

## Evaluation of Interactive Stem Modules for Diverse Learning Styles in Selected Secondary Schools in Igbo Etche, Etche Local Government of Rivers State, Nigeria

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### Abstract

Science, Technology, Engineering, Mathematics (STEM) education is central to fostering innovation, problem-solving skills, and economic development. In Nigeria, challenges including limited ICT infrastructure and inadequate teacher preparation constrained STEM effectiveness. This study evaluated interactive STEM modules in ten secondary schools in Igbo Etche to determine their alignment with diverse learning styles and their impact on engagement, motivation, and academic performance. Using a descriptive survey design, 243 students (out of 409 students) from SS1–SS3 completed an online questionnaire covering learning styles, module design, engagement, and academic outcomes. Experts in Science Education and Measurement & Evaluation validated the questionnaire. A pilot study ( $n=30$ ) produced Cronbach's Alpha values of 0.79–0.88, confirming acceptable reliability, the questionnaire was administered online over four weeks. Descriptive statistics (mean and standard deviation) were computed. Mean scores  $\geq 2.50$  indicated agreement. Data were analysed using descriptive statistics (mean and standard deviation). Findings revealed that modules were well-designed, multimedia-rich, compatible with visual, auditory, reading/writing, and kinesthetics learning styles, and significantly enhanced engagement, motivation, and academic performance. Recommendations include integrating interactive STEM modules into daily instruction, improving ICT infrastructure, and promoting teacher training in digital pedagogy.

**Keywords:** STEM education, interactive modules, learning styles, engagement, academic performance

### Introduction

STEM (Science, Technology, Engineering, Mathematics) education is recognised globally as critical for developing 21st-century skills, fostering innovation, and driving sustainable economic growth (Bybee, 2018; UNESCO, 2021). Effective STEM instruction requires attention to diverse learning styles, including visual, auditory, reading/writing, and kinesthetics modalities

(VARK) (Kolb, 1984). Students' preferred modes of learning influence comprehension, retention, and application of STEM concepts (Fleming & Mills, 2019; Taheri et al., 2021).

Interactive STEM modules digital, multimedia-rich, and learner-centered—offer a promising approach to align instructional materials with students' diverse learning preferences. They typically include multimedia presentations, simulations, hands-on virtual labs, and quizzes that foster engagement, motivation, and problem-solving skills (Zydney et al., 2018). Such modules are increasingly important in Nigeria, where educational challenges include limited ICT infrastructure, teacher preparedness, and curriculum gaps (Ejiwale, 2018; Obi & Iwu, 2021).

Despite these challenges, evidence suggests that technology-enhanced learning in STEM can improve student understanding, motivation, and achievement (Ogunleye & Babajide, 2019; John & Olayinka, 2022). However, few studies in Nigeria have focused on how interactive STEM modules align with diverse learning styles, especially in secondary schools outside major urban centres. This study seeks to address this gap by investigating students' learning preferences, module design features, and the impact of interactive STEM modules on engagement, motivation, and academic performance in selected secondary schools in Igbo Etche, Etche Local Government of Rivers State.

## Literature review

Learning is most effective when instructional strategies align with students' preferred learning styles (Fleming & Mills, 2019; Kolb, 1984). The VARK model identifies four modalities: visual (diagrams, charts), auditory (lectures, discussions), reading/writing, and kinesthetics (hands-on activities). Although critics argue that rigid “learning styles” classifications may oversimplify learning processes (Kirschner, 2017), adapting teaching to multiple modalities can enhance student engagement and comprehension (Shams & Seitz, 2018).

Digital tools, including multimedia modules, simulations, and virtual labs, improve conceptual understanding, problem-solving skills, and learning motivation (Bybee, 2013; Mayer, 2017). For example, virtual laboratories allow kinesthetics learners to manipulate variables in controlled simulations, while multimedia presentations support visual and auditory learners (Gui et al., 2023). Interactive STEM modules also foster engagement, sustained attention, and collaborative learning (Fredricks et al., 2016).

