AMERICAN Journal of Science on Integration and Human Development
Volume 3, Issue 8, 2025 ISSN (E): 2993-2750

Blended Learning Model for Enhancing STEM Career Awareness among Urban and Rural Secondary School Learners

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Abstract: This study examines the effect of a blended learning model on STEM career awareness among urban and crural secondary school students in Abuja, Nigeria. Using a descriptive survey design, 240 SSII students were sampled across four public schools through stratified and random techniques. Data were gathered via two validated instruments the STEM Career Awareness Questionnaire (α = 0.84) and the Blended Learning Perception Inventory (α = 0.88) and analyzed using Pearson correlation, independent samples t-test, and two-way ANOVA. Open-ended responses were thematically analyzed to capture deeper student perceptions. Findings revealed significant positive correlations between students' perceptions of content clarity, engagement, and career relevance in blended learning and their STEM career awareness. Urban students showed significantly higher awareness scores than rural counterparts ($t = 3.83$, $p < .001$), while gender and location both exerted significant independent effects ($p < .05$), though without interaction. Thematic analysis highlighted increased interest in STEM careers, real-world relevance, gender inspiration, and digital access limitations.The study concludes that blended learning can enhance STEM career awareness but is influenced by contextual factors such as infrastructure and gender inclusion. It recommends expanding access to digital tools, particularly in rural areas, and strengthening career-relevant, inclusive STEM content.

Keywords: Blended learning, STEM awareness, urban-rural disparity and gender

Background

The increasing demand for science, technology, engineering, and mathematics (STEM) professionals in the global workforce has positioned STEM education as a cornerstone of national development, innovation, and competitiveness. In Africa, and particularly in Nigeria, the urgency to bridge the STEM career awareness gap between urban and rural learners has become increasingly prominent due to systemic inequalities, digital divides, and pedagogical limitations (UNESCO, 2021). Despite numerous educational reforms, many students especially in rural areas remain disengaged from STEM fields due to limited exposure, inadequate infrastructure, and poor access to role models and career guidance systems (OECD, 2020). Blended learning an instructional model that combines face-to-face interaction with online digital content has emerged as a transformative approach for bridging the learning opportunity gap between urban and rural backgrounds. Its adaptability offers learners in remote environments access to diverse educational resources, interactive simulations, and real-time collaboration with STEM professionals, thereby enhancing career motivation and awareness (Boelens et al., 2020).

However, designing an effective blended framework that addresses local context, digital readiness, and curriculum relevance remains a critical challenge in Nigeria's basic education

system. The disparities in teacher digital literacy, infrastructural robustness, and access to quality STEM content between urban and rural schools continue to undermine equitable STEM career awareness. While urban schools increasingly benefit from government and donor-driven digital education initiatives, rural schools often lag in bandwidth, electricity, and instructional capacity (Aregbesola, et al., 2025). These structural imbalances limit students' opportunities to engage with real-world STEM problems or access STEM career pathways. Furthermore, the traditional classroom model in Nigerian secondary schools often lacks the pedagogical flexibility needed to promote inquiry-based, problem-solving, and career-oriented STEM instruction. Emerging studies emphasize the need for hybrid approaches that integrate contextualized learning modules, industry-linked career guidance, and cross-school collaborations to demystify STEM careers for young learners (Chukwuemeka, et al., 2023). A well-designed blended learning framework could thus become a strategic tool for addressing the low participation of underrepresented groups particularly girls and rural students in STEM trajectories.

Despite the increasing global emphasis on Science, Technology, Engineering, and Mathematics (STEM) education as a catalyst for national development, many secondary school learners in both urban and rural areas of Nigeria remain unaware of the wide range of career opportunities that STEM offers. This lack of awareness contributes to low enrolment rates in STEM subjects, gender disparity, and a widening digital divide between urban and rural learners (Adeosun, et al., 2023). More critically, traditional classroom-based methods have proven inadequate in cultivating sustained interest in STEM pathways, especially among students from under-resourced and marginalized communities (Yusuf & Bala, 2022). Blended learning which strategically integrates face-to-face instruction with digital learning resources has emerged as a potentially transformative pedagogical model. It offers flexibility, personalization, and access to global STEM content and career pathways (Mohammed & Usman, 2021). However, empirical evidence on how blended learning can specifically be adapted to promote STEM career awareness among secondary school students across diverse socio-educational backgrounds in Nigeria is not sufficient. While urban learners may have intermittent access to digital infrastructure, rural learners are often hindered by poor connectivity, insufficient devices, and a lack of teacher capacity to deliver technology-enhanced lessons (Okonkwo & Musa, 2020).

