

Enhancing Entrepreneurial Skills Through Geographic Information Systems (GIS) in Technology Education: A Study of Nigerian Secondary Schools

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Abstract: Lack of integration of geographic information systems (GIS) in technology education in Nigerian secondary schools, resulting in gaps in students' practical skills development for entrepreneurship. This is compounded by inadequate curriculum support for technology-based entrepreneurship education, leaving students unprepared for real-world business challenges. The objective of the study was to investigate the integration of Geographic Information Systems (GIS) in technology education to enhance entrepreneurial skills among secondary school students in Anambra State, Nigeria. The study utilized a descriptive research design targeting 141 technology education teachers across secondary schools. A multistage sampling technique ensured diverse participation. Data were collected via a validated structured questionnaire assessing GIS awareness and challenges. Data were analyzed using SPSS. Findings revealed that teachers generally lacked awareness and training in GIS applications, which limited effective integration into the curriculum. The study identified challenges such as limited access to GIS software, inadequate institutional support, high costs of GIS tools, and resistance to new technologies. Despite these challenges, the potential of GIS to foster critical thinking, collaboration, and data-driven decision-making was recognized. The study concluded that enhancing GIS integration in technology education could significantly improve entrepreneurial skills among students, recommending targeted training for teachers and improved resource allocation to facilitate GIS adoption.

Keyword: Geographic Information Systems, Technology Education, Entrepreneurial Skills, Spatial Awareness, Secondary Schools, Nigeria

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Introduction

Enhancing entrepreneurial skills through Geographic Information Systems (GIS) in technology education has become an important area of focus, particularly in developing countries like Nigeria. Geographic Information Systems (GIS) are computer-based tools used for mapping, analyzing, and visualizing spatial or geographic data. GIS integrates hardware, software, and data to capture, manage, and display information related to positions on Earth's surface (Xiang & Liu, 2019). It allows users to visualize geographic patterns, relationships, and trends by layering different types of data, such as demographics, topography, or infrastructure. GIS is widely used in various fields, including urban planning, environmental management,

agriculture, and business, to make informed decisions based on spatial information (Aguilar et al, 2024). Its ability to analyze and interpret spatial data makes it essential for addressing complex geographical and societal issues.

The integration of GIS into technology education provides a platform for students to acquire practical skills that are crucial for entrepreneurship. Technology education involves teaching students about the tools, processes, and systems used to create, operate, and innovate technological solutions (Kerski, 2022). It focuses on developing practical skills, critical thinking, and problem-solving abilities, preparing students for careers in various fields such as engineering, information technology, and applied sciences. Technology education equips learners with the competencies needed to navigate and contribute to a technology-driven world. Geographic Information Systems (GIS) provide tools and methods that support data analysis, visualization, and interpretation, all of which are essential across various sectors, including business and entrepreneurship (Körkkö et al, 2024). Within technology education, GIS equips students with the ability to solve real-world problems, fostering creativity and innovation. In Nigeria, GIS is increasingly recognized as a critical component in preparing students for the workforce, equipping them with technical skills that are in demand.

Entrepreneurial skills are the abilities and attributes necessary to identify opportunities, create and manage businesses, and drive innovation. These skills include critical thinking, problem-solving, creativity, and effective communication. They also encompass financial literacy, risk management, leadership, and the ability to adapt to changing environments. Developing entrepreneurial skills enables individuals to launch and sustain ventures, make informed decisions, and successfully navigate the challenges of the business world (Abitoye et al, 2023). The entrepreneurial potential of GIS stems from its ability to allow students to visualize business opportunities, understand spatial relationships, and analyze markets more effectively. Studies indicate that students trained in GIS are able to identify and map out business opportunities, such as locating potential customers, analyzing competition, and planning logistics (Benevolo et al, 2021). These abilities, tied to interpreting and utilizing spatial data, enhance decision-making skills, which are essential for entrepreneurship. According to Labianca (2021), GIS empowers students in Nigeria with critical thinking and problem-solving abilities, attributes that are vital for entrepreneurial success.

Furthermore, GIS training nurtures the development of digital and technological skills, which are increasingly relevant in modern business environments. Sukubo and Atteng (2023) emphasizes that Nigerian technology education should include GIS to offer students practical experience in applying technology to business contexts. This practical exposure helps bridge the gap between theoretical knowledge and its real-world application, a gap often presents in Nigeria's educational system

(Iyekekpolor & Francis, 2023). Incorporating GIS into technology education enables students not only to master advanced software but also to understand the ways technology can be applied in entrepreneurial settings.

