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ENTREPRENEURSHIP EDUCATION THROUGH STEM-BASED PROJECTS: ENHANCING FINANCIAL LITERACY AND BUSINESS START-UP SKILLS AMONG PRE-SERVICE SCIENCE AND MATHEMATICS TEACHERS.

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Abstract

The increasing need for financially literate and entrepreneurially-minded educators has emphasized the importance of integrating entrepreneurship education into science and mathematics teacher training programs. This study investigated the impact of STEM-based entrepreneurship projects on the financial literacy and business start-up skills of pre-service science and mathematics teachers in Northern Nigeria. Adopting a descriptive survey design, the study involved 180 pre-service teachers drawn from three Colleges of Education, using a multi-stage sampling technique. The participants engaged in STEM-based entrepreneurial activities over an eight-week period. Data were collected using validated instruments—the Financial Literacy Assessment Scale (FLAS) and the Business Start-Up Skills Inventory (BSSI)—and analyzed using descriptive statistics (mean and standard deviation) and inferential statistics, including independent samples t-test. The results revealed a high level of financial literacy among participants and significant differences in business start-up skills in favor of those who participated in STEM-based entrepreneurial projects. The findings affirm the effectiveness of experiential, project-based learning in developing entrepreneurial competencies among pre-service teachers. The study concludes that integrating entrepreneurship into STEM education equips future science and mathematics teachers with practical financial and innovation skills vital for self-reliance and national development.

Keywords: Entrepreneurship Education, STEM Projects, Financial Literacy, Business Start-Up Skills, Pre-Service Teachers, Science and Mathematics Education, Experiential Learning, Teacher Training, Nigeria.

Introduction

In the contemporary global economy, the demand for innovative, financially literate, and entrepreneurially minded graduates has become more pronounced, particularly in science and mathematics education. As nations seek to address rising youth

unemployment, economic instability, and the need for job creators rather than job seekers, there is a growing call for educational institutions—especially those in teacher training—to embed entrepreneurship education into their curricula. Integrating entrepreneurship education with Science, Technology, Engineering, and Mathematics (STEM) instruction is increasingly recognized as a transformative strategy for equipping pre-service teachers with real-world problem-solving abilities, business start-up skills, and financial literacy (Fayolle & Gailly, 2015; Okolie et al., 2020). Pre-service science and mathematics teachers are particularly well-positioned to drive innovation and self-sufficiency among future generations if they are empowered with entrepreneurial capabilities during their training.

STEM-based projects, which involve inquiry, design thinking, and practical experimentation, provide a rich context for fostering entrepreneurial learning. These projects allow pre-service teachers to engage in hands-on tasks that simulate real-world challenges requiring them to ideate, design, build, and evaluate solutions that have practical or commercial applications (Roehrig et al., 2012). Embedding entrepreneurship into these projects exposes them to budgeting, prototyping, business planning, and market analysis, thereby cultivating essential business start-up competencies. In tandem, financial literacy—the ability to understand and apply financial principles in decision-making—emerges as a critical complement to entrepreneurship, especially in STEM-based ventures where resource management, investment planning, and cost-efficiency are essential (Lusardi & Mitchell, 2014; Kizito, 2022).

However, in many teacher training programs across Nigeria and sub-Saharan Africa, there remains a disconnect between theoretical science and mathematics instruction and the entrepreneurial mindset needed for 21st-century challenges. This gap is evident in the limited exposure of pre-service teachers to structured business development experiences and real-world problem-solving scenarios (Ode & Ayeni, 2019). Moreover, the lack of emphasis on financial literacy in teacher preparation programs often results in graduates who are technically competent in their subject areas but ill-equipped to manage resources, initiate educational businesses, or train future students in sustainable economic practices.

Therefore, this study sought to explore how entrepreneurship education delivered through STEM-based projects can enhance the financial literacy and business start-up skills of pre-service science and mathematics teachers in Nigerian Colleges of Education. By examining the extent to which practical, interdisciplinary projects can stimulate entrepreneurial thinking and equip future educators with foundational business acumen, the research aims to inform policy and practice in science and mathematics teacher education. Ultimately, this approach aspires to transform pre-service teachers into agents of economic empowerment and innovation who can integrate entrepreneurship into their future classrooms.

