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UTILIZING SCIENCE AND MATHEMATICS EDUCATION TO FOSTER ENTREPRENEURIAL SKILLS DEVELOPMENT AMONG SECONDARY SCHOOL STUDENTS IN KATSINA STATE, NIGERIA

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ABSTRACT

Given the pressing issue of limited employment opportunities in Nigeria, particularly affecting secondary school students who may not proceed to higher education, the integration of entrepreneurial skills development becomes imperative. Science and mathematics education have the potential to enhance students' entrepreneurial skills development by fostering self-employment, raising income levels, improving living standards, and enhancing the overall quality of life. The purpose of this paper is to assess the relevance of science and mathematics education as an important tool for developing entrepreneurial skills among secondary school students in Katsina state, Nigeria. The paper employed a cross-sectional survey method to collect primary data from 400 secondary school students across three senatorial zones in the state. The collected data were analyzed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach. The results indicate that science and mathematics education have a positive impact on secondary school students' entrepreneurial skills development. Based on these findings, the paper proposes recommendations including curriculum enhancement with practical entrepreneurship components, teacher training, experiential learning opportunities, mentor-ship programs, access to resources, innovation competitions, industry collaborations, financial literacy education, government support, and continuous evaluation.

Keywords*:* Entrepreneurial Development Skills, Science, Mathematics, Education

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INTRODUCTION

The significance of science and mathematics education as powerful drivers for a nation's progress and economic prosperity has been widely recognized. This acknowledgement has prompted nations worldwide to actively seek advancement in these fields as a fundamental aspect of their development agendas (Atomatofa, 2013,: Yau, 2010). As a result, there has been a sustained and unwavering emphasis on promoting scientific literacy over the years. In today's modern society, where science and technology play a central role in shaping the world, achieving scientific literacy is regarded as a crucial objective in science education (Achor, Ogbeba & Amadu. 2014; Okolocha, & Nwaukwa, 2020).

Scientific literacy, within the context of science education, serves a multifaceted purpose. Not only does it seek to improve individuals' understanding of scientific principles, their attitudes toward scientific disciplines, and their capacity to actively engage in scientific processes, but it also aims to enhance a nation's international competitiveness and contribute to an overall elevation in the quality of life (Adejoh, Ochu, Ogbe-Okpenge & Ejeh., 2021). This holistic approach to scientific literacy is geared towards promoting societal well-being. It encompasses diverse aspects, such as increased productivity and greater overall happiness within individuals' lives and circumstances (Yemi, & Adebimpe, 2017). Similarly, mathematics education plays a pivotal role in promoting entrepreneurship skills among secondary school students by nurturing critical thinking, problem-solving abilities, and quantitative reasoning (Bela, 2011). It equips students with the analytical tools necessary for financial planning, risk assessment, and market analysis, essential components of entrepreneurial decision-making. Furthermore, mathematics education fosters resilience and adaptability in the face of challenges, vital attributes for entrepreneurs navigating a dynamic business landscape. By developing mathematical competencies, students are better prepared to model, evaluate,

and innovate in various entrepreneurial ventures, enhancing their potential for success in the world of business and contributing to economic growth (Mohammed, 2019).

This study has a particular emphasis on examining how science and mathematics education can be utilized to cultivate entrepreneurial skills among secondary school students in Katsina State, Nigeria. Given the well-recognized influence of scientific and mathematical knowledge in propelling economic growth and overall welfare, this research endeavors to investigate the correlation between these educational subjects and the development of the competencies and entrepreneurial mindset essential for business endeavors. In undertaking this research, our goal is to enhance our comprehension of how science and mathematics education can be effectively employed to equip individuals with the capabilities necessary for success in entrepreneurial pursuits, ultimately contributing to both personal and national prosperity.

Purpose of the Study:

The purpose of this study is to assess the relevance of science and mathematics education as an important tool for developing entrepreneurial skills, among secondary school students in Katsina state Nigeria.