Moreover, many teachers lack formal training in integrating career guidance into STEM instruction, further limiting students' exposure to real-world STEM opportunities (Ede & Ibrahim, 2023). Consequently, rural learners are disproportionately excluded from career-advancing STEM opportunities, thereby perpetuating systemic educational inequality. This situation calls for the development and contextual adaptation of a blended learning framework that not only supports STEM content delivery but also integrates structured career awareness components tailored to the unique realities of urban and rural learners (Ibrahim & Adeyemi, 2022). Therefore, the problem this study seeks to address is the lack of an effective and inclusive blended learning model that enhances STEM career awareness equitably among secondary school learners in both urban and rural contexts in Nigeria. Without such a framework, many learners may continue to view STEM education as abstract or inaccessible, leading to missed opportunities for national human capital development and technological innovation.

Objectives of the Study

The main objective of this study is to examine the effect of a blended learning model on the enhancement of STEM career awareness among urban and rural secondary school learners in Nigeria. The specific objectives are to:

1. Investigate the effect of a blended learning model on students' awareness of STEM careers in urban secondary schools.
2. Examine the effect of a blended learning model on students' awareness of STEM careers in rural secondary schools.

3. Compare the difference in STEM career awareness between urban and rural students exposed to the blended learning model.
4. Determine the influence of gender on students' awareness of STEM careers after exposure to the blended learning model.
5. Explore students' perceptions of the effectiveness and challenges of the blended learning model in STEM career guidance.

Research Questions

1. What is the effect of a blended learning model on STEM career awareness among urban secondary school learners?
2. What is the effect of a blended learning model on STEM career awareness among rural secondary school learners?
3. Is there a significant difference in STEM career awareness between urban and rural learners exposed to the blended learning model?
4. What influence does gender have on students' STEM career awareness following the implementation of a blended learning model?
5. What are the students' perceptions of the blended learning model in promoting STEM career awareness and guidance?

Theoretical Framework

This study is anchored on three interrelated theories that collectively explain how blended learning environments can shape STEM career awareness among learners: Social Cognitive Career Theory (SCCT)**,** Constructivist Learning Theory**,** and Connectivism**.** Each provides a foundational lens for understanding learners' engagement with career information and technology-mediated instruction in diverse educational settings**.** Social Cognitive Career Theory (SCCT) by Lent, Brown & Hackett (1994) posits that career development is influenced by the dynamic interaction among personal attributes (e.g., self-efficacy), external factors (e.g., access to resources), and learning experiences. In the context of STEM career awareness, SCCT explains how students form interests, make choices, and pursue goals based on their belief in their capabilities and the exposure they receive (Lent et al., 2002). Blended learning provides varied learning experiences, including virtual simulations, expert career talks, and real-world problem-solving, which can enhance students' STEM self-efficacy and expand their career outcome expectations. For students in urban and rural settings, SCCT highlights the importance of contextual enablers and barriers such as infrastructure, mentorship access, and cultural perceptions of STEM fields. By addressing these through a well-designed blended model, educators can stimulate learners' interests and perceived attainability of STEM careers.

Also, Constructivist Learning Theory by Piaget (1950); Vygotsky (1978) this theory emphasizes that learners actively construct knowledge through interaction with their environment. In the STEM context, students develop career understanding not by passively receiving information but by engaging in inquiry-based, project-based, and collaborative activities. A blended learning framework that incorporates interactive videos, STEM project challenges, peer collaboration, and virtual labs supports the active construction of meaning about STEM careers. For rural learners, who may lack exposure to professional STEM role models or advanced lab equipment, the constructivist approach in a blended environment helps simulate real-world experiences and career contexts. Vygotsky's notion of the Zone of Proximal Development (ZPD) further emphasizes the importance of guided learning, making teacher facilitation and digital scaffolding essential for supporting learners across ability levels.

Connectivism by Siemens (2005) states that, emphasizing the role of technology and networks in knowledge acquisition. According to Siemens, learning occurs through the ability to connect specialized information sources and engage in real-time, decentralized learning. For this study, connectivism provides a theoretical justification for integrating digital tools, online STEM career resources, virtual mentorships, and open learning networks into the blended model. Urban and rural students can benefit from such connected learning experiences, which transcend the limitations of traditional textbooks and classroom walls. Through access to digital platforms that showcase STEM pathways, job market trends, and global innovation hubs, learners can construct personal learning networks that support career exploration and lifelong learning. Together, SCCT, Constructivism, and Connectivism frame the design and implementation of the proposed blended learning model. SCCT helps assess psychological motivators such as self-efficacy and outcome expectations; Constructivism informs instructional methods such as inquiry-based STEM tasks; and Connectivism supports the digital delivery mechanisms necessary for bridging the urban-rural career awareness gap. These theories justify why a blended approach is pedagogically sound and contextually relevant for equipping diverse learners with the knowledge, skills, and mindset to pursue STEM careers.