The motivation for the study arises from the need to address gaps in technology education and entrepreneurship training. Many secondary schools in Nigeria lack the integration of modern technological tools like GIS, which hinders students' development of practical skills necessary for entrepreneurship (Krasulia et al, 2022). Previous research highlights inadequate curriculum support for technology-driven entrepreneurship education, leaving students unprepared for real-world business challenges (Brenner & Dymond, 2023). Exploring GIS's potential addresses this gap, offering innovative methods to integrate technology education that promotes critical thinking, problem-solving, and entrepreneurial skills.

Method

The study employed a descriptive research design. The target population consisted of 141 technology education teachers across various secondary schools. To ensure a representative sample, a multistage sampling technique was utilized. Schools were categorized by urban and rural locations, followed by random selection within these categories to ensure diverse participation. Data were collected using a structured questionnaire designed to assess teachers' awareness, utilization, and perceived challenges related to GIS tools in enhancing entrepreneurial skills. The questionnaire underwent validation through expert reviews, incorporating feedback to ensure relevance and clarity. Reliability was tested through a pilot study, aiming for a Cronbach's alpha of 0.77 or higher to confirm internal consistency. Data collection involved distributing questionnaires to selected teachers, facilitated by technology education coordinators. The gathered data were analyzed using descriptive statistics and inferential statistics, including ANOVA and regression analysis, with the Statistical Package for the Social Sciences (SPSS).

Results and Discussion

Table 1. Distribution of Respondents by Location

| | Frequency | Valid Percent | Valid Percent | Cumulative Percent |
|-------------|-----------|---------------|---------------|--------------------|
| Valid Urban | 140 | 99.3 | 99.3 | 99.3 |
| Rural | 1 | .7 | .7 | 100.0 |
| Total | 141 | 100.0 | 100.0 | |

The distribution of respondents by location in Table 1 reveals a predominantly urban demographic, with 140 (99.3%) participants residing in urban areas and only 1

(0.7%) in rural areas. This significant urban concentration indicates that the majority of respondents are from urban settings, accounting for 100% of the total 141 participants

Table 2. Distribution of Respondents by Age in years

| | | Frequenc y | Percent | Valid Percent | Cumulative Percent |
|-------|-------|---------------|---------|------------------|-----------------------|
| Valid | 18-28 | 97 | 68.8 | 68.8 | 68.8 |
| | 29-39 | 39 | 27.7 | 27.7 | 96.5 |
| | 40-50 | 5 | 3.5 | 3.5 | 100.0 |
| | Total | 141 | 100.0 | 100.0 | |

The distribution of respondents by age indicates that the majority, 97 (68.8%), are aged 18-28 years, suggesting a youthful demographic. Following this, 39 (27.7%) respondents fall within the 29-39 age range, while only 5 (3.5%) are aged 40-50 years.

Table 3. Distribution of Respondents by Gender

| | | Frequenc y | Percent | Valid Percent | Cumulative Percent |
|-------|--------|---------------|---------|------------------|-----------------------|
| Valid | Male | 74 | 52.5 | 52.5 | 52.5 |
| | Female | 67 | 47.5 | 47.5 | 100.0 |
| | Total | 141 | 100.0 | 100.0 | |

The distribution of respondents by gender shows that 74 participants (52.5%) identify as male, while 67 participants (47.5%) identify as female. This indicates a slight male majority in the sample. The total number of respondents is 141, reflecting a relatively balanced gender representation in the study, with males slightly outnumbering females.

Research questions

Research question 1: How can GIS be integrated into technology education to enhance students' entrepreneurial skills?

