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Effect of iSTEM Approach on Female Students' Attitude towards Mathematics Career Selection among Senior Secondary School Students in Sokoto State, Nigeria

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Abstract

Mathematics plays a crucial role in STEM careers, providing the foundation for problem solving and logical reasoning; yet, female students often exhibit lower participation and motivation in pursuing mathematics related fields. This study examines the impact of the iSTEM approach on female students' attitude toward selecting mathematics as a career in Sokoto State, Nigeria. The research addressed two research questions and tested corresponding hypotheses. The study population comprised 1769 female public senior secondary school students, from which 370 SSII students were selected using a multi-stage sampling technique. Four senior secondary schools were chosen through simple random sampling and intact classes were assigned to both the experimental or control groups purposively. The study employed a quasi-experimental pre-test and post-test design, where the experimental groups received instruction using the iSTEM approach, while the control groups were taught using the conventional approach. Data were collected using a Students Attitude towards Mathematic Career selection Questionnaire (SAMCSQ)The two null hypotheses were tested at a 0.05 alpha level of significance using the Mann-Whitney U test and Wilcoxom. The results indicated significant changes in attitude, demonstrating how the iSTEM experience influenced students' perceptions, beliefs and behaviors (attitude) regarding mathematics careers. Based on the findings, the researchers recommends that curriculum developers integrate the iSTEM approach into mathematics teaching. Teachers should receive training in hands-on, interdisciplinary methods, while targeted programs like mentorship and STEM clubs can help sustain female students' interest in mathematics related careers.

Keywords: Female Students, Attitude, Career Selection, iSTEM approach, and Mathematics

Introduction

Mathematics is necessary at all educational levels from basic through senior secondary to higher institutions, which justify its prominent position in curricula (Smith & White, 2020). It is crucial for national development as well

as scientific and technological advancements promoting diversity and equitable representation in various sectors, particularly in STEM (Science, Technology, Engineering and Mathematics) subject and, has become increasingly important in recent years. Hence exploring female students' perspectives on selecting mathematics as a viable career option is a significant area of focus.

Mathematics is the study of structure, order and relationships which evolved from the basic duties of counting, measuring and describing the shapes of objects. Over time, mathematics has changed its focus to more idealized and abstract concepts. Nevertheless, it requires quantitative computations and logical reasoning (Harper, 2022). Since 17th century, mathematical sciences and technology have greatly advanced through the utilization of this indispensable tool. Being proficient in mathematics is seen as a necessary condition for success in today's culture. In view of this, all levels of education in Nigeria (primary, secondary and tertiary) students are required to take mathematics as a foundational subject (Ogunleye & Akinoso, 2016). Mathematics skills enhance critical thinking, logical reasoning, spatial awareness and concrete problem-solving abilities (Neelakanta, 2019). It is essential skills for decision-making processes.

Attitude is a fundamental aspect of human identity, shaping how individuals perceive, interpret, and respond to the world around them. It influences thoughts, emotions, and behaviors, and plays a critical role in decision-making, interpersonal relationships, and personal development. In view of this, Anthony and Walshaw (2017) indicates that, learning mathematics involves more than just thinking and reasoning but it also depends on how students feel about learning. Also, Han and Carpenter (2018) proposed that attitudes comprise individuals' behavioral, affective and cognitive reactions to the environment, influenced by their emotions or interests. According to Ingram, Holmes, Linsell, Livy, McCormick and Sullivan (2019) stated that sentiments or emotions that a person experiences during the process of learning mathematics make up the component of attitude.

There are extremely few female students in Nigeria studying mathematics, some of the drive factors could be component of attitude which consists of the person's sentiments or emotions associated with learning mathematics (Ajai & Imoko 2015). Thus, Students are motivated to get interested in mathematics to learning and selection of mathematics as area of study or future career.