METHODOLOGY

To achieve the purpose of this study, a cross-sectional survey method has been used to collect primary data from 400 secondary school students across three senatorial zones in the state. The collected data were analyzed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach. There are 251 Junior Secondary Schools and 245 Senior Secondary Schools with an enrolment of 300,125 (166,270 males and 133,855 females) and 198,773 (119,037 males and 79,736 females) respectively. Therefore, the study's population comprises all the 498, 898 students in Katsina state. (Source: Katsina state ministry of education September, 2023). The optimal sample size of this study is 400 students, obtained by Taro Yamane formular.

To draw this sample, cluster sampling technique is used. This is one of the probability sampling techniques that involves the division of a population into smaller sub-groups known as clusters. The sampling and a share of the overall sample was then randomly selected from each cluster. This offers each of the respondent in the population an equal chance of selection and fair representation as well as a basis for generalization. Therefore, the total secondary schools in Katsina state were divided into three (3) clusters (3 senatorial zones: Katsina, Daura & Funtua) in the state. The first stage in the sampling process is the selection of ten (10) secondary schools across these three (3) senatorial zones in the state. The second stage is the random selection of 40 respondents (students) from each of the selected secondary school, making the total sample size of 400.

The dependent variable (Students' Entrepreneurial Skills Development) is measured by four (4) items: (i) interested in starting business, (ii) skills and knowledge necessary to start and run a successful business., (iii) confidence to succeed as an entrepreneur, and (iv) ability to take the risks associated with starting and running a business. On the other hand, the first independent variable (science education) is also measured by four (4) items: (i) enjoy learning science subjects; (ii) understanding the basic concepts of science; (iii) ability to apply science knowledge to solve real-world problems; and (iv) interest in pursuing a career in science or technology. Moreover, the second independent variable (mathematics education) is also measured by four (4) items: (i) enjoy learning mathematics; (ii) understanding the basic concepts of mathematics; (iii) ability to apply mathematics knowledge to solve real-world problems; and (iv) interested in pursuing a career in mathematics or engineering. Structured questionnaire was employed as an instrument of data collection. The Likert scale was used to measure the constructs, allowing participants to rate their agreement on a 5-point scale, ranging from strongly agree (1) to strongly disagree (5).

The instrument was administered to the respondents by enumerators with the active collaboration and support of teachers in the schools. To ease the process of data collection and to avoid missing information, this study used computer designed digital questionnaire in the form of Open Data Kit (ODK). The ODK Collect App is a free, open-source suite of tools that allows data collection using Android mobile devices and data submission to an online server, even without an internet connection or mobile carrier service at the time of data collection. The instrument comprises four sections: background information of the respondents, entrepreneurship development skills, science and mathematics education.

Two main analyses were performed on the collected data: the measurement model analysis and the structural model analysis. These analyses were conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM). The measurement model analysis focused on assessing the reliability and validity of the measurement scales used in the questionnaire. This analysis examined the relationships between the observed items and the latent constructs (i.e. entrepreneurship development skills, science and mathematics education). It helped ensure that the measurement scales accurately captured the intended constructs (Idika, Egbeji, Edoho & Egbai, 2022). On the other hand, the structural model analysis investigated the relationships between the latent constructs. It examined the effect of science and mathematics education on fostering entrepreneurship development skills in Katsina state, Nigeria. This analysis helped determine the strength and significance of these relationships, providing insights into the impact of science and mathematics education on entrepreneurship development.

The PLS-SEM analysis was conducted using specialized software (SmartPLS4). This software enabled the estimation of the measurement model and the structural model, providing statistical outputs that helped interpret the relationships among the constructs.

RESULTS AND DISCUSSION

The background information of the respondents is presented in Tables 1 to 3. The tables provide information on different aspects such as age groups, gender, and class of respondents.

