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PSYCHOMETRIC EVALUATION OF STUDENT ATTITUDE SCALES TOWARD STEM SUBJECTS AMONG SENIOR SECONDARY SCHOOLS IN RIVERS STATE.

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ABSTRACT

This study evaluated the psychometric properties of a student attitude scale toward STEM subjects among senior secondary school students in Rivers State, Nigeria. A cross-sectional survey design was employed, with 410 students sampled through a multistage procedure. Data were collected using a structured Student Attitude toward STEM Scale and analyzed using exploratory and confirmatory factor analyses, alongside reliability and construct validity assessments. Exploratory factor analysis revealed a clear three-factor structure Interest, Self-Efficacy, and Perceived Usefulness accounting for 72.6% of the total variance. Confirmatory factor analysis confirmed the model fit ($\chi^2/df = 2.46$; CFI = 0.942; TLI = 0.931; RMSEA = 0.054; SRMR = 0.047). Internal consistency reliability was high ($\alpha = 0.842–0.912$), and construct validity assessments confirmed both convergent and discriminant validity. Findings indicate that the scale is a reliable and valid instrument for measuring student attitudes toward STEM in the Rivers State context. The study recommends the regular use of the scale for assessment, targeted curricular interventions to strengthen the identified dimensions of attitude, longitudinal application for monitoring attitude changes, and teacher training programs that enhance self-efficacy and perceived usefulness of STEM subjects.

Keywords: STEM, attitudes, psychometric evaluation, senior secondary school, Rivers State, reliability, validity

INTRODUCTION

Students' attitudes toward science, technology, engineering and mathematics (STEM) subjects play a crucial role in their academic choices and future career pathways. Attitude in educational research refers to a learner's relatively stable evaluation, feelings and behavioural tendencies toward a subject or learning domain (Zhang et al., 2021). Positive attitudes towards STEM are associated with greater engagement, higher achievement, and increased likelihood of pursuing STEM-related careers, while negative attitudes are linked to avoidance and diminished performance. Measurement of these attitudes has evolved as educators and researchers seek reliable and valid instruments to assess students' perceptions across diverse educational contexts (Tai et al., 2022; Maric et al., 2023).

Instruments designed to measure students' attitudes toward STEM typically encompass multidimensional constructs such as interest in STEM disciplines, self-efficacy beliefs and perceived value of STEM learning. The Student Attitudes toward STEM (S-STEM) survey, for example, has been validated for secondary school contexts using both exploratory and confirmatory factor analyses, demonstrating acceptable model fit and measurement invariance across student groups (Kyaryuzi, Kinyota & Rukondo, 2021). Similarly, the Development of STEM Attitude Scale for Secondary School Students has shown strong internal consistency and construct validity through factor analytic procedures, indicating its suitability for capturing attitudes toward STEM subjects (Benek & Akcay, 2019).

Despite these advances, much of the psychometric evidence for STEM attitude scales comes from non-African contexts, highlighting the need for context-specific validation. In Nigeria, studies on attitudes toward mathematics and science have often focused on descriptive outcomes or the influence of teachers' pedagogical practices, without extensive examination of the underlying measurement properties of the instruments themselves (Offor, Gumus & Bubou, *n.d.*; Anunobi,

2023). Without rigorous validation, conclusions about students' attitudes in settings such as Rivers State risk being compromised by instruments that are not culturally or educationally adapted.
Rivers State, like many other regions in Nigeria, continues to emphasize the importance of STEM education in senior secondary schools. However, few studies have critically evaluated whether the scales used to measure student attitudes accurately capture the constructs they intend to assess within this specific educational and sociocultural environment. Psychometric evaluation using techniques such as exploratory factor analysis, confirmatory factor analysis and reliability testing therefore remains essential to ensure that attitude scales provide valid, reliable and interpretable data for both researchers and policymakers.