According to Douglas (2020) Career refers to an individual's journey in the workforce, encompassing the various positions, responsibilities and experiences they undertake over their working years. It entails pursuing individual objectives, growing professionally and gaining knowledge in a particular sector or discipline. A career may entail job shifts, advancements and role changes, influenced by factors such as available opportunities, skills, interests and financial circumstances.

Researchers have extensively studied the determinant factors impacting secondary school student's career decisions (Salami & Oluwaseun, 2013; Eremie & Chiamaka, 2019). Presently, students encounter challenges in selecting a career due to the rapid advancements in technology within the information industry. Initially, female child tends to hold more favorable views towards mathematics compared to boys, but these perceptions tend to become increasingly negative as they progress through school.

Abubakar and Anas (2023) discovered that Sokoto students often exhibit favourable attitude toward mathematics, expressing a liking for and enjoyment of mathematics lessons. Contrary to common belief, these high school students don't generally have a bad opinion on mathematics; instead, they exhibit favourable attitudes towards mathematics. However, while positive attitudes are present, they may not directly correlate with academic execution, as evidenced by the academic standing of the student (Ormrod, 2016). Additional elements like student dedication and effort act as mediators between attitude and achievement; without these factors, positive attitudes alone may not translate into academic success. STEM education, as defined by Bybee (2010), entails an educational framework that interconnects the disciplines of science, technology, engineering and mathematics with practical, application-oriented methods. Broadly speaking, STEM education involves merging these disciplines with real life problems to devise solutions. This educational approach aims to equip students with problem solving abilities, fostering innovation, invention, self-assurance, logical reasoning and technological proficiency. Since gaining independence, Nigeria's approach to teaching students in the fields of science, technology, engineering and mathematics (STEM) has changed. A number of studies, such as those conducted in 2015 by Akase, Mwekaven, Awuhe and Tombuwua, have connected problems with STEM education to the difficulties facing sustainable development in Nigeria. Nigeria has made great strides in STEM in the past, but it still has serious issues that need to be resolved. Studies reveal that STEM education has

resulted in significant progress in areas including telecommunications, agriculture and health.

STEM plays an important role in the development of any nation or economy because it forms the basis for the different emerging technologies that the world's operations are now hinged upon. Hence, the development of girls in STEM cannot be over emphasized because of the roles they play in the society. The truth is that with more girl education in Nigeria, we would have a healthier, more educated, more empowered and more productive nation because the girls of today are the mothers of tomorrow. STEM plays an important role in the development of any nation or economy because it forms the basis for the different emerging technologies that the world's operations are now hinged upon. Hence, the development of girls in STEM cannot be over-emphasized because of the roles they play in the society. Moreover, Akinsowon and Osisanwo (2014) stated that with more girl-education in Nigeria, we would have a healthier, more educated, more empowered and more productive nation because the girls of today are the mothers of tomorrow.

Abubakar and Anas (2023) stated that, despite recognizing the significance of mathematics and aspiring to achieve good grades, many students encountered difficulties in maintaining the level of dedication required for success. This lack of commitment may hinder their prospects in pursuing careers related to mathematics despite their ambitions. Despite the positive achievements of female student in mathematics their overall enrollment and participation in mathematics and mathematics related careers are still limited. The constraints imposed by parental attitudes, societal expectations and a lack of educational and community support continues to restrict the aspiration of many girls who are interested in mathematics (Abdullahi & Salihu, 2022). The limited presence of female mathematics students in Nigeria and selection of the area as career motivated the researcher to investigate female students' attitude towards mathematics career selection by given them intervention through iSTEM approach with hope to improve their motivation towards mathematics career selection in Sokoto state, Nigeria.

Statement of the Problem

The underrepresentation of female students persists in the domains of mathematics, reflecting broader gender disparities in Mathematics education

and careers in many countries. Despite efforts to promote gender equality in education, cultural norms, societal expectations and limited resources continue to hinder female students' engagement and motivation in mathematics.