Table 1: Age Group of the Respondents

Age	Frequency	Percentage
15-16 years old	63	15.75
17-18 years old	267	66.75
Above 18 years old	18	4.50
Below 13 years old	52	13.00
Total	400	100.00

The result in Table 1 displays the distribution of respondents across various age groups. The results show that, 15.75% of respondents are aged 15 to 16 years old, while majority of the students (66.75%) are within the age group of 17-18 years old. Additionally, 4.50% are above 18 years old, while only 13.00% are below 13 years old.

Table 2: Gender of the Respondents

Gender	Frequency	Percentage
Female	140	35.00
Male	260	65.00
Total	400	100.00

The result in Table 2 shows the distribution of respondents according to their gender. The result shows that, majority of the students (65.00%) are male while the remaining 35.00% are female.

Table 3: Class of the Respondents

Class	Frequency	Percentage
Secondary 1 - 3	150	37.50
Secondary 4 - 6	250	62.50
Total	400	100.00

The result in Table 3 shows the distribution of respondents according to their classes. The result shows that, majority of the students (62.50%) are in senior secondary school (Secondary 4 – 6) while the remaining 37.50% are in junior secondary school
(Secondary 1 – 3).

Measurement Model Analysis

The analysis of the measurement model is conducted to assess the reliability and validity of the latent variables (constructs). To establish the reliability and validity of the constructs, this study employed the reliability coefficient as a measure of internal consistency. Additionally, convergent validity is evaluated to check how well the constructs are measured by their selected indicators. To evaluate convergent validity, the average variance extract (AVE) scores are utilized, and the results are presented in Table 4.

Table 4: Results of Reliability and Validity of the Latent Variables and Indicators

Latent Variables	Indicators	Factor Loadings	Cronbach's Alpha	Composite Reliability	Average Variance Extract (AVE)
Entrepreneurship Development Skills (EDS)	EDS1	0.995	0.915	0.925	0.799
	EDS2	0.996			
	EDS3	0.993			
	EDS4	0.996			
Science Education (SCE)	SCE1	0.995	0.749	0.994	0.639
	SCE2	0.987			
	SCE3	0.992			
	SCE4	0.989			
Mathematics Education (MATH)	MATH1	0.994	0.725	0.720	0.687
	MATH2	0.861			
	MATH3	0.993			
	MATH4	0.994			

Source: Authors' Computation using SmartPLS4 software

The results presented in Table 4 indicate that all indicator factor loadings exceed 0.7, indicating that the construct accounts for over 50 percent of the variance in the indicators, thereby demonstrating satisfactory indicator reliability. Similarly, to ascertain the internal consistency and reliability of the constructs, both Cronbach's Alpha and Composite Reliability should be higher than the threshold of 0.7. It is evident from Table 4 that the latent indicators are all reliable, as their values exceed the threshold of 0.7. Furthermore, in evaluating convergent validity, the Average Variance Extracted (AVE) ought to surpass 0.5. Convergent validity pertains to the degree to which the construct aligns to elucidate the variance within its constituent items. As illustrated in Table 4, the AVE values for all constructs exceed 0.5, affirming that our constructs meet the criterion for convergent validity. This also underscores that all constructs account for 50 percent or more of the variance found within their respective indicators comprising the construct.

Alongside assessing the validity of the indicators, the validity of constructs at a higher level was evaluated employing the Fornell–Larcker criterion (Fornell & Larcker, 1981). According to this criterion, each construct's self-correlation should be higher. This self-correlation is represented by the square root of AVE. Moreover, these values concurrently indicate the interrelationships among the variables under study, and the positive or negative signs associated with them signify the direction of the relationship. The results of analysis in table 5 indicated that all constructs conformed to the Fornell–Larcker criterion.