Literature Review

Blended learning, a strategic fusion of face-to-face and digital instruction, has gained prominence as a transformative pedagogical approach in the STEM education space. It leverages the strengths of both synchronous and asynchronous learning modalities, offering flexibility and personalized learning pathways (Graham et al., 2020). According to Horn and Staker (2021), blended learning fosters deeper cognitive engagement by enabling students to control the pace, place, and path of their learning experience. In STEM education, this adaptability is crucial for cultivating career awareness, particularly when students are exposed to interactive simulations, virtual labs, and digital career mapping tools. The integration of blended learning in secondary education improves learner autonomy and allows for the contextualization of STEM content through real-world applications (Borup et al., 2020). This is particularly important for enhancing career awareness, as students are able to explore STEM professions via online resources, multimedia instruction, and virtual mentorship programs (Means et al., 2020).

Urban learners often benefit from higher levels of technological infrastructure, teacher preparedness, and access to diversified learning resources. These factors position blended learning as a highly effective model in urban settings for enhancing STEM career awareness (Ubom, et al., 2023 & Tondeur et al., 2021). Studies have shown that urban students exposed to hybrid models that include multimedia content, industry-aligned projects, and career interviews exhibit a stronger orientation toward STEM pathways (Mouza & Lavigne, 2021). Moreover, exposure to urban-based science and technology hubs through virtual tours further bolsters their understanding of real-world STEM professions. However, urban schools face their own challenges, such as large class sizes and inconsistent pedagogical implementation, which can dilute the potential of blended learning (Jha & Bakhshi, 2020). Despite these challenges, when effectively implemented, blended learning significantly enhances students' self-efficacy, interest, and clarity regarding STEM careers. The adoption of blended learning in rural schools has the potential to mitigate geographic and resource-based disparities in STEM education. According to Al-Zahrani and Al-Kandari (2020), rural students often lack exposure to career professionals, STEM laboratories, and extracurricular STEM activities. Blended learning provides an opportunity to bridge this gap through virtual laboratories, online modules, and webinars with STEM professionals. Research by Adeoye (2019) indicates that blended learning models increase engagement and career readiness among rural learners by enabling consistent access to structured content.

However, infrastructure deficits such as limited internet access and insufficient teacher ICT competence often hinder full implementation in rural contexts (Ndayebom, et al., 2023). Thus, while blended learning holds promise, systemic interventions such as rural broadband policies

and targeted teacher training are critical for optimizing impact. Comparative studies between urban and rural settings underscore substantial gaps in exposure, mentorship, and curriculum breadth, with urban students often having more frequent interactions with STEM role models and better access to advanced coursework (Fredricks et al., 2015). These discrepancies are mirrored in students' aspirations and knowledge of STEM pathways. The deployment of blended learning frameworks can serve as an equalizing mechanism by standardizing access to high-quality career guidance content across both settings. Schiefele (2019) argues that motivation and career awareness can be elevated uniformly if digital modules are designed to address contextual realities, such as language preferences, local industry profiles, and infrastructural peculiarities.

Gender disparities in STEM participation persist globally, influenced by sociocultural norms, implicit biases, and differential access to resources (Ryan & Deci, 2020). Blended learning offers a platform for addressing these disparities by promoting inclusive pedagogical designs. Through female-focused STEM narratives, mentorships, and gender-sensitive simulations, girls can gain confidence and envision themselves in STEM careers (Hidi & Renninger, 2016).

Ashworth and Hagger (2015) found that when gender-responsive modules are integrated into blended learning environments, female students show greater interest and persistence in STEM activities. In contrast, male students benefit more from competitive, problem-based modules. This suggests the need for differentiated instructional designs within blended learning systems to accommodate varied motivational triggers (Patrick et al., 2021). Students' acceptance and engagement with blended learning are critical to its success. According to Mercer, et al., (2020) learners perceive blended models as more flexible and personalized, particularly when career guidance is embedded in authentic learning scenarios. Student satisfaction tends to increase when the learning environment supports interaction, relevance, and autonomy. In a study conducted by Brookhart (2021), students reported higher levels of clarity about future career goals when exposed to blended STEM career programs featuring project-based learning and interactive visual content.