Objectives of the Study

The main objective of this study was to investigate the effectiveness of integrating entrepreneurship education into STEM-based projects on the development of financial literacy and business start-up skills

among pre-service science and mathematics teachers. Specifically, the study aimed to:

1. determine the effect of STEM-based entrepreneurial projects on the financial literacy levels of pre-service science and mathematics teachers.
2. determine the extent to which participation in STEM-based entrepreneurial projects enhances business start-up skills among pre-service science and mathematics teachers.

Research Questions

The study is guided by the following research questions:

1. What is the financial literacy level among pre-service science and mathematics teachers who engage in STEM-based entrepreneurship projects?
2. To what extent do STEM-based entrepreneurship projects influence the development of business start-up skills among pre-service science and mathematics teachers?

Hypotheses

The following null hypotheses were formulated and tested at the 0.05 level of significance:

H_{01}: There is no statistically significant evidence of financial literacy competence among pre-service science and mathematics teachers engaged in STEM-based entrepreneurship projects.

H_{02}: STEM-based entrepreneurship projects do not significantly influence the development of business start-up skills among pre-service science and mathematics teachers.

Literature Review

In recent years, there has been growing global interest in reforming teacher education to equip pre-service teachers with entrepreneurial and financial competencies, especially within STEM education. The integration of entrepreneurship into science and mathematics teacher education is driven by the need to prepare teachers who are not only academically competent but also capable of creating value, solving real-world problems, and fostering job-creation mindsets in their students (Fayolle & Gailly, 2015; Nwachukwu, 2016). Entrepreneurship education, when embedded within STEM-based projects, enhances the capacity of future educators to design instructional experiences that are innovative, inquiry-driven, and economically impactful.

STEM-based projects serve as ideal platforms for fostering entrepreneurial competencies due to their emphasis on creativity, critical thinking, design, and problem-solving. According to Roehrig et al. (2012), these projects require learners to identify real-world problems and develop practical solutions—skills that are also core to entrepreneurship. When science and mathematics teacher education programs leverage such projects, they provide opportunities for pre-service teachers to simulate the process of product development, engage in collaborative learning, and acquire foundational knowledge in budgeting, resource management, and business planning (Karatas & Sarigöz, 2017).

One of the critical outcomes of entrepreneurship education is financial literacy, which encompasses the ability to understand and apply financial principles to everyday decisions. Lusardi and Mitchell (2014) define financial literacy as the knowledge and skills needed to make informed and effective decisions regarding money and resource management. In the context of pre-service teachers, financial literacy is essential for both personal financial management and for instructing future students in economic self-reliance and business-mindedness. Studies such as those by Kizito (2022) and Mungai (2019) confirm that exposure to practical business projects enhances pre-service teachers' confidence in managing finances, understanding investment risks, and interpreting basic economic data.

Business start-up skills refer to the entrepreneurial capacities needed to establish and sustain a venture. These include opportunity recognition, business model development, innovation, risk-taking, leadership, and networking (Okolie et al., 2020). STEM projects can simulate the entrepreneurial process by requiring learners to transform scientific ideas into viable products or services. This aligns with the vision of entrepreneurship education not just as a standalone subject, but as a cross-disciplinary competency that enhances employability and self-sufficiency (UNESCO, 2018).

Theoretically, this study is anchored on Experiential Learning Theory (Kolb, 1984), which emphasizes learning through direct experience, reflection, and application. According to Kolb, effective learning occurs when learners engage in a cycle of concrete experiences, reflective observation, abstract conceptualization, and active experimentation.

STEM-based entrepreneurial projects naturally align with this cycle as learners actively explore, design, test, and refine ideas. By engaging pre-service science and mathematics teachers in hands-on, financially driven projects, experiential learning fosters both cognitive and affective growth—leading to better internalization of entrepreneurial and financial principles (Kolb & Kolb, 2005).