Many researchers in Nigeria, made efforts to investigate the problems of gender and attitude towards mathematics and career selection. Most of the researchers give emphasis to look into how female students feel about choosing a career in mathematics. In Sokoto State, the number of female students interested in pursuing a career in mathematics remains very low, reflecting a wider issue of gender imbalance in the field. According to data collected from the Ministry of Education, there are 171 mathematics teachers in the public secondary schools in the state, but only 38 of them are female, making up just about 22.2% of the total. This limited number of female mathematics teachers means that many young girls lack visible role models in the subject, which negatively affect their interest, confidence, and motivation to consider mathematics as a career in future.

However, previous studies investigated the perception of female students regarding career selection without given any intervention. Thus, the use of conventional strategy and belief are among common problems in Nigeria and Sokoto State which affect the female students' attitudes towards mathematics and select the area as career.

Looking at this problem at hand, the present study deemed it imperative to conduct research and provide intervention for female students using iSTEM approach, with hope to explore female students' Attitude and motivation towards mathematics carrier selection through iSTEM approach in Sokoto, and hope to bridge the gap to encourage female representation in Mathematics related professions.

Research Objectives

The main objective of this study is to examine the impact of the iSTEM approach on female students' attitudes toward selecting mathematics as a career in Sokoto State, Nigeria. The specific objectives of the study are to:

1. Investigate difference in female students' attitudes toward selecting Mathematics as a career before and after learning Mathematics using the iSTEM approach among Senior Secondary school Students in Sokoto State, Nigeria.

2. Identify the difference in attitudes between female students taught using the iSTEM approach and those taught using the conventional method in selecting Mathematics as a career among Senior Secondary school Students in Sokoto State, Nigeria.

Research Questions

The following research questions guided this study:

1. Is there difference in Female students' Attitude toward selecting mathematics as a career before and after learning Mathematics using iSTEM approach among Senior Secondary school Students in Sokoto State, Nigeria?

2. Is there any difference in Attitudes between Female Students taught using iSTEM approach and those taught using Conventional approach in selecting Mathematics as a career among Senior Secondary School Students in Sokoto State, Nigeria?

Null Hypotheses

Based on the above research questions the following hypothesis were generated and tested:

H_{01}: There is no significant difference in Female students' Attitude toward selecting Mathematics as a Career before and after learning Mathematic using iSTEM approach among Senior Secondary Schools Students in Sokoto State, Nigeria.

H_{02}: There is no significant difference in Female students' Attitude taught using iSTEM approach and those taught using Conventional approach in selecting Mathematics as a Career among Senior Secondary Schools Students in Sokoto State, Nigeria

Methodology

In this study Quasi experimental research design was used. The study's population of all 10,769 female students enrolled in Senior Secondary School II (SSII) in Sokoto State. The study population comprised female public senior secondary school students, from which 370 SSII students were selected using a multi-stage sampling technique. Research instrument titled Students Attitude

towards Mathematic Career Selection Questionnaire **(**SAMCSQ**)** was validated by two expert , after a pilot study, reliability indexes of 0.85 was established, the instrument was structured in 4 Liker Type Rating scale of "Strongly Agree" (SA)=4, "Agree" (A)=3, "Disagree" (D)=2, "Strongly Disagree" (SD)=1. The data collected was analyzed using descriptive statistic and non-parametric test (Mann Whitney U test and Wilcoxom test) at 0.05 level of significance.

Results

Based on the results obtained from the analyses and interpretations of were done with the use of tables to provide a clear picture of the finding as follows:

Research Question

Is there difference in female students' attitude toward selecting mathematics as a career before and after learning Mathematics using iSTEM approach among Senior Secondary school Students in Sokoto State, Nigeria? Table 1 shows the median score of pretest and posttest median score of female student's attitude in selecting mathematics as a career before and after learning Mathematics using iSTEM approach.