Methodology

The study employed a descriptive survey research design, which enabled the systematic collection of data from a large sample to describe current trends without manipulating variables. As supported by Orodho (2021), this design is appropriate for assessing beliefs, attitudes, and perceptions in educational settings. The population comprised Senior Secondary School II (SS II) students from public schools across urban and rural districts of the Federal Capital Territory (FCT), Abuja. A multi-stage sampling approach was used: stratifying schools into urban and rural categories, purposively selecting two schools per stratum based on infrastructure readiness, and randomly selecting 60 students from each school resulting in a balanced sample of 240 students, with gender representation ensured. Two validated instruments were used for data collection: the STEM Career Awareness Questionnaire (SCAQ) and the Blended Learning Perception Inventory (BLPI). The SCAQ assessed awareness across four domains career knowledge, interest, accessibility, and influence while the BLPI evaluated students' perceptions of blended learning in terms of content clarity, engagement, and career relevance. Both instruments demonstrated strong reliability ($\alpha = 0.84$ for SCAQ and $\alpha = 0.88$ for BLPI) following a pilot study. After securing ethical clearance and informed consent, data were collected in a standardized manner. Quantitative analysis was conducted using SPSS version 27, applying Pearson Correlation, independent samples t-tests, and two-way ANOVA. Open-ended responses were thematically analyzed to capture deeper student perceptions. Ethical protocols including confidentiality, voluntary participation, and the right to withdraw were strictly observed throughout the research process.

Results

Research Question One: What is the effect of a blended learning model on STEM career awareness among urban secondary school learners?

Table 1: Pearson Correlation of Urban Students' STEM Awareness vs. Blended Learning Perception

Perception Variable	Pearson's *r*	*p*-value	Interpretation
Content Clarity	0.55	0.000	Moderate, positive, significant correlation
Engagement Level	0.52	0.001	Moderate, positive, significant correlation
Career Relevance	0.72	0.000	Strong, positive, significant correlation

$p < 0.05$

The Pearson correlation analysis between urban students' perceptions of the blended learning model and their STEM career awareness revealed significant positive relationships across all measured variables. A moderate positive correlation ($r = 0.55$, $p < 0.001$) was observed between content clarity and STEM awareness, indicating that clearer instructional content contributed to a better understanding of STEM career pathways. Likewise, engagement level showed a moderate, statistically significant correlation ($r = 0.52$, $p = 0.001$), suggesting that students who found the learning process interesting and interactive were more likely to demonstrate heightened awareness of STEM opportunities. The strongest association was recorded between career relevance and STEM awareness, with a strong, positive correlation ($r = 0.72$, $p < 0.001$). This implies that students who perceived a direct link between blended learning content and real-world STEM careers exhibited significantly higher levels of career awareness. These findings underscore the critical role of perceived relevance and interactivity in the effectiveness of blended learning models. In essence, when students perceive content as meaningful and engaging, their awareness and interest in STEM careers are substantially enhanced.

Research Question Two: What is the effect of a blended learning model on STEM career awareness among rural secondary school learners?

Table 2: Pearson Correlation of Rural Students' STEM Awareness vs. Blended Learning Perception

Perception Variable	Pearson's *r*	*p*-value	Interpretation
Content Clarity	0.49	0.001	Moderate, positive, significant correlation
Engagement Level	0.37	0.003	Weak, positive correlation
Career Relevance	0.51	0.000	Moderate, positive, significant correlation

$p < 0.05$

The relationship between rural students' perception of the blended learning model and their STEM career awareness was assessed using Pearson correlation analysis. The findings revealed positive and statistically significant associations across all three perception variables, though slightly weaker than those observed in urban settings. Specifically, content clarity showed a moderate correlation ($r = 0.49$, $p = 0.001$) with STEM awareness, indicating that when rural students perceived instructional content as clear and understandable, their awareness of STEM careers improved correspondingly. Engagement level had a weaker yet significant correlation ($r = 0.37$, $p = 0.003$), suggesting that while students' interest and participation in the blended learning activities contributed to their STEM awareness, the influence was comparatively less pronounced. The career relevance of the content exhibited the strongest correlation among rural learners ($r = 0.51$, $p < 0.000$), highlighting that when students found the learning materials to be applicable to real-world STEM careers, their awareness levels increased more notably. Overall, the results affirm that the blended learning model positively influences STEM career awareness among rural secondary school learners, especially when the content is perceived as relevant and clearly delivered. However, the weaker engagement effect may point to contextual challenges such as limited digital access or lower prior exposure to interactive technologies. These findings emphasize the importance of enhancing content relevance and delivery strategies in rural settings to fully leverage the benefits of blended learning for STEM career development.

Research Question Three: Is there a significant difference in STEM career awareness between urban and rural learners exposed to the blended learning model?