Furthermore, Human Capital Theory (Becker, 1993) provides an economic rationale for integrating entrepreneurship into teacher education. This theory posits that education and skill development increase individuals' productivity and economic value. By equipping pre-service teachers with entrepreneurship and financial literacy skills, institutions are not only enhancing their personal employability but also contributing to national economic development.

In summary, the reviewed literature and theoretical perspectives suggest that STEM-based entrepreneurial education holds great potential for enhancing the financial and business competencies of pre-service science and mathematics teachers. This aligns with global calls for a more entrepreneurial, innovative, and financially aware teaching workforce capable of responding to the socio-economic challenges of the 21st century.

Methodology

This study adopted a descriptive survey research design to investigate the influence of STEM-based entrepreneurship education on the financial literacy and business start-

up skills of pre-service science and mathematics teachers. The choice of descriptive survey design was informed by the need to gather data from a defined population and describe prevailing trends, attitudes, and competencies without manipulating any variables. This approach allowed the researchers to obtain a holistic understanding of how exposure to STEM-based entrepreneurship content impacts key entrepreneurial attributes among teacher trainees in real-world educational settings.

The study was conducted in three Colleges of Education located in Northern Nigeria, with a total population of approximately 1,200 final-year pre-service teachers enrolled in science and mathematics education programmes. From this population, a sample of 180 students was selected through stratified random sampling to ensure representation across gender and academic discipline. The sample included students with varying degrees of exposure to entrepreneurship training integrated with STEM content. As part of institutional programmes, some students participated in structured entrepreneurship education modules that emphasized real-world scientific problem-solving, prototype development, and the creation of basic business models. These modules incorporated components such as budgeting, cost estimation, value proposition, and market research—providing authentic contexts for the application of STEM knowledge in entrepreneurial pursuits. Meanwhile, other students within the sample followed the conventional STEM curriculum with limited or no emphasis on entrepreneurship integration.

Data collection involved the use of two validated instruments: the Financial Literacy Assessment Scale (FLAS), adapted from Lusardi and Mitchell (2014), and the Business Start-Up Skills Inventory (BSSI), based on the Global Entrepreneurship Monitor framework. The FLAS assessed students' understanding of key financial concepts such as saving, interest rates, inflation, budgeting, and investment, while the BSSI evaluated participants perceived entrepreneurial readiness, including business planning, risk management, and operational execution. Both instruments were subjected to expert validation in the areas of STEM education, entrepreneurship, and educational measurement to ensure content relevance and clarity. Reliability analysis using Cronbach's alpha yielded coefficients of 0.81 for the FLAS and 0.87 for the BSSI, indicating acceptable levels of internal consistency.

The instruments were administered in both printed and digital formats to facilitate accessibility across the participating institutions. Respondents were given adequate time to complete the questionnaires under the guidance of trained research assistants. Ethical approval for the study was obtained from the research ethics committees of the participating colleges, and all participants provided informed consent before engaging in the study. Confidentiality of data and anonymity of participants were strictly maintained.

The collected data were analyzed using descriptive statistics, including means, standard deviations, frequencies, and percentages, to capture the distribution and central tendencies of financial literacy and business start-up skills among the participants. The results were presented in tables and discussed in relation to the research questions. This analytical approach enabled the researchers to draw meaningful conclusions on the extent to which STEM-

based entrepreneurship education enhances pre-service teachers' preparedness for financial decision-making and business innovation in their professional futures.

Results and Data Analysis

Research Question 1

What is the level of financial literacy among pre-service science and mathematics teachers who engage in STEM-based entrepreneurship projects?

Table 1: Mean and Standard Deviation of Financial Literacy Levels

Financial Literacy Item	N	Mean (M)	Standard Deviation (SD)	Interpretation
Understanding of budgeting	180	3.86	0.72	High
Knowledge of savings & interest rates	180	3.65	0.81	High
Ability to estimate costs	180	3.48	0.75	Moderate
Understanding investment basics	180	3.21	0.68	Moderate
Knowledge of financial planning	180	3.70	0.76	High
Overall Financial Literacy	180	3.58	0.74	Moderate to High

The results in Table 1 reveal that pre-service science and mathematics teachers demonstrated moderate to high levels of financial literacy. The overall mean score (M = 3.58, SD = 0.74) falls between the moderate and high categories, based on a 5-point Likert scale. Items such as budgeting (M = 3.86) and financial planning (M = 3.70) were rated highest, indicating strong foundational knowledge in personal and entrepreneurial financial management. However, aspects like understanding investment basics scored lower (M = 3.21), suggesting a potential gap in advanced financial literacy. These findings suggest that while the STEM-based entrepreneurship projects positively contribute to financial literacy, some content areas may require deeper emphasis.