Despite global advances, Nigerian secondary schools face challenges in STEM delivery, including limited ICT infrastructure, teacher preparedness, and curriculum gaps (Ejiwale, 2018; Obi & Iwu, 2021; Olatunde, 2021). Studies show that interactive digital tools can mitigate these barriers by providing multimedia-rich, learner-centered instruction adaptable to various learning preferences (Adeyemi & Adepoju, 2020; Akani & Chukwunenye, 2022).

While several studies address STEM education and technology-enhanced learning in Nigeria, few have explored the relationship between interactive STEM modules and diverse learning styles at the secondary school level. This study extends current research by examining how interactive modules affect engagement, motivation, and academic performance in Igbo Etche secondary schools.

## Methodology

A descriptive survey design was adopted, suitable for evaluating participants' perceptions of interactive STEM modules and their alignment with diverse learning styles (Creswell & Creswell, 2018).

Ten secondary schools in Igbo Etche were selected, representing public and private institutions. The population comprised 243 students from SS1–SS3 who completed an online questionnaire.

Stratified sampling ensured proportional representation across class levels and school types. All students who completed the online questionnaire were included.

A researcher-developed online questionnaire (with this link:

[https://docs.google.com/forms/d/e/1FAIpQLSfhK0uJ7PqWaeUE4jB-tH-](https://docs.google.com/forms/d/e/1FAIpQLSfhK0uJ7PqWaeUE4jB-tH-4VYCGs2eCxP6BRRUteoiK8hA7rg/viewform?usp=header)

[4VYCGs2eCxP6BRRUteoiK8hA7rg/viewform?usp=header](https://docs.google.com/forms/d/e/1FAIpQLSfhK0uJ7PqWaeUE4jB-tH-4VYCGs2eCxP6BRRUteoiK8hA7rg/viewform?usp=header)) measured five constructs: these were drawn from the research objectives: Identify the predominant learning styles among secondary school students in Igbo Etche; examine the design features of existing interactive STEM modules used in selected schools; assess the alignment of interactive STEM modules with the various learning styles (visual, auditory, kinesthetics, etc.), evaluate the effectiveness of interactive STEM modules in improving students' engagement and motivation; determine the impact of interactive STEM modules on students' academic performance in STEM subjects. Research Questions: What are the predominant learning styles among secondary school students in Igbo Etche? What are the key design features of the existing interactive STEM modules used in selected secondary schools? To what extent do the interactive STEM modules align with various student learning styles (visual, auditory, kinesthetic, etc.)? How effective are interactive STEM

modules in enhancing students' engagement and motivation in STEM subjects? What is the impact of interactive STEM modules on students' academic performance in STEM subjects?

Responses were rated on a four-point Likert scale, SA – Strongly Agree, A – Agree, D – Disagree, SD – Strongly Disagree. With SA=4 and SD=1.

Experts in Science Education and Measurement & Evaluation validated the questionnaire.

A pilot study (n=30) produced Cronbach's Alpha values of 0.79–0.88, confirming acceptable reliability (see Table 1).

**Table 1. Reliability Coefficients of Questionnaire Sections**

Section	Items	Cronbach's Alpha
Learning Styles	5	0.81
Design Features	5	0.83
Alignment	5	0.79
Engagement & Motivation	5	0.85
Academic Performance	5	0.88
Overall	25	0.83

The questionnaire was administered online over four weeks. Descriptive statistics (mean and standard deviation) were computed. Mean scores  $\geq 2.50$  indicated agreement.

Participation was voluntary, responses were anonymous, and data were used solely for academic purposes.

## Results

### 4.1 Predominant Learning Styles (Objective/Research question one)

What are the predominant learning styles of students using interactive STEM modules?