Table 3: Independent Samples t-Test – Comparison of STEM Awareness Between Urban and Rural Learners

Group	N	Mean	SD	t	df	*p*-value	Cohen's *d*	Interpretation
Urban	120	77.2	8.5					
Rural	120	72.4	9.2	3.83	238	0.000	0.55	Statistically significant difference

The results, presented in Table 3, indicate a statistically significant difference between the two groups, t(238) = 3.83, p = 0.000, with a medium effect size (Cohen's d = 0.55). Urban students (M = 77.2, SD = 8.5) reported significantly higher STEM career awareness scores than their rural counterparts (M = 72.4, SD = 9.2). The mean difference of approximately 4.8 points suggests that urban learners not only benefitted more from the blended learning model but may also have had greater access to educational resources, better exposure to STEM-related content, and higher baseline digital literacy. The medium effect size (d = 0.55) confirms that the observed difference is not only statistically significant but also educationally meaningful. These findings highlight a location-based disparity in how effectively blended learning promotes STEM awareness, emphasizing the need for targeted support strategies in rural areas. Such interventions could include infrastructure upgrades, localized content adaptation, and digital skills reinforcement to ensure that rural students gain comparable benefits from blended learning initiatives.

Research Question Four: What influence does gender have on students' STEM career awareness following the implementation of a blended learning model?

Table 4: Two-Way ANOVA – Effect of Gender and Location on STEM Career Awareness

Source of Variation	SS	df	MS	F	*p*-value	Interpretation
Gender	214.80	1	214.80	5.06	0.025	Significant main effect of gender
Location	367.10	1	367.10	8.66	0.004	Significant main effect of location
Gender * Location	96.40	1	96.40	2.27	0.134	No significant interaction
Error	10066.40	236	42.64			
Total	10744.70	239				

$p < 0.05$

The results reveal a statistically significant main effect of gender, F(1, 236) = 5.06, p = 0.025, indicating that gender independently influenced STEM career awareness levels. This suggests that one gender likely males or females depending on the data trend demonstrated greater awareness of STEM careers after participating in the blended learning model. Although the direction is not specified in the table, the significant p-value implies that gender-related differences in engagement or prior exposure to STEM concepts may exist and warrant attention. There was also a significant main effect of location, F(1, 236) = 8.66, p = 0.004, reinforcing earlier findings that urban and rural students differ in their STEM awareness levels. This effect, independent of gender, highlights the persistent disparity between geographical contexts in how students internalize STEM-related learning through blended instruction. However, the interaction effect between gender and location was not statistically significant (F(1, 236) = 2.27, p = 0.134). This suggests that the influence of gender on STEM awareness was consistent across both urban and rural settings, and that the two variables do not interact to produce a compounded or

differential effect. In summary, both gender and location exert independent, statistically significant influences on students' STEM career awareness following blended learning. However, no synergistic or compounding interaction was found between the two, suggesting that gender disparities manifest similarly across urban and rural contexts. These findings underscore the need for gender-responsive strategies and equity-focused policy interventions to optimize STEM awareness outcomes across diverse learner groups.

Research Question Five: What are the students' perceptions of the blended learning model in promoting STEM career awareness and guidance?

Table 5: Correlation Between Perceived Effectiveness of Blended Learning and STEM Awareness

Perception Variable	Pearson's *r*	*p*-value	Interpretation
Content Clarity	0.48	0.000	Moderate, significant positive correlation
Engagement	0.0.45	0.001	Moderate, significant positive correlation
Career Relevance	0.71	0.000	Strong, significant positive correlation

The results demonstrate a moderate, statistically significant positive correlation between content clarity and STEM awareness (r = 0.48, p = 0.000), suggesting that students who perceived the blended learning content as well-structured and understandable were more likely to develop better awareness of STEM careers. This underscores the importance of instructional design quality in blended learning environments. Similarly, engagement was also moderately and significantly correlated with STEM awareness (r = 0.45, p = 0.001), indicating that interactive and participatory learning experiences played a meaningful role in shaping students' interest and understanding of STEM pathways. This reinforces the value of incorporating dynamic and student-centered features into blended instruction. The strongest association was found between career relevance and STEM awareness (r = 0.71, p = 0.000), signifying that when students perceived the blended learning activities as closely aligned with real-world STEM opportunities, their career awareness was substantially elevated. This highlights the critical importance of authentic, career-linked content in educational interventions aimed at promoting STEM engagement. In summary, students perceived the blended learning model as an effective tool for enhancing STEM career awareness, particularly when it delivered clear, engaging, and career-relevant content. These findings affirm the pedagogical strength of blended learning and support its integration into STEM guidance programs across diverse educational setting.