Table 5: Results of Discriminant Validity (Fornell-larcker Criterion)

Latent Variables	Entrepreneurship Development Skills	Science Education	Mathematics Education
Entrepreneurship Development Skills	0.753		
Science Education	0.817	0.7.21	
Mathematics Education	0.768	0.672	0.825

Source: Authors' Computation using SmartPLS4 software

Furthermore, the explanatory power of the model is assessed using the coefficient of determination (R^2) and the results is presentenced in Table 6. This table provides two statistical parameters: R Square and Adjusted R Square, which are used to assess how effectively the model accounts for the variance observed in the latent variables. The results indicate that the coefficient of R^2 of all the constructs are above 0.75 which indicate a high explanatory power of the exogenous variables. For " Entrepreneurship Development Skills," the R Square value is 0.823, indicating that the model explains approximately 82.3% of the variance in Entrepreneurship Development Skills. For " Science Education," the R Square value is 0.758, implying that the model accounts for around 75.8% of the variance in Science Education. For " Mathematics Education," the R Square value is 0.810, suggesting that the model elucidates about 81.0% of the variance in Mathematics Education.

Table 6: Results of the Explanatory Power of the Model

Latent Variables	R Square	Adjusted R Square
Entrepreneurship Development Skills	0.823	0.801
Science Education	0.758	0.711
Mathematics Education	0.810	0.793

Source: Authors' Computation using SmartPLS4 software

Structural Model Analysis

The analysis of the structural model involves evaluating its path coefficients, coefficient of determination (R^2), and sizes of effects. The PLS-SEM path model is visually represented in Figure 4, and the results of the model's direct and indirect effects are reported in Table 5.