Table 1: Pretest and Posttest Median score of Female Students' Attitude in Selecting Mathematics as a Career before and after learning Mathematics using iSTEM approach

Attitude	N	Median	Standard Deviation	Median Difference
Pretest	182	2.00	1.100	1.00
Posttest	182	3.00	1.109	

The results in table 1 indicate a positive change in attitude among female students, with the median attitude score increasing from 2.00 (pretest) to 3.00 (posttest). This shows that the iSTEM approach had a significant impact on students' attitudes towards selecting mathematics as a career. The median difference between the pretest and posttest scores is 1.00, further including improvement in attitude.

The standard deviation remains relatively consistent, with a slight increase from 1.100 (pretest) to 1.109 (posttest). This indicates that the spread of attitude scores did not change. The findings from Research Question 1 (RQ1) affirmatively, confirming that there is a median difference between female

students' attitudes in selecting mathematics as a career before and after learning mathematics using the iSTEM approach. However, the scores obtained were subjected to test significance using Wilcoxom see Table 2

$H0_1$**:** There is no significant difference in Female students' Attitude toward selecting Mathematics as a Career before and after learning Mathematic using iSTEM approach among Senior Secondary Schools Students in Sokoto State, Nigeria. This null hypothesis was tested using Wilcoxon test of attitude in selecting Mathematics as a Career before and after learning Mathematic using iSTEM approach

Table 2: Wilcoxon Test on Female Students' Attitude in Selecting Mathematics as a Career before and after learning Mathematic using iSTEM approach

Attitude	N	Z	P-value	Decision
Pretest / Posttest	182	10947.0	.000	Null H_0 Rejected

Table 2 indicates a statistically significant difference in the attitudes of female students towards selecting Mathematics as a career before and after learning Mathematics using the iSTEM approach. The p-value is .000, which is less than the significance level. This leads to the rejection of the null hypothesis, suggesting that the iSTEM approach has a significant impact on female students' attitudes.

Research Question: Is there any difference in Attitudes between Female Students taught using iSTEM approach and those taught using Conventional approach in selecting Mathematics as a career among Senior Secondary School Students in Sokoto State, Nigeria? Table 3 shows the median score difference between female students taught using iSTEM and those taught conventional approach.

Table 3: Median Difference between Female Students' Attitude exposed to iSTEM Approach and those exposed Conventional Approach in Selecting Mathematics as a Career

Group	**N**	**Median**	**Standard Deviation**	**Median Differences**
iSTEM Approach	182	3.0	1.10	
				1.2
Conventional Approach	188	2.5	1.09	

Table 3 shows that the median and standard deviation of the attitudes of female students taught using the iSTEM approach with those taught using the conventional approach. The median score of the attitudes of female students taught using the iSTEM approach is 3.0 and the standard deviation is 1.10.

While the median score of the attitude of those taught using the conventional approach is 2.5 and their standard deviation is 1.09. The median difference is 1.2. The result shows that there is a median difference between the female students' attitudes taught using the iSTEM approach with those taught using the conventional approach. However, the scores obtained were subjected to Mann-Witney U test (see Table 3) for significance.

Hypothesis

H02: There is no significant difference in Female students' Attitude taught using iSTEM approach and those taught using Conventional approach in selecting Mathematics as a Career among Senior Secondary Schools Students in Sokoto State, Nigeria. This null hypothesis was tested using Mann Whitney test of attitude of students taught using iSTEM and those with conventional approach. The result of the analysis is presented in Table 4.

Table 4: Mann-Witney U-Test on Female students' Attitude taught using iSTEM approach and those taught using conventional approach in selecting Mathematics as a Career

Test	N	Mean rank	Sum of Mean rank	U	P-value	Decision	
iSTEM approach	182	181.08	6337				
				7.04	.03	Null Rejected	H_0
Conventional approach	188	169.46	5931				
Total	370						

Table 4 showed significant differences in attitude scores between the iSTEM and conventional approach groups for the overall attitude. The p-values 0.03 indicate significant difference. This indicates that the null hypothesis (H_{02}) is rejected. The iSTEM approach was more effective than the conventional approach in promoting positive attitudes towards selection of mathematics as a future carrier.