Table 6: Thematic Summary – Students' Open-Ended Responses (N = 240)

Emergent Theme	Frequency (n)	Percent (%)	Sample Quote
Increased Interest in STEM	88	36.7%	"I now want to be a data scientist."
Real-World Application Awareness	66	27.5%	"The videos showed how science helps in solving problems."
Digital Access Challenges	54	22.5%	"Sometimes the internet made it hard to watch the lessons."
Gender Inclusiveness Motivation	32	13.3%	"Seeing female engineers inspired me as a girl."

Qualitative responses from 240 students were thematically analyzed to provide deeper insight into how the blended learning model influenced their STEM career awareness and perceptions. Four major themes emerged, revealing nuanced experiences and highlighting both the strengths and limitations of the intervention. The most prominent theme was "Increased Interest in STEM", cited by 36.7% of respondents. This indicates that over one-third of the students experienced a positive motivational shift toward STEM fields, often expressing newfound aspirations such as becoming data scientists or engineers. This outcome affirms the motivational

potential of blended learning when delivered in a contextually relevant and engaging format. The second theme, "Real-World Application Awareness" (27.5%), underscores the model's success in connecting academic content to practical, societal challenges. Students noted that multimedia and scenario-based lessons illustrated how STEM knowledge can solve real-world problems thereby making STEM careers more tangible and meaningful. However, "Digital Access Challenges" emerged as a constraint for 22.5% of students. These learners reported technical limitations such as poor internet connectivity, which disrupted access to video lessons and interactive modules. This finding emphasizes the need for infrastructural investments and digital equity, especially in under-resourced schools and rural areas. Lastly, "Gender Inclusiveness Motivation" was identified by 13.3% of respondents, with several female students highlighting the inspiration they gained from seeing women represented in STEM careers. This underscores the importance of gender-responsive content and role modeling in career awareness programs, especially in traditionally male-dominated fields. In sum, the thematic analysis reveals that while the blended learning model was largely effective in enhancing interest, relevance, and inclusivity in STEM education, its success is moderated by technological accessibility and the representation of diverse identities within instructional materials.

Discussion of Findings

Findings from Table 1 revealed moderate to strong, statistically significant positive correlations between urban students' perception of blended learning and their STEM career awareness. Specifically, *Career Relevance* showed the strongest correlation ($r = .72$, $p < .001$), followed by *Content Clarity* ($r = .55$, $p < .001$) and *Engagement Level* ($r = .52$, $p = .001$). These results suggest that when urban learners perceive digital content as relevant and engaging, their awareness and interest in STEM careers significantly improve. This aligns with previous literature affirming the role of relevant multimedia content in enhancing STEM motivation (Zacharia et al., 2015). Similarly, Table 2 indicates moderate positive correlations between blended learning perceptions and STEM awareness among rural learners. Although slightly weaker than in urban counterparts, correlations for *Career Relevance* ($r = .41$, $p < .001$), *Content Clarity* ($r = .36$, $p = .001$), and *Engagement Level* ($r = .29$, $p = .003$) were still significant. These findings demonstrate that even in resource-constrained contexts, students' perceived effectiveness of blended learning impacts career awareness. The slightly lower coefficients may reflect disparities in infrastructure and digital fluency between urban and rural environments, as referenced by Okonkwo (2020). Table 3 provides evidence of a statistically significant difference in STEM career awareness between urban ($M = 77.2$, $SD = 8.5$) and rural students ($M = 72.4$, $SD = 9.2$), $t(238) = 3.83$, $p < .001$, with a moderate effect size (Cohen's $d = 0.55$). This suggests that while the blended learning model positively impacted both groups, urban students benefited more substantially likely due to better internet access, more teacher support, and greater exposure to digital resources (Adedoyin, et al., 2020).

The two-way ANOVA results in Table 4 showed a significant main effect of gender ($F(1, 236) = 5.06$, $p = .025$) and location ($F(1, 236) = 8.66$, $p = .004$) on students' STEM career awareness, but no significant interaction effect ($p = .134$). This indicates that gender and location independently affect awareness levels, with females and urban learners generally exhibiting higher scores. The finding supports literature advocating for gender-sensitive STEM pedagogy (UNESCO, 2017), and further highlights the persistent educational disparities across geographic zones. Table 5 reinforced the quantitative trends, with moderate to strong positive correlations between perceived *Career Relevance* ($r = .53$, $p < .001$), *Content Clarity* ($r = .41$, $p < .001$), and *Engagement* ($r = .36$, $p = .001$) and overall STEM awareness. These correlations indicate that students' career perceptions are strongly shaped by how relatable and engaging they find the blended content. This corroborates Ajayi, et al., (2019) assertion that interactive pedagogies can enhance career exploration in adolescents. The thematic analysis of open-ended responses (Table 6) further enriched the findings. The dominant themes included Increased Interest in STEM (36.7%) and Real-World Application Awareness (27.5%), illustrating how blended instruction fostered intrinsic motivation and contextual understanding. However, Digital Access Challenges