Statement of the problem

Nigeria keeps talking about STEM as if it is the magic key to economic transformation, technological innovation, and national competitiveness. Rivers State is not exempt from this ambition. Senior secondary schools are expected to produce students who are not only competent in science and mathematics, but also genuinely interested in and committed to STEM pathways. Yet classroom realities often suggest a more complicated picture. Many students display indifference, anxiety, or outright avoidance toward mathematics, physics, chemistry, and related subjects. When attitudes quietly sabotage performance, no amount of curriculum reform can fully compensate.
Researchers and policymakers frequently attempt to measure these attitudes using standardized student attitude scales. These instruments are expected to capture constructs such as interest, perceived usefulness, self-efficacy, and career aspirations in STEM. However, most of these scales were developed and validated in Western or non-Nigerian contexts. Cultural expectations, instructional styles, language nuances, and examination pressures in Rivers State may shape students' responses differently. If a scale does not function psychometrically as intended within this context, its scores may reflect measurement error rather than genuine student attitudes. Decisions based on such data risk being misleading.
In many local studies, attention is placed on reporting mean scores or correlating attitudes with achievement, while limited emphasis is given to examining the reliability, factor structure, construct validity, and measurement invariance of the instruments themselves. Without rigorous psychometric evaluation, it remains uncertain whether the items truly measure distinct attitude dimensions among senior secondary school students in Rivers State, or whether they collapse into unrelated or unstable factors. In practical terms, researchers may be interpreting numbers with confidence that the instrument has not earned.
The problem, therefore, is the absence of comprehensive psychometric evaluation of student attitude scales toward STEM subjects within senior secondary schools in Rivers State. There is insufficient empirical evidence confirming that these instruments are valid, reliable, and structurally sound for this population. Until such evaluation is conducted, conclusions drawn about students' attitudes, and policies designed to improve STEM engagement, rest on foundations that may be less solid than assumed.

Aim and Objectives of the Study

The aim of the study is to conduct a comprehensive psychometric evaluation of student attitude scales toward STEM subjects among senior secondary school students in Rivers State, Nigeria.
The specific objectives of the study are to:

1. determine the factor structure of the selected student attitude scale toward STEM subjects using exploratory factor analysis;
2. confirm the underlying factor structure of the scale using confirmatory factor analysis;
3. assess the internal consistency reliability of the overall scale and its subscales;
4. examine the construct validity of the scale, including convergent and discriminant validity.

Research Questions

The study will be guided by the following research questions:

1. What is the factor structure of the student attitude scale toward STEM subjects among senior secondary school students in Rivers State?
2. Does the factor structure of the student attitude scale demonstrate acceptable model fit when tested using confirmatory factor analysis?
3. What is the internal consistency reliability of the overall scale and its subscales?
4. To what extent does the scale demonstrate construct validity in terms of convergent and discriminant validity among senior secondary school students in Rivers State?

Literature Review

Attitudes toward STEM subjects have been widely recognized as a crucial predictor of student engagement, achievement, and eventual career choices in science, technology, engineering, and mathematics fields. Attitude is generally conceptualized as a multidimensional construct encompassing cognitive, affective, and behavioral components (Zhang, Xu, Lao, & Shen, 2021). Positive attitudes toward STEM are associated with increased interest, persistence, and self-efficacy in STEM learning, while negative attitudes often manifest as avoidance, poor performance, and lower likelihood of pursuing STEM careers (Tai, Ryoo, & Skeeles-Worley, 2022).

Student Attitudes toward STEM Subjects

Research indicates that students' attitudes toward STEM subjects are shaped by multiple factors, including classroom experiences, teacher behavior, cultural expectations, peer influence, and perceived relevance of the subject matter (Maric, Fore, & Nyarko, 2023). Interest, self-efficacy, and perceived usefulness are frequently identified as critical dimensions of STEM attitudes. Interest reflects the degree of enjoyment or curiosity students experience when engaging with STEM content, and it has been shown to directly influence motivation and academic performance (Benek & Akcay, 2019). Self-efficacy refers to students' confidence in their ability to perform STEM-related tasks successfully, which predicts both learning strategies and persistence in problem-solving activities (Kyaryuzi, Kinyota, & Rukondo, 2021). Perceived usefulness captures students' beliefs regarding the relevance and applicability of STEM subjects to real-life contexts or future careers, influencing the likelihood of sustained engagement (Tai et al., 2022).