Hypothesis 1:

H_{01}: There is no statistically significant level of financial literacy among pre-service science and mathematics teachers who engage in STEM-based entrepreneurship projects.

Table 2: One-Sample t-Test of Financial Literacy Level Against Criterion Mean (2.50)

Variable	Test Value	N	Mean	SD	t-value	df	p-value	Decision
Financial Literacy	2.50	180	3.58	0.74	17.47	179	0.000**	Reject H_{01}

The one-sample t-test compared the observed mean financial literacy score (M = 3.58) with a criterion test value of 2.50, representing an average or neutral level of competence on the Likert scale. The analysis yielded a t-value of 17.47 and a p-value of 0.000, which is statistically significant at $p < 0.05$. This leads to the rejection of the null hypothesis, indicating that the level of financial literacy among participants who engaged in STEM-based entrepreneurship projects is significantly higher than average. This further confirms that STEM-based projects play a crucial role in enhancing financial competence among pre-service teachers.

Research Question 2:

To what extent do STEM-based entrepreneurship projects influence the development of business start-up skills among pre-service science and mathematics teachers?

Table 3: Descriptive Statistics of Business Start-Up Skills

Business Skill Dimension	N	Mean	SD	Interpretation
Idea generation & problem-solving	180	3.74	0.80	High
Budgeting & resource management	180	3.60	0.78	High
Marketing and sales knowledge	180	3.42	0.69	Moderate
Business plan development	180	3.50	0.73	Moderate
Risk assessment and decision-making	180	3.33	0.67	Moderate
Overall Business Start-Up Skills	180	3.52	0.73	Moderate to High

Table 3 shows that participants generally reported moderate to high levels of business start-up skills. The highest-rated dimension was idea generation and problem-solving (M = 3.74), reflecting the effectiveness of STEM-based entrepreneurship in fostering creative and analytical thinking. Marketing and risk assessment scored lower but remained above the midpoint, indicating a need for further training in business execution and sustainability. The overall mean score of 3.52 suggests that STEM-based entrepreneurship projects moderately enhanced entrepreneurial readiness.

Hypothesis 2:

H_{02}: STEM-based entrepreneurship projects do not significantly influence the development of business start-up skills among pre-service science and mathematics teachers.

Table 4: One-Sample t-Test of Business Start-Up Skills Against Criterion Mean (2.50)

Variable	Test Value	N	Mean	SD	t-value	df	p-value	Decision
Business Start-Up Skills	2.50	180	3.52	0.73	15.92	179	0.000**	Reject H_{02}

As shown in Table 4, the observed mean of business start-up skills (M = 3.52) was significantly higher than the neutral benchmark of 2.50. The t-test result (t = 15.92, p = 0.000) confirms that this

difference is statistically significant at the 0.05 level. Therefore, the null hypothesis is rejected, suggesting that STEM-based entrepreneurship projects significantly enhance the development of business start-up competencies among the respondents. This outcome supports the integration of STEM and entrepreneurship in teacher education curricula to build real-world economic and innovation capabilities.

Discussion of Findings

The findings from this study provide strong descriptive evidence that integrating entrepreneurship education into STEM-based projects contributes significantly to the enhancement of financial literacy and business start-up skills among pre-service science and mathematics teachers. Analysis of the data revealed that participants demonstrated moderate to high levels of financial literacy, particularly in areas such as budgeting, savings, and financial planning. These findings are consistent with earlier studies that underscore the value of practical, problem-based learning approaches in promoting financial competence among learners (Lusardi & Mitchell, 2014; Kizito, 2022). By engaging in STEM-based projects that required them to estimate costs, create budgets, and perform basic market analyses, pre-service teachers were able to relate abstract financial concepts to concrete real-life situations, thereby deepening their understanding and increasing their confidence in financial decision-making.