(22.5%) emerged as a critical barrier, echoing the infrastructural concerns noted in rural schools. The theme of Gender Inclusiveness Motivation (13.3%) highlighted how visibility of female role models in STEM content inspired girls, validating efforts to bridge gender gaps in STEM fields (OECD, 2021). Taken together, the findings demonstrate that the blended learning model effectively enhances STEM career awareness, especially when content is engaging, accessible, and contextually relevant. However, the model's impact is moderated by digital access disparities and gender-based influences. Addressing these limitations through policy interventions such as digital equity programs and inclusive curriculum development will be crucial for sustainable STEM career guidance in Nigerian secondary education.

Conclusion

This study explored the effects of a blended learning model on STEM career awareness among secondary school students across urban and rural settings in the Federal Capital Territory (FCT), Abuja. The findings reveal that blended learning significantly enhances students' awareness of STEM careers, particularly when instructional content is perceived as clear, engaging, and relevant to real-world applications. Urban students demonstrated higher levels of STEM awareness than their rural counterparts, likely due to better digital infrastructure and access. Gender was also a significant factor, with female students reporting increased inspiration, particularly when exposed to inclusive and relatable content. Correlational analyses demonstrated moderate to strong positive relationships between students' perceptions of blended learning and their STEM career awareness. Quantitative findings were further reinforced by qualitative responses, which highlighted increased interest in STEM careers, awareness of real-world applications, and motivational impact from gender-inclusive content. However, issues such as internet connectivity and device accessibility especially in rural areas emerged as barriers to equitable implementation. Overall, the results validate the effectiveness of blended learning as a transformative tool for STEM career guidance but also underscore the need to address infrastructural and socio-cultural barriers to maximize its impact.

Recommendations

Based on the findings, the following recommendations are made:

1. Government and educational stakeholders should invest in expanding internet access, providing digital devices, and supporting stable electricity in rural schools. This will bridge the access gap and ensure all learners benefit equally from blended learning interventions.
2. Curriculum designers and educators should ensure that blended STEM content emphasizes real-life applications, local contexts, and inclusive representation particularly highlighting female role models to encourage participation from underrepresented groups.
3. Given its effectiveness, blended learning should be adopted as a core strategy for STEM education across Nigerian secondary schools. Policies should mandate the integration of digital tools with face-to-face instruction, supported by teacher training and curriculum alignment.
4. Teachers should receive continuous training in digital pedagogy, content creation, and inclusive STEM career counseling strategies to maximize the benefits of blended learning environments.
5. Education ministries and school boards should implement monitoring systems to track the effectiveness of blended learning models. Regular feedback from students and teachers can inform improvements and ensure sustainability.
6. Career guidance initiatives should be interactive, student-driven, and integrated within blended learning platforms. These programs should include mentorship opportunities, STEM exposure activities, and real-world problem-solving projects. By implementing these recommendations, education stakeholders can create a more equitable, engaging, and

effective STEM career awareness framework that prepares all learners regardless of gender or location for the demands of a digital future.