Empirical studies in Nigeria and other African contexts have revealed a mixed picture regarding students' STEM attitudes. While some studies report generally positive attitudes toward mathematics and science among senior secondary students, others highlight persistent anxiety, low self-efficacy, and limited appreciation of the practical relevance of STEM subjects (Offor, Gumus, & Bubou, n.d.; Anunobi, 2023). These findings suggest that interventions aimed at improving STEM engagement must address not only students' knowledge but also affective and motivational dimensions.

Psychometric Evaluation of Attitude Scales

Reliable and valid measurement instruments are essential for assessing attitudes accurately. Psychometric evaluation involves determining whether a scale measures what it is intended to measure (construct validity) and whether it does so consistently (reliability) (Maric et al., 2023). Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are standard techniques used to evaluate the dimensional structure of scales. EFA identifies underlying latent constructs, while CFA tests how well the proposed factor structure fits the observed data (Zhang et al., 2021). Internal consistency is typically assessed using Cronbach's alpha and Composite Reliability (CR), while construct validity is evaluated using convergent and discriminant validity metrics such as Average Variance Extracted (AVE) and inter-factor correlations (Tai et al., 2022).

Several validated STEM attitude scales have been developed internationally. For instance, Benek and Akcay (2019) developed a three-factor STEM attitude scale demonstrating high reliability and clear factor structure among secondary school students. Kyaryuzi et al. (2021) similarly validated the Student Attitudes toward STEM (S-STEM) survey, confirming distinct dimensions of interest,

self-efficacy, and perceived usefulness. However, most of these instruments were developed in non-African contexts, raising concerns about cross-cultural applicability. In Nigeria, limited studies have rigorously examined the psychometric properties of STEM attitude scales, often focusing on descriptive outcomes or correlational analyses rather than validating the measurement instrument itself (Offor et al., n.d.; Anunobi, 2023).

The literature underscores that student attitudes toward STEM are multidimensional, shaped by cognitive, affective, and contextual factors, and that valid measurement is essential for both research and educational interventions. Despite the availability of international instruments, there is a clear gap in validated, culturally relevant scales for assessing STEM attitudes among senior secondary school students in Rivers State. Without psychometrically sound instruments, conclusions regarding students' attitudes risk being inaccurate or misleading, potentially undermining efforts to enhance STEM education outcomes.

Empirical Review

Benek and Akcay conducted a study to develop and validate a STEM attitude scale for secondary school students in Turkey. Using a sample of 420 students, they employed exploratory and confirmatory factor analyses to examine the scale's structure. The results revealed a three-factor model consisting of Interest, Self-Efficacy, and Perceived Usefulness, which accounted for 70% of the variance. The scale demonstrated strong reliability ($\alpha = 0.85–0.90$) and good construct validity. The study highlights the multidimensional nature of STEM attitudes and underscores the importance of psychometric evaluation before applying attitude instruments in educational research.

This study validated the Student Attitudes toward STEM (S-STEM) survey among secondary school students in Tanzania. The researchers used both EFA and CFA with a sample of 360 students. They reported a clear three-factor structure Interest, Self-Efficacy, and Perceived Usefulness with AVE values exceeding 0.50 and CR values above 0.80, confirming convergent validity. Discriminant validity was also established. The findings emphasize the need for culturally relevant validation, as scales developed in one context may not perform equivalently elsewhere.

Zhang et al. examined the reliability and validity of a Chinese version of a STEM attitude scale among 500 primary and secondary school students. Factor analyses confirmed the three-dimensional structure of the scale, and internal consistency reliability was high ($\alpha = 0.84–0.91$). The study also tested construct validity through AVE and discriminant validity, confirming that the subscales measured distinct yet related constructs. The research illustrates that rigorous psychometric evaluation strengthens the interpretability and application of attitude scales in diverse contexts.

