugu metropolis. The analytic sample was 322 teachers (180 men, 55.90%; 142 women, 44.10%), mean age 46.7 years, drawn from 34 public secondary schools across Enugu South, Enugu East and Enugu North. Five four-point Likert instruments measured ICT self-efficacy ($\alpha = .76$), ICT attitude ($\alpha = .89$), ICT motivation ($\alpha = .89$), access ($\alpha = .90$) and utilization ($\alpha = .81$). Measurement-

model diagnostics supported convergent and discriminant validity. The model was estimated with the seminr package in R, using bootstrapped confidence intervals for direct and indirect paths.

4. RESULTS

Table 1. Direct path coefficients in the Enugu mathematics-teacher ICT model

Path	β	Decision	Magnitude
Access → Attitude	.77	Significant	Strong
Access → Motivation	.15	Not significant	Weak
Access → Self-efficacy	.43	Significant	Moderate
Access → Utilization	.22	Significant	Weak, moderate
Attitude → Motivation	.53	Significant	Moderate
Attitude → Self-efficacy	.19	Not significant	Weak
Attitude → Utilization	.18	Significant	Weak
Motivation → Self-efficacy	.07	Not significant	Negligible
Motivation → Utilization	.28	Significant	Weak, moderate
Self-efficacy → Utilization	.12	Significant	Weak

Explained variance in utilization was $R^2 = .44$, a moderate effect in behavioural research (Hair et al., 2022).

Table 2. Selected indirect effects

Indirect path	β	95% CI	Mediation
Access → Attitude → Motivation	.41	[0.20, 0.62]	Full
Access → Attitude → Utilization	.14	[0.02, 0.26]	Complementary partial
Attitude → Motivation → Utilization	.15	[0.06, 0.27]	Complementary partial
Attitude → Self-efficacy → Utilization	.02	[0.01, 0.09]	Complementary partial

Access → Motivation → Utilization	.04	[-0.01, 0.13]	Not supported

Attitude fully mediated the relationship between access and motivation and exerted a complementary partial mediation between access and utilization. Motivation is activated more by attitude than by access alone (Ogbu, 2025). Independent Enugu studies of training needs, competence needs, virtual-learning adoption and teacher motivation support the same architecture (Anaeche et al., 2016; Nneji & Nsude, 2022; Nsude & Onyegegbu, 2024; Ezeugo, 2026).

5. DISCUSSION

Access is necessary and it does some work directly. The larger effect of access, however, is attitudinal. Teachers who can reach tools develop more favourable evaluations of ICT in mathematics teaching. Those evaluations then energize motivation and, to a lesser extent, feed utilization. Self-efficacy adds a smaller but reliable increment, and access also builds efficacy through mastery and exposure (Bandura, 1997). Devices on a bench do not automatically make teachers want to redesign lessons. Desire appears after teachers judge the tools to be educationally worthwhile.

Enugu still faces first-order barriers: electricity, laboratory security, consumables, and the mismatch between generic ICT rooms and mathematics-specific software. Smart Green School investment attacks those barriers at scale. The model shows why that investment is necessary but insufficient. Second-order barriers, attitude quality, motivational climate, and efficacy, carry unique variance in utilization. Professional development that teaches only device operation will lift access-related confidence without lifting TPACK, and the utilization coefficient will remain modest.

Limitations include a single-wave self-report PLS-SEM study in Enugu metropolis, utilization not triangulated with lesson observation, a sample mean age near 47 years, and cautious causal language. Future work should estimate multi-group models contrasting Smart Green Schools with legacy

schools, use longitudinal three-wave designs, pair structural models with TPACK-coded observation, and add student-level outcomes.

Training-need inventories in Enugu State show that educational administrators expect mathematics teachers to be proficient across a wide stack of applications, word processors, presentation packages, spreadsheets, programming languages, networks, computer-aided instruction, visualization, and graphics (Nneji & Nsude, 2022). Competence-need studies in Nsukka Local Government Area likewise find that teachers themselves rate pedagogical ICT competence for inclusive mathematics teaching as a high-priority gap, with no significant gender difference in those needs (Okeke et al., 2024). These findings indicate that demand for capability is recognized even where supply of structured professional development is thin.

Private-school studies in other Nigerian regions similarly identify lack of access and unreliable power as the dominant disablers even when teachers report motivation and positive attitudes. Recent state investment in Smart Green Schools is intended to shift this constraint by installing solar power, connectivity, smart boards, and classroom devices. Access, however, remains an exogenous starting point in any causal model. It can raise opportunity, but it does not by itself produce skilled pedagogical use.

In Nigerian mathematics classrooms, teachers frequently report positive dispositions toward ICT's benefits, organization of information, encoding of new knowledge, and support for problem-solving strategies, while simultaneously reporting low technological literacy (Uka & Ezeh, 2022). That combination is theoretically important. Positive attitude without skill or access produces intention that is not enacted. When tools are visible, functional, and used by respected colleagues, evaluative beliefs

tend to improve. When laboratories are locked or machines are obsolete, attitude may remain abstractly positive but behaviourally inert.

The modest size of the self-efficacy-to-utilization path (β = .12) should not be read as unimportance. In a model that already contains access, attitude, and motivation, efficacy's unique contribution is the residual confidence needed to attempt public use. Mathematics teachers in Enugu, with a mean age near 47 years in the core sample, may have had limited pre-service exposure to dynamic mathematics software. Efficacy may therefore be both lower and more plastic than attitude. Targeted mastery experiences could raise this path's practical importance even if its current standardized coefficient is small.

6. CONCLUSION AND RECOMMENDATIONS

Mathematics teachers' effective ICT utilization in Enugu classrooms is a modelled outcome of access, motivation, attitude, and self-efficacy, not a simple function of hardware counts. As the state installs smart boards, solar power, connectivity and devices, the binding constraint will increasingly shift from first-order access to second-order will and skill. State and local governments should continue to provide functional ICT facilities, including mathematics-relevant software, reliable power and protection against theft, paired with guaranteed departmental scheduling. Teacher education should treat attitude, motivation and self-efficacy as design targets through peer modelling, supervision that rewards integration, and mastery sequences rather than one-off workshops. Faculties and colleges of education should embed ICT in methods courses rather than in isolated computer-appreciation units.

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Taken together, the evidence presented in this article is intended to inform classroom practice, teacher education and education-office supervision in Enugu State. The recommended actions are feasible with existing staff, existing compounds or devices, and existing scheme-of-work time, provided that school leaders protect the instructional routine long enough for teachers and students to internalize it.