Table 4. Descriptive Statistics on How GIS Can Be Integrated Into Technology Education to Enhance Students' Entrepreneurial Skills

| | Mean | Std. Deviation | Skewness | Std. Error | Kurtosis | Std. Error |
|---|-----------|-------------------|-----------|---------------|-----------|---------------|
| | Statistic | Statistic | Statistic | Error | Statistic | Error |
| GIS can enhance practical learning in technology education through mapping applications. | 2.37 | 1.301 | .135 | .204 | -1.721 | .406 |
| Integrating GIS helps students develop spatial analysis skills for entrepreneurship. | 3.47 | .703 | -1.076 | .204 | .325 | .406 |
| Technology education with GIS promotes critical thinking in problem-solving processes. | 3.14 | .930 | -.828 | .204 | -.263 | .406 |
| GIS integration encourages innovation in geographic-based business decision-making processes. | 2.98 | .929 | -.336 | .204 | -1.052 | .406 |
| Incorporating GIS encourages collaboration and teamwork in entrepreneurial projects. | 2.28 | 1.261 | .164 | .204 | -1.679 | .406 |
| GIS helps students visualize business trends, enhancing data-driven decisions. | 2.98 | .815 | -1.006 | .204 | 1.035 | .406 |
| Valid N (listwise) | | | | | | |

The descriptive statistics in Table 4 showed that integrating GIS helps students develop spatial analysis skills for entrepreneurship has the highest mean at 3.47 (SD = 0.703), indicating strong agreement on its importance for skill development. "Technology education with GIS promotes critical thinking in problem-solving processes" follows with a mean of 3.14 (SD = 0.930), suggesting a recognition of GIS's role in fostering critical thinking. In contrast, "GIS can enhance practical learning in technology education through mapping applications" has a lower mean of 2.37 (SD = 1.301), reflecting limited belief in its effectiveness for practical learning. Additionally, the means for "Incorporating GIS encourages collaboration and teamwork in entrepreneurial projects" (2.28, SD = 1.261) and "GIS helps students visualize business trends, enhancing data-driven decisions" (2.98, SD = 0.815) suggest that there is less consensus on the collaborative and visualization aspects of GIS. The skewness values indicate that responses are generally skewed toward lower levels of agreement, particularly for the statements with lower means.

Research question 2: What is the level of awareness in using GIS tools among technology education students for entrepreneurial purposes?

Table 5. Descriptive Statistics on The Level of Awareness in Using GIS Tools Among Technology Education Students for Entrepreneurial Purposes

| | Std. | | Skewness | Kurtosis | | |
|---|-----------|-----------|-----------|----------|-----------|-------|
| | Mean | Deviation | | Std. | Std. | |
| | Statistic | Statistic | Statistic | Error | Statistic | Error |
| GIS tools are underutilized in technology education entrepreneurial training. | 3.13 | 1.023 | -1.006 | .204 | -.142 | .406 |
| No knowledge about GIS applications in technology education students. | 2.12 | 1.268 | .475 | .204 | -1.509 | .406 |
| GIS integration in entrepreneurship is not fully embraced by students. | 3.15 | .948 | -1.068 | .204 | .320 | .406 |

| | | | | | | |
|--|------|-------|--------|------|-------|------|
| Limited resources affect students' awareness of GIS entrepreneurial potential. | 3.21 | 1.114 | -1.092 | .204 | -.342 | .406 |
| GIS training is lacking in most technology education entrepreneurship courses. | 3.01 | .902 | -.738 | .204 | -.117 | .406 |
| No knowledge about how GIS can enhance business strategies. | 3.10 | .951 | -.808 | .204 | -.307 | .406 |
| Valid N (listwise) | | | | | | |

From Table 5, the statement "Limited resources affect students' awareness of GIS entrepreneurial potential" has the highest mean at 3.21 (SD = 1.114), indicating a notable recognition of resource limitations. Following closely, "GIS integration in entrepreneurship is not fully embraced by students" has a mean of 3.15 (SD = 0.948), reflecting similar awareness. "GIS tools are underutilized in technology education entrepreneurial training" shows a mean of 3.13 (SD = 1.023), suggesting underutilization. Conversely, the statement "No knowledge about GIS applications in technology education students" has the lowest mean of 2.12 (SD = 1.268), indicating a significant gap in awareness among students regarding GIS applications and their relevance in entrepreneurial contexts.

Research question 3: What challenges do educators face in using GIS for entrepreneurial skill development in technology education?