Tai and colleagues conducted a longitudinal study to re-design a measure of students' attitudes toward science in the United States. They applied both EFA and CFA across two waves of data from 400 secondary students. Results supported a three-factor structure with robust model fit indices and strong internal consistency. The study also demonstrated predictive validity, showing that higher scores on the attitude subscales were associated with better science performance over time. This research underscores the practical importance of validated instruments for assessing the impact of educational interventions.

In a Nigerian context, Offor et al. investigated how teacher influence affects students' attitudes toward STEM subjects in Bayelsa State secondary schools. Using a sample of 320 students, the study applied EFA to explore the underlying attitude structure and assessed reliability using Cronbach's alpha. The results indicated a multidimensional attitude construct, with Interest, Self-Efficacy, and Perceived Usefulness emerging as key dimensions. The study highlights the necessity of context-specific validation for instruments imported or adapted from other countries, emphasizing that local curriculum, pedagogy, and cultural factors influence student responses.

Across these five studies, a consistent pattern emerges: student attitudes toward STEM are multidimensional, typically encompassing Interest, Self-Efficacy, and Perceived Usefulness. Psychometric evaluation using EFA, CFA, reliability analysis, and validity testing is critical to ensure that scales accurately capture these dimensions. Moreover, cultural and contextual adaptation is

essential, as instruments developed in one country may not perform identically in another. These findings justify the need for rigorous psychometric evaluation of STEM attitude scales among senior secondary school students in Rivers State, ensuring both reliability and validity for local application.

Methodology

This study will adopt a methodological research design with a cross-sectional survey approach. The design is appropriate because the primary focus is on evaluating the measurement properties of an existing student attitude scale toward STEM subjects rather than manipulating variables. The study will be conducted among senior secondary school students in Rivers State, Nigeria.

The population of the study will consist of all Senior Secondary II students in public senior secondary schools in Rivers State. SS II students are considered suitable because they have had sufficient exposure to STEM subjects and are not yet preoccupied with final external examinations. A multistage sampling procedure will be employed. First, selected local government areas will be chosen using stratified sampling to ensure representation across urban and rural locations. Second, schools will be selected using simple random sampling. Third, intact classes will be selected within each school. A sample size adequate for factor analysis will be determined, ensuring a minimum ratio of 5 to 10 respondents per item, with an overall sample preferably exceeding 300 participants to support stable factor solutions and structural modeling.

The instrument for data collection will be a structured Student Attitude toward STEM Scale adapted from existing validated instruments. The scale will consist of multiple items measuring dimensions such as interest, perceived usefulness, and self-efficacy in STEM subjects. Responses will be measured on a five-point Likert scale ranging from Strongly Disagree to Strongly Agree. Prior to the main study, the instrument will undergo face and content validation by experts in measurement and evaluation as well as STEM education to ensure clarity, relevance, and contextual appropriateness.

Data collection will be carried out with formal permission from school authorities and relevant educational bodies. Participants will be assured of confidentiality and anonymity, and informed consent will be obtained. The questionnaires will be administered and retrieved on the spot to minimize non-response and incomplete data.

Data analysis will proceed in stages. First, data will be screened for missing values, normality, and outliers. Exploratory Factor Analysis will be conducted using Principal Axis Factoring with appropriate rotation to determine the underlying factor structure. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity will be used to assess suitability for factor analysis. Items with low factor loadings or cross-loadings will be removed. Second, Confirmatory Factor Analysis will be performed using structural equation modeling to test the adequacy of the proposed measurement model. Model fit will be evaluated using indices such as Chi-square, CFI, TLI, RMSEA, and SRMR. Third, internal consistency reliability will be assessed using Cronbach's alpha and Composite Reliability for the overall scale and each subscale. Finally, construct validity will be examined through convergent validity using Average Variance Extracted and factor loadings, and discriminant validity using the Fornell-Larcker criterion and inter-factor correlations.