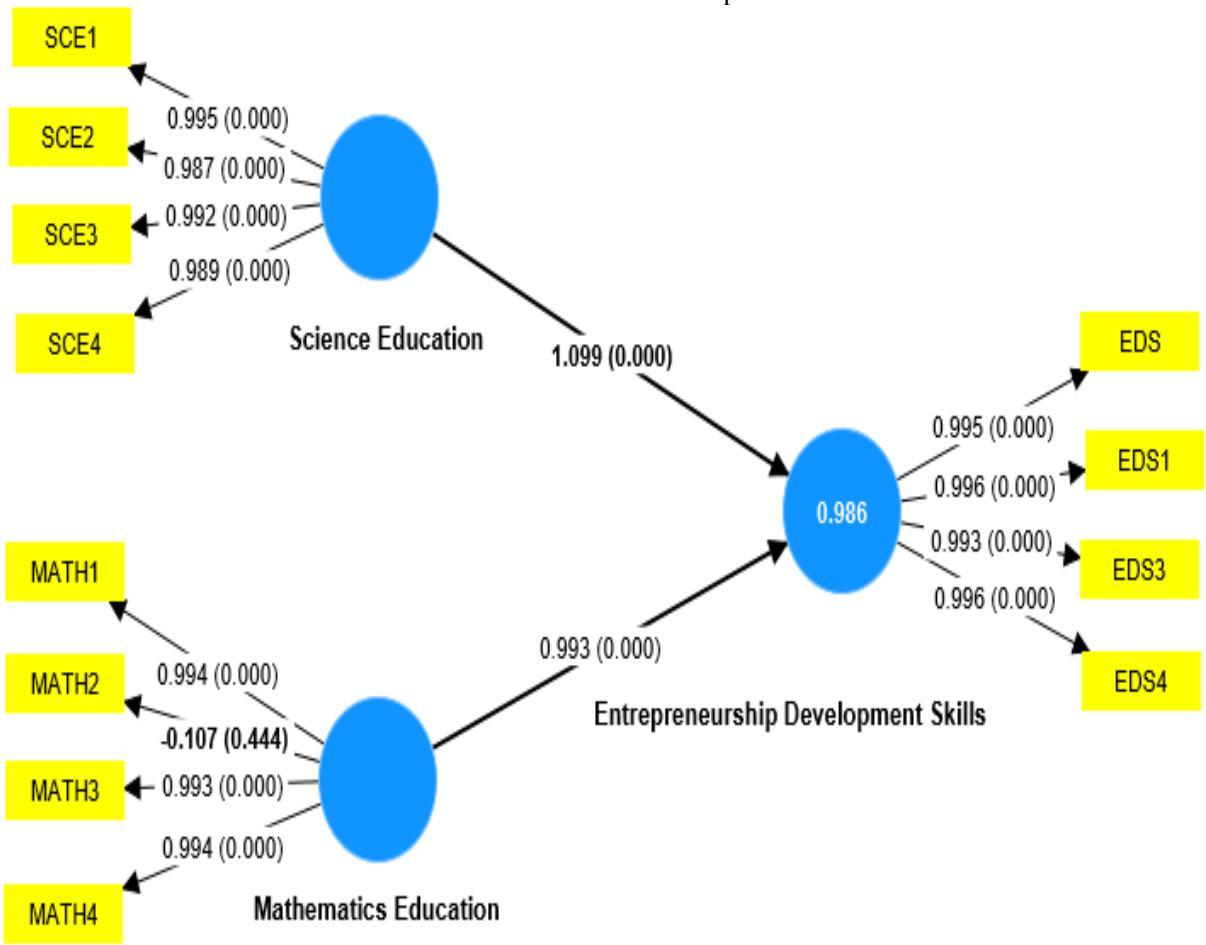

Figure 4: PLS-SEM Path Model

Table 7: Effects of Science and Mathematics Education in Entrepreneurial Skills

Type	Effect	B	SE	t-Statistics	p-values
Direct	SCE ⇒ EDS	1.099	0.062	5.370	0.000
	MATH ⇒ EDS	0.993	0.023	32.323	0.000

Source: Authors' Computation using SmartPLS4 software

Note: β = standardized path coefficient; SE = Standard Error; SCE = Science Education; MATH = Mathematics Education; and EDS = Entrepreneurship Development Skills

The results presented in Table 7 indicate that science education has a positive, and statistically significant effect (β = 1.099, p = 0.000) on entrepreneurial development skills. As a result, the null hypothesis H01 is rejected. This result provides the strong evidence that science education positively influences entrepreneurial development skills in Katsina state. Similarly, mathematics education also has positive and statistically significant effect (β = 0.993, p = 0.000) on entrepreneurial development skills. Consequently, the null hypothesis H02 is rejected. This indicates that mathematics education also significantly contributes to the development of entrepreneurial skills among secondary students in Katsina state.

CONCLUSION AND RECOMMENDATIONS

The overall conclusion drawn from the findings is that both science and mathematics education have a significant impact on entrepreneurial development skills for secondary students in Katsina state. This result is valuable for policymakers and educators, as it suggests that a strong foundation in science and mathematics can positively influence the development of entrepreneurial skills, which are important for the future success and economic development of individuals and the state. In summary, the study's results support the idea that investing in science and mathematics education can be a valuable strategy for fostering entrepreneurial skills among secondary students in Katsina state.

Based on the findings, the following recommendations are provided. First, there is a need to revamp the science and mathematics curriculum for secondary education in Katsina state. This should involve making these subjects more engaging and relevant to students and ensuring that teachers are well-prepared to deliver them effectively. In addition, teacher training and development should be a priority, with a focus on equipping educators with the skills and knowledge necessary to inspire students and convey the practical relevance of science and mathematics in the context of developing entrepreneurial skills.

To make the subjects more practical, it's essential to integrate real-world problem-solving and entrepreneurial activities into the curriculum. This practical application can help students see how science and mathematics concepts are applicable in real-life situations. Encouraging interdisciplinary learning that combines science, mathematics, and entrepreneurial skills is another key recommendation. This holistic approach to education can help students understand the interconnections of these areas and reinforce their importance in the development of entrepreneurial skills.

Mentor-ship programs connecting students with entrepreneurs and professionals can offer valuable guidance and practical insights, motivating students and providing real-world perspectives on entrepreneurship. Collaboration with local businesses and industries is crucial to create opportunities for internships, apprenticeships, and collaborative projects. Such experiences allow students to gain practical exposure and witness entrepreneurship in action.

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