Table 6. Descriptive Statistics on Challenges Educators Face in Using GIS for Entrepreneurial Skill Development in Technology Education

| | Mean | Std. Deviation | Skewness | Kurtosis | | |
|---|-----------|----------------|-----------|------------|------------|------|
| | | | | Std. Error | Std. Error | |
| Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | |
| Limited access to GIS software hinders educators' effective teaching efforts. | 3.28 | .988 | -1.274 | .204 | .483 | .406 |

| | | | | | | |
|---|------|-------|--------|------|--------|------|
| Lack of institutional support complicates integrating GIS into curricula. | 3.31 | .994 | -1.327 | .204 | .559 | .406 |
| High cost of GIS tools poses a significant financial challenge. | 3.36 | .966 | -1.507 | .204 | 1.180 | .406 |
| Time constraints limit educators' ability to teach GIS applications. | 3.39 | 1.087 | -1.471 | .204 | .496 | .406 |
| Inadequate infrastructure hampers the practical use of GIS technologies. | 2.14 | 1.263 | .485 | .204 | -1.473 | .406 |
| Resistance to new technologies affects GIS adoption in classrooms. | 2.79 | 1.025 | -.505 | .204 | -.837 | .406 |
| Valid N (listwise) | | | | | | |

The descriptive statistics in Table 6 highlight significant challenges educators encounter when integrating GIS for entrepreneurial skill development. Notably, the mean for "High cost of GIS tools" is the highest at 3.36 (SD = 0.966), indicating strong agreement on the financial burden this poses. "Time constraints" follows closely with a mean of 3.39 (SD = 1.087), suggesting that these limits significantly affect teaching effectiveness. "Limited access to GIS software" has a mean of 3.28 (SD = 0.988), reflecting a prevalent concern. Conversely, "Inadequate infrastructure" has a lower mean of 2.14 (SD = 1.263), indicating less consensus on its impact, while "Resistance to new technologies" shows a mean of 2.79 (SD = 1.025), suggesting moderate disagreement among educators.

Hypothesis 1: GIS cannot be effectively integrated into technology education to enhance students' entrepreneurial skills.

Table 7. ANOVA Results for GIS Integration into Technology Education

| | Sum of Squares | df | Mean Square | F | Sig. |
|----------------|----------------|-----|-------------|-------|------|
| Between Groups | 6.222 | 2 | 3.111 | 7.451 | .001 |
| Within Groups | 57.617 | 138 | .418 | | |
| Total | 63.838 | 140 | | | |

With a calculated F-value of (7.451) and a p-value of (0.001), the data in Table 7 demonstrate a significant difference among the groups. Specifically, the sum of squares between groups is (6.222), while the within-group sum of squares is (57.617), culminating in a total sum of squares of (63.838). Since the p-value is significantly less than 0.05, we reject the null hypothesis, indicating that GIS integration in technology education is indeed beneficial for developing entrepreneurial skills.

Hypothesis 2: There is no significant level of awareness in using GIS tools among technology education students for entrepreneurial purposes.

Table 8. ANOVA Results for Level of Awareness in Using GIS Tools

| | Sum of Squares | df | Mean Square | F | Sig. |
|----------------|----------------|-----|-------------|------|------|
| Between Groups | .734 | 2 | .367 | .633 | .532 |
| Within Groups | 79.926 | 138 | .579 | | |
| Total | 80.660 | 140 | | | |

Table 8 reveal an F-value of (0.633) and a p-value of (0.532). Since the p-value exceeds the conventional alpha level of (0.05), we fail to reject the null hypothesis. This indicates no significant differences in awareness levels regarding GIS tools among the groups studied. The analysis suggests that technology education students generally lack awareness of GIS tools for entrepreneurial applications

Hypothesis 3: Educators do not face significant challenges in using GIS for entrepreneurial skill development in technology education.

Table 9. ANOVA Results for Challenges in Using GIS

| | Sum of Squares | df | Mean Square | F | Sig. |
|----------------|----------------|-----|-------------|------|------|
| Between Groups | .212 | 2 | .106 | .141 | .086 |
| Within Groups | 104.028 | 138 | .754 | | |
| Total | 104.240 | 140 | | | |

The ANOVA results in table 9 reveal an F-value of (0.141) and a p-value of (0.869). The sum of squares between groups is (0.212), while the within groups sum is (104.028). Since the p-value exceeds the conventional alpha level of 0.05, we fail to reject the null hypothesis. This indicates that there is no statistically significant evidence to suggest that educators encounter significant challenges when integrating GIS into their curriculum for developing entrepreneurial skills.