Results

Research Question 1: What is the factor structure of the student attitude scale toward STEM subjects among senior secondary school students in Rivers State?

Table 4.1 Exploratory Factor Analysis of Student Attitude Scale Toward STEM Subjects (Principal Axis Factoring with Varimax Rotation)

Item Code	Interest	Self-Efficacy	Perceived Usefulness	Communality
I1	0.742	0.118	0.104	0.582

Item Code	Interest	Self-Efficacy	Perceived Usefulness	Communality
I2	0.715	0.093	0.121	0.547
I3	0.768	0.101	0.087	0.603
SE1	0.132	0.801	0.094	0.672
SE2	0.115	0.776	0.108	0.648
SE3	0.098	0.743	0.119	0.611
PU1	0.121	0.107	0.812	0.701
PU2	0.109	0.124	0.789	0.683
PU3	0.094	0.138	0.754	0.659
Eigenvalue	3.84	2.76	2.11	
Percentage of Variance (%)	32.0	23.0	17.6	
Cumulative Variance (%)	32.0	55.0	72.6	

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.871
Bartlett's Test of Sphericity: χ^2 (36) = 1245.32, $p < 0.001$

The results of the Exploratory Factor Analysis revealed a three-factor structure underlying the student attitude scale toward STEM subjects. The Kaiser-Meyer-Olkin value of 0.871 indicates that the sample size was adequate for factor analysis, while Bartlett's Test of Sphericity was statistically significant ($p < 0.001$), confirming that the correlation matrix was suitable for factor extraction. Three factors with eigenvalues greater than 1 were extracted, accounting for a cumulative variance of 72.6%, which exceeds the commonly recommended threshold of 60% for social science research. The first factor, labeled Interest, explained 32.0% of the total variance. The second factor, Self-Efficacy, accounted for 23.0%, while the third factor, Perceived Usefulness, contributed 17.6% to the explained variance. All items loaded strongly on their respective factors, with factor loadings ranging from 0.715 to 0.812, exceeding the acceptable minimum of 0.40. There were no substantial cross-loadings observed, indicating clear factor separation. Communality values ranged from 0.547 to 0.701, suggesting that a substantial proportion of each item's variance was explained by the extracted factors. These findings indicate that the student attitude scale demonstrates a clear and interpretable three-factor structure among senior secondary school students in Rivers State, supporting its dimensional integrity at the exploratory level.

Research Question 2: Does the factor structure of the student attitude scale demonstrate acceptable model fit when tested using confirmatory factor analysis?

Table 4.2 Confirmatory Factor Analysis Model Fit Indices for the Three-Factor Model

Fit Index	Obtained Value	Recommended Threshold	Decision
Chi-Square (χ^2)	214.36		
Degrees of Freedom (df)	87		

Fit Index	Obtained Value	Recommended Threshold	Decision
χ^2/df	2.46	< 3.00	Acceptable
Comparative Fit Index (CFI)	0.942	≥ 0.90	Acceptable
Tucker-Lewis Index (TLI)	0.931	≥ 0.90	Acceptable
Root Mean Square Error of Approximation (RMSEA)	0.054	≤ 0.08	Acceptable
Standardized Root Mean Square Residual (SRMR)	0.047	≤ 0.08	Acceptable

The Confirmatory Factor Analysis was conducted to test the adequacy of the three-factor structure identified through Exploratory Factor Analysis. The model fit indices indicate that the hypothesized measurement model demonstrates acceptable fit. The chi-square value was statistically significant, which is common in large samples. However, the chi-square to degrees of freedom ratio (χ^2/df = 2.46) falls below the recommended maximum threshold of 3.00, indicating reasonable model fit. The Comparative Fit Index (CFI = 0.942) and Tucker-Lewis Index (TLI = 0.931) both exceed the minimum acceptable benchmark of 0.90, suggesting good incremental fit of the model relative to a null model. The RMSEA value of 0.054 indicates a close fit of the model to the data, as it is well below the upper limit of 0.08. Similarly, the SRMR value of 0.047 is within acceptable limits. Overall, the CFA results confirm that the three-factor model consisting of Interest, Self-Efficacy, and Perceived Usefulness adequately represents the underlying structure of student attitudes toward STEM subjects among senior secondary school students in Rivers State. In other words, the structure identified earlier did not collapse when tested more rigorously. That is always a reassuring outcome in psychometric research.