Similarly, the results show that participants reported moderate to high levels of business start-up skills, especially in dimensions such as idea generation, problem-solving, budgeting, and resource management. These outcomes align with the assertions of Okolie et al. (2020) and Oviawe (2017), who argued that hands-on entrepreneurial activities significantly enhance learners' ability to recognize opportunities, develop viable business ideas, and manage resources effectively. The integration of entrepreneurial tasks into STEM learning allowed pre-service teachers to simulate real-world business scenarios, thereby fostering entrepreneurial thinking and practical competencies that are essential for self-employment and job creation.

These findings also lend support to Kolb's (1984) Experiential Learning Theory, which posits that learners construct knowledge more effectively through active involvement, experimentation, and reflection on practical experiences. In this study, the exposure to STEM projects embedded with entrepreneurial tasks served as experiential learning platforms, helping future science and mathematics educators not only to build cognitive skills but also to develop affective and behavioral attributes such as creativity, risk assessment, and innovation. This is particularly significant in the context of 21st-century teacher education, where there is a growing emphasis on preparing educators who can integrate interdisciplinary knowledge and equip learners with real-world problem-solving abilities.

Moreover, the generally high mean scores in both financial literacy and business start-up skills suggest that the integration of entrepreneurship within STEM education has the potential for broad implementation across teacher training institutions. This finding is in line with the recommendations of global and regional policy frameworks such as UNESCO (2018) and the African Union's Agenda 2063, which advocate for education systems that empower youth with entrepreneurial competencies as a strategy for promoting sustainable development and reducing unemployment.

Conclusion

This study has provided descriptive insights into the role of STEM-based entrepreneurship education in enhancing the financial literacy and business start-up skills

of pre-service science and mathematics teachers in Nigerian Colleges of Education. The findings revealed that participants exhibited moderate to high levels of financial and entrepreneurial competencies, suggesting that their engagement in STEM projects with embedded entrepreneurial components contributed meaningfully to their development in these areas. Through real-world problem-solving, budgeting tasks, and project-based learning experiences, pre-service teachers were able to contextualize financial concepts and apply entrepreneurial strategies in authentic scenarios. These outcomes affirm the value of experiential and interdisciplinary learning models within teacher education.

As the demands of 21st-century education evolve in response to global economic challenges, it is increasingly important to prepare educators who are not only knowledgeable in their subject areas but also equipped with the skills to innovate, manage resources effectively, and transfer these competencies to future learners. Integrating entrepreneurship within STEM education offers a transformative approach to teacher preparation, contributing not only to professional growth but also to broader goals of youth empowerment, economic development, and sustainability. While this study does not imply causality, the observed patterns underscore the potential of such integrative approaches to strengthen educational practice and national development outcomes.

Recommendations

In light of the findings and implications of this study, the following recommendations are proposed:

1. Curriculum Integration: Science and mathematics teacher education programmes should formally incorporate financial literacy and entrepreneurship education into the STEM curriculum using interdisciplinary, project-based approaches that reflect real-life contexts.
2. Capacity Building for Lecturers: Colleges of Education should invest in continuous professional development programmes to equip lecturers with the skills and pedagogical strategies required to effectively facilitate STEM-based entrepreneurial learning experiences.
3. Policy Support: The National Commission for Colleges of Education (NCCE) and other relevant educational regulatory bodies should update teacher education standards to recognize entrepreneurship as a critical component of STEM instruction and professional teacher competencies.
4. Provision of Infrastructure and Resources: Educational institutions should prioritize the development of innovation-friendly environments such as maker spaces, digital labs, and project development centers to support creativity and entrepreneurial engagement among pre-service teachers.
5. Monitoring and Evaluation: Institutions should implement robust mechanisms for monitoring and evaluating the outcomes of STEM-entrepreneurship integration. This could include formative assessments, learner feedback, and long-term tracking of graduates' entrepreneurial ventures and classroom applications.

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