Summary of the findings

Based on the analyses of results, the following were the findings of the study:

1. The iSTEM approach significantly increased students' attitude to select a mathematics career. They also became more aware of career opportunities for Mathematics graduates.

2. Students who learned through the iSTEM approach demonstrated significantly more positive attitudes across affective, cognitive, and behavioral domains compared to those taught through conventional method.

Discussion

The results for research question one indicates a positive shift in attitude towards selecting mathematics as a career among female students after learning mathematics using the iSTEM approach. This finding could be related to the Ajzen (2020) which offers insights into how attitudes impact career choices in mathematics. In this context, attitudes towards selection of mathematics as career, perceived behavioral control (the perception of ease or difficulty in pursuing a mathematics related career) and subjective norms (social influences) all significantly influence individuals' intentions to pursue careers in mathematics related fields.

The outcome from research question two suggests there is a difference in attitude between female students taught using the iSTEM approach and those taught using the conventional approach in selecting mathematics as a career. This outcome aligns to the applicability of Lent (2018) to the realm of mathematics on how females' confidence in their mathematical abilities, perceptions of mathematics as a viable career path and exposure to mathematical tasks and role models affect their aspirations in career selection (Wang & Degol, 2017). In this regard enhancing self-efficacy beliefs and showcasing successful female mathematicians can help to motivate more females to pursue careers in mathematics, as suggested.

The results of hypothesis one indicated that iSTEM approach had positive impact on students' attitudes toward pursuing mathematics career with significant improvements. These findings agree to that of Owu-Anne and Assud (2023) who found that there is relationship between the value of mathematics and mathematics achievement also there were positive and significant correlations between the value of mathematics and mathematics achievement. Thus, the significant Impact could be as a result of collaborative and appreciative factors associated with the iSTEM approach. This is in line with the findings of Kelana, Wardan, Firdaus, Altaftazaniand, Rahayu (2020) who found enhanced positive impact on students' affective attitudes toward pursuing mathematics career leading to increased confidence enthusiasm.

The results of hypothesis two demonstrate significant improvements in students' attitudes toward pursuing a mathematics career after the iSTEM intervention. The findings reveal positive changes in all three areas: affective, cognitive, and behavioral attitudes. The results indicate a significant positive change in students' emotional responses toward mathematics after the intervention. These outcome conflict with that of Adetayo and Samuel (2020), the results showed that, there were no appreciable differences in the attitudes toward mathematics held by female students in private and public senior secondary schools, or by male and female students in the same school. The significant positive changes in affective, cognitive, and behavioral attitudes suggest that the iSTEM intervention can help students develop more positive attitudes toward mathematics (Dokme, Arif & Zeynep, 2022). The positive changes in attitudes and behaviors suggest that the iSTEM intervention can potentially increase the number of students pursuing mathematics careers as agreed in the findings of Razali et al., (2020). Impliedly, the findings of this study demonstrate the effectiveness of the iSTEM intervention in improving students' attitudes toward pursuing a mathematics career.

Conclusion

Based on the results under the present study, the researchers concluded that the iSTEM approach significantly improved female students' attitudes toward selecting mathematics as a career. The intervention led to meaningful advancements in students' emotional, cognitive and behavioral engagement with mathematics, fostering a deeper connection to the subject and its career prospects. When compared to conventional teaching methods, the iSTEM approach provide more effective in enhancing students' attitudes toward mathematics.

Recommendations

Based on the findings of the study, the researchers made the following recommendations:

1. Curriculum developers should integrate iSTEM approach into mathematics teaching to enhance relevance and interest in career applications.

2. Mathematics teachers should be trained in hands on, integrated teaching methods to effectively implement iSTEM across mathematics topics.

3. Special programs (e.g., mentorship, career talks, and STEM clubs) should target female students to sustain their interest in mathematics and related careers.

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