Item	Mean	SD	Decision
Visual aids	3.31	0.77	Agree
Verbal explanations	3.22	0.62	Agree
Hands-on activities	2.82	0.76	Agree
Technology-based	3.70	0.46	Strongly Agree
Reading/writing	3.56	0.69	Strongly Agree
Grand Mean	3.32	-	Agree

#### 4.2 Design Features of Interactive STEM Modules (Objective/Research question two)

What design features characterize interactive STEM modules?

Item	Mean	SD	Decision
Easy navigation	3.41	0.59	Agree
Clear instructions	3.38	0.61	Agree
Multimedia use	3.45	0.55	Agree
Encourage interaction	3.33	0.63	Agree
Curriculum alignment	3.29	0.67	Agree
Grand Mean	3.37	-	Agree

#### 4.3 Alignment with Diverse Learning Styles (Objective/Research question three)

To what extent do interactive STEM modules align with diverse learning styles?

Item	Mean	SD	Decision
Visual learners	3.36	0.60	Agree
Auditory learners	3.08	0.66	Agree
Kinesthetic learners	3.14	0.64	Agree
Balance preferences	3.22	0.61	Agree
Teacher adaptation	3.18	0.68	Agree
Grand Mean	3.20	-	Agree

#### 4.4 Engagement and Motivation (Objective/Research question four)

How do interactive STEM modules influence student engagement and motivation?

Item	Mean	SD	Decision
Learning enjoyment	3.47	0.52	Agree
Increased motivation	3.42	0.56	Agree
Active participation	3.39	0.58	Agree
Attention	3.51	0.49	Strongly Agree
Interest in STEM	3.44	0.54	Agree
Grand Mean	3.45	-	Agree

#### 4.5 Academic Performance (Objective/Research question five)

What is the influence of interactive STEM modules on students' academic performance?

Item	Mean	SD	Decision
Understanding concepts	3.46	0.53	Agree
Improved test scores	3.31	0.61	Agree
Problem-solving skills	3.37	0.58	Agree
Real-life application	3.29	0.62	Agree
Overall performance	3.34	0.60	Agree
Grand Mean	3.35	-	Agree

#### Discussion

The results indicate that interactive STEM modules effectively accommodate diverse learning styles (addressing research question one and four), supporting constructivist learning theory (Kolb, 1984). Modules were multimedia-rich, easy to navigate, and curriculum-aligned, promoting student engagement, motivation, and academic performance (addressing research question five). This aligns with studies emphasizing digital tools' role in enhancing STEM education- addressing research question two (Bybee, 2013; Çetin & Özdemir, 2022).

Students demonstrated strong preferences for visual, reading/writing, and technology-based learning, consistent with other studies in Nigeria and Africa-addressing research question three. (Mokgobu & Naidoo, 2019; Eze & Onyekwelu, 2019). The positive outcomes suggest that integrating interactive digital modules can mitigate challenges associated with limited teacher preparedness and ICT infrastructure (Obi & Iwu, 2021; Olatunde, 2021).

Moreover, the findings indicate that interactive modules support inclusive learning environments, catering to visual, auditory, and kinesthetics learners, which enhances active participation and motivation (Fredricks et al., 2016; Shams & Seitz, 2018).

#### Conclusion

Interactive STEM modules are effective instructional tools for accommodating diverse learning styles, improving student engagement and motivation, and positively influencing academic performance in secondary schools in Igbo Etche. They are particularly relevant in the current era of AI (artificial intelligence), IoT (internet of Things) and ML (Machine Learning), where digital literacy and problem-solving skills are essential.

## Recommendations

Teachers should regularly integrate interactive STEM modules into classroom instruction. Schools should provide adequate ICT infrastructure and continuous teacher training. Curriculum developers should create multimedia-rich, learner-centered STEM content. Policymakers should support and fund digital STEM initiatives in (Igbo Etche) secondary education. It is suggested that further Research be Conducted on longitudinal studies to assess sustained learning outcomes, comparative studies across different Local Government Areas, and experimental studies be done using achievement tests to measure module effectiveness.

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