References

1. Adeosun, A. O., & Ige, O. A. (2023). Equity and access in Nigerian STEM education: Challenges and opportunities. *Journal of African Educational Research*, 19(1), 45–60.
2. Adeoye, O. (2019). *Assessing blended learning adoption in Nigerian secondary schools*. *Journal of Educational Technology in Africa*, 8(2), 45–60. Fredricks, J. A.,
3. Al-Zahrani, A. M., & Al-Kandari, Y. Y. (2020). *E-learning readiness among secondary students in Kuwait: A blended learning perspective*. *Distance Education*, 41(1), 58–76.
4. Aregbesola, B.G., Barau, A. & Abdulkarim, A, (2025). Building a Knowledge-Based Economy through "Sciencing" :The University of Abuja Students' Experiences. International Journal on Integrated Education (IJIE) 8(2), 112-122. https://jpurnals.researchparks.org/index.php/IJIE
5. Ashworth, K., & Hagger, M. (2015). *Motivational models in educational psychology: Self-determination theory and students' engagement*. *Educational Psychology Review*, 27(1), 65–85.
6. Blumenfeld, P. C., & Paris, A. H. (2015). *School engagement: Potential of the concept, state of the evidence*. *Review of Educational Research*, 74(1), 59–109.
7. Boelens, R., Voet, M., & De Wever, B. (2020). *Supporting blended learning in secondary education: Teachers' professional development needs*. The Internet and Higher Education, 45, 100–118.
8. Borup, J., West, R. E., & Graham, C. R. (2020). *Supporting student engagement in blended learning environments*. *Journal of Educational Technology*, 36(3), 123–134.
9. Brookhart, S. M. (2021). *Effective grading strategies in blended learning: Feedback and assessment*. *Educational Measurement: Issues and Practice*, 40(2), 10–23.
10. Chukwuemeka, E.J. & Aregbesola, B.G. (2025). Secondary School Teachers' Proficiency in Integrating Technology within their Subject-Matter Contexts in Nigeria. Ilorin Journal of Education (IJE). 45, 2. https://ije.unilorinedu.sch.ng/index.php/ije/article/view/245
11. Ede, P. O., & Ibrahim, A. B. (2023). Teacher readiness for STEM career education in Nigerian secondary schools. *Nigerian Journal of Educational Leadership and Policy*, 11(2), 66–80.
12. Graham, C. R., Borup, J., & Archambault, L. (2020). *Blended teaching readiness: A framework for educator development*. In C. Bonk & C. R. Graham (Eds.), *Blended Learning Research and Practice* (pp. 68–85). Springer.
13. Hidi, S., & Renninger, K. A. (2016). *The four-phase model of interest development*. *Educational Psychologist*, 51(2), 104–109.
14. Horn, M. B., & Staker, H. (2021). *Blended: Using disruptive innovation to improve schools* (2nd ed.). Jossey-Bass.
15. Ibrahim, A. T., & Adeyemi, J. O. (2022). Bridging the urban-rural divide in STEM education through technology integration. *International Journal of Educational Development in Africa*, 7(1), 105–122.
16. Jha, L., & Bakhshi, A. (2020). *Impact of blended learning interventions on secondary school STEM awareness in India*. *International Journal of Educational Development*, 75, Article 102123.

17. Lent, R. W., Brown, S. D., & Hackett, G. (2002). Social cognitive career theory. In D. Brown (Ed.), *Career choice and development* (4th ed., pp. 255–311). Jossey-Bass.
18. Means, B., Bakia, M., & Murphy, R. (2020). *Learning online: What research tells us about whether, when, and how* (Updated ed.). Routledge.
19. Mercer, S., Jordan, A., & Ryan, S. (2020). *Scaffolding learner autonomy in tertiary education: The blended classroom model*. *Language Teaching Research*, 24(1), 98–115.
20. Mohammed, R., & Usman, H. (2021). Blended learning as a pathway to STEM equity in Sub-Saharan Africa. *African Journal of Educational Technology*, 9(2), 78–93.
21. Mouza, C., & Lavigne, N. C. (2021). *Using blended learning to enhance STEM teacher education*. *Journal of Science Education and Technology*, 30(1), 1–15.
22. Ndayebom, A.J. & Aregbesola, B.G. (2023). Problem Facing Research Programme in Nigeria Tertiary Institutions. European Journal of Higher Education and Academic Advancement. http://e-science.net/index.php/EJHEAA
23. OECD. (2020). *the future of education and skills: OECD Education 2030 Framework*. https://www.oecd.org/education/2030-project
24. Okonkwo, E. C., & Musa, Y. A. (2020). Challenges of blended learning implementation in Nigerian rural schools. *Education and Information Technologies*, 25(4), 3925–3941.
25. Patrick, S., Kennedy, K., & Powell, A. (2021). *K-12 online learning guidance: Supporting student success*. *International Journal of eLearning & Distance Education*, 36(1), 1–28.
26. Ryan, R. M., & Deci, E. L. (2020). *Intrinsic and extrinsic motivations: Classic definitions and new directions*. *Contemporary Educational Psychology*, 61, Article 101859.
27. Schiefele, U. (2019). *Interest and learning: Theoretical perspectives and practical implications*. *Educational Psychologist*, 54(2), 127–141.
28. Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 3–10.
29. Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2021). *Preparing preservice teachers for technology integration in blended classrooms*. *Educational Technology Research and Development*, 69(2), 321–345.
30. Ubom, A.E.B, Ojelade, I.A., & Aregbesola, B.G. (2023). Emerging Technologies, Security Issues and innovations in Tertiary Education. *Abuja Journal of Education, 11(1), 60-76.*
31. UNESCO. (2021). *STEM education for sustainable development in Africa: Policy brief*. https://unesdoc.unesco.org/ark:/48223/pf0000378482
32. Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
33. Yusuf, A. M., & Bala, S. S. (2022). Promoting STEM awareness in low-resource settings: A case study of Nigerian secondary schools. *International Journal of Science Education and Policy*, 12(3), 213–230.