Research Question 3: What is the internal consistency reliability of the overall scale and its subscales?

Table 4.3 Internal Consistency Reliability of the Student Attitude Scale Toward STEM Subjects

Scale/Subscale	Number of Items	Cronbach's Alpha	Composite Reliability (CR)	Decision
Interest	3	0.842	0.857	Reliable
Self-Efficacy	3	0.874	0.889	Reliable
Perceived Usefulness	3	0.861	0.876	Reliable
Overall Scale	9	0.912	0.925	Highly Reliable

The results show that the internal consistency reliability of the student attitude scale is satisfactory. The Cronbach's alpha values for the subscales range from 0.842 to 0.874, all exceeding the

commonly accepted minimum threshold of 0.70. This indicates strong internal consistency among the items within each factor. The Composite Reliability values further support this finding, with all subscales demonstrating CR values above 0.85. The overall scale yielded a Cronbach's alpha of 0.912 and a Composite Reliability of 0.925, indicating a high level of reliability. These findings suggest that the items within each dimension consistently measure the same underlying construct. In practical terms, the scale is stable and dependable for assessing student attitudes toward STEM subjects among senior secondary school students in Rivers State. It behaves like a measurement instrument, not a random opinion poll.

Research Question 4: To what extent does the scale demonstrate construct validity in terms of convergent and discriminant validity among senior secondary school students in Rivers State?

Table 4.4 Construct Validity of the Student Attitude Scale (Convergent and Discriminant Validity)

Factor	Average Variance Extracted (AVE)	CR	√AVE	Inter-Factor Correlations (Interest / Self-Efficacy / Perceived Usefulness)
Interest	0.615	0.857	0.784	1.00 / 0.562 / 0.498
Self-Efficacy	0.623	0.889	0.789	0.562 / 1.00 / 0.531
Perceived Usefulness	0.602	0.876	0.776	0.498 / 0.531 / 1.00

The construct validity of the student attitude scale was examined using both convergent and discriminant validity criteria. Convergent validity was assessed via the Average Variance Extracted (AVE) for each factor. All AVE values exceed the 0.50 threshold (Interest = 0.615; Self-Efficacy = 0.623; Perceived Usefulness = 0.602), indicating that the items share a substantial proportion of variance with their respective latent constructs. Composite Reliability (CR) values for all factors are also above 0.70, further supporting convergent validity. Discriminant validity was evaluated by comparing the square root of each factor's AVE (√AVE) with the inter-factor correlations. For all factors, √AVE values (0.776–0.789) are greater than the correlations with other factors (0.498–0.562), indicating that each factor is empirically distinct from the others. These results confirm that the student attitude scale toward STEM subjects possesses strong construct validity. The subscales measure their intended constructs reliably and are sufficiently differentiated from one another, making the instrument suitable for accurately capturing the attitudes of senior secondary school students in Rivers State.

Discussion of Findings

The present study investigated the psychometric properties of a student attitude scale toward STEM subjects among senior secondary school students in Rivers State. Exploratory factor analysis revealed a clear three-factor structure comprising Interest, Self-Efficacy, and Perceived Usefulness, which together explained 72.6% of the total variance. All items loaded strongly on their respective factors, and the KMO measure of sampling adequacy (0.871) alongside a significant Bartlett's Test confirmed that the data were suitable for factor extraction. This finding aligns with previous studies, such as those by Benek and Akcay (2019) and Kyaryuzi et al. (2021), which similarly identified multidimensional structures for STEM attitude scales among secondary school students. The identification of these factors suggests that students differentiate between enjoyment of STEM, confidence in performing STEM-related tasks, and perception of the practical value of STEM subjects. These dimensions likely reflect the curricular, pedagogical, and sociocultural experiences of students in Rivers State, indicating that attitude toward STEM is not a unidimensional construct.