Discussion

Integrating Geographic Information Systems (GIS) into technology education can significantly enhance students' entrepreneurial skills. For instance, GIS can enhance practical learning through mapping applications, allowing students to visualize and analyze real-world data. This finding aligns with Abitoye et al, (2023), who highlighted the importance of practical applications in enhancing learning outcomes. In contrast, Kerski (2022) emphasized that integrating GIS fosters spatial analysis skills, crucial for entrepreneurship, enabling students to make informed decisions based on geographic data. Furthermore, technology education that incorporates GIS promotes critical thinking in problem-solving processes. This finding agrees with Benevolo et al, (2021), who noted that critical thinking is essential for effective decision-making in entrepreneurial ventures. Additionally, GIS encourages innovation in geographic-based business decision-making, enabling students to leverage location-based data for competitive advantage. Moreover, incorporating GIS fosters collaboration and teamwork in entrepreneurial projects, as students often work in groups to analyze and present data. This collaborative approach aligns with the findings of Thapa (2024), who reported that teamwork enhances entrepreneurial skill development. GIS helps students visualize business trends, enhancing data-driven decisions, further preparing them for the complexities of the entrepreneurial landscape.

The analysis reveals a concerning lack of awareness among technology education students regarding Geographic Information Systems (GIS) tools for entrepreneurial applications. Specifically, GIS tools are underutilized in

entrepreneurial training, indicating a gap between available resources and student engagement. This finding aligns with research by Aguilar et al, (2024), who noted that many students are unaware of GIS applications relevant to their fields. Furthermore, the integration of GIS in entrepreneurship is not fully embraced by students. In contrast, Labianca (2021) found that effective training significantly enhances students' understanding of GIS's role in business strategies. Limited resources exacerbate this issue, as students struggle to appreciate GIS's entrepreneurial potential, which agrees with Xiang and Liu (2019) assertion that insufficient access to tools hampers awareness. Additionally, GIS training is lacking in most technology education entrepreneurship courses, further contributing to the knowledge gap. In a related study, Kerski et al, (2013) emphasized that structured training programs are essential for developing entrepreneurial skills through GIS. Many students express uncertainty about how GIS can enhance their business strategies, highlighting the need for curriculum improvements to address these deficiencies.

Educators face several challenges in using Geographic Information Systems (GIS) for developing entrepreneurial skills in technology education. Limited access to GIS software significantly hinders effective teaching efforts, as highlighted by Körkkö et al, (2024), who found that inadequate resources restrict educators' ability to provide comprehensive training. This finding contrasts with Brenner and Dymond (2023), who noted that well-supported institutions see better integration of GIS into curricula. Moreover, the high cost of GIS tools poses a financial challenge, complicating implementation efforts, as reported by Krasulia et al, (2022). This limitation often restricts access for both educators and students. Time constraints further limit educators' capacity to teach GIS applications effectively, a challenge echoed by Iyekekpolor and Francis (2023), who emphasized the need for dedicated time in curricula. Additionally, inadequate infrastructure hampers the practical use of GIS technologies in classrooms. This finding aligns with Sukubo and Atteng (2023), who pointed out that effective GIS instruction requires reliable technological support. Resistance to new technologies affects GIS adoption, creating barriers to integration. Despite these challenges, the analysis indicates no statistically significant evidence to suggest that educators encounter significant obstacles in incorporating GIS into their curricula, highlighting the need for further investigation into this discrepancy.

The implications of the research results indicate that there needs to be a systematic and comprehensive effort to optimize the use of GIS in entrepreneurship technology education. Educational institutions need to invest in GIS technology infrastructure, educator competency development, and curriculum updates that effectively integrate GIS. In addition, strategies are needed to increase students' awareness and understanding of the benefits of GIS in the context of entrepreneurship, for example through special training programs, practical case studies, and collaboration with industry. The research findings also imply the need for financial

and policy support from stakeholders to overcome cost and access barriers to GIS software. Furthermore, appropriate evaluation methods are needed to measure the effectiveness of GIS integration in improving students' entrepreneurial skills, as well as further research to identify best practices in implementing GIS in technology education environments.

Conclusion

It is concluded that the integration of Geographic Information Systems (GIS) in technology education has great potential to enhance students' entrepreneurial skills through mapping applications, spatial analysis, and decision-making based on geographic data. However, there are several challenges that need to be addressed, including the lack of awareness among students about the benefits of GIS for entrepreneurial applications, as well as obstacles faced by educators such as limited access to GIS software, high costs, time constraints, and inadequate infrastructure. Although research shows that GIS can encourage critical thinking, innovation, and teamwork in entrepreneurial projects, there is still a need for curriculum improvements and better resource support to optimize the use of GIS in developing entrepreneurial skills in technology education.

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