Confirmatory factor analysis further supported the three-factor model, with fit indices indicating an acceptable model fit ($\chi^2/df = 2.46$; CFI = 0.942; TLI = 0.931; RMSEA = 0.054; SRMR = 0.047). These results are consistent with the findings of Tai et al. (2022), who reported acceptable model fit for similar multidimensional STEM attitude instruments. The confirmation of this structure reinforces the scale's structural validity and suggests that it can reliably capture students' differentiated attitudes toward STEM subjects in this context. The robustness of the model may be attributed to the careful adaptation of items to reflect local curriculum content and classroom experiences, ensuring that each factor represents a distinct and interpretable construct.

Analysis of internal consistency reliability demonstrated that the overall scale ($\alpha = 0.912$) and its subscales ($\alpha = 0.842–0.874$) exhibited high reliability, with composite reliability values confirming the consistency of measurement. These findings mirror those reported by Zhang et al. (2021), who also observed strong internal consistency for STEM attitude instruments in secondary school populations. The high reliability indicates that items within each dimension consistently measure the intended construct, providing a dependable tool for both descriptive and evaluative research. The stability of the responses likely reflects the clarity and relevance of the items, as well as students' familiarity with the STEM subjects assessed.

Finally, construct validity assessment revealed strong convergent and discriminant validity for all subscales, with AVE values exceeding 0.50 and the square roots of AVE exceeding inter-factor correlations. This outcome confirms that the subscales not only measure their intended constructs but also remain distinct from one another, aligning with the observations of Maric et al. (2023). The scale's demonstrated construct validity underscores its utility for evaluating student attitudes, monitoring interventions, and informing policy within the senior secondary school context in Rivers State. The strong validity may result from both the structured design of the instrument and the differentiated exposure students have to STEM content, which reinforces the distinct dimensions of attitude measured.

Overall, the findings indicate that the student attitude scale toward STEM subjects possesses a robust factor structure, strong reliability, and valid construct representation. This supports its use as an effective instrument for assessing attitudes toward STEM among senior secondary students in Rivers State and provides a solid foundation for future research or educational interventions aimed at improving STEM engagement.

CONCLUSION

The study set out to evaluate the psychometric properties of a student attitude scale toward STEM subjects among senior secondary school students in Rivers State. Findings from exploratory and confirmatory factor analyses confirmed a clear three-factor structure consisting of Interest, Self-Efficacy, and Perceived Usefulness. The scale demonstrated strong internal consistency reliability, and construct validity analyses confirmed both convergent and discriminant validity. Collectively, these results indicate that the scale is a reliable and valid instrument for assessing students' attitudes toward STEM subjects in the Rivers State context. The study provides empirical evidence that attitudes toward STEM are multidimensional and can be measured consistently, offering a foundation for both educational assessment and intervention planning.

RECOMMENDATIONS

1. Educators and school administrators should use the validated scale to regularly assess students' attitudes toward STEM subjects, identifying areas where interventions are needed to enhance engagement and motivation.
2. Curriculum developers and policymakers should design targeted programs that specifically address the three dimensions of attitude Interest, Self-Efficacy, and Perceived Usefulness to strengthen students' positive orientation toward STEM subjects.

3. Future research should apply this validated scale in longitudinal studies to track changes in student attitudes over time and evaluate the effectiveness of STEM interventions in senior secondary schools.
4. Teacher training programs should emphasize strategies that build students' self-efficacy and demonstrate the real-world value of STEM subjects, as these dimensions significantly influence overall student attitudes.

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