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Original Research Article

Secondary School Students' Interest in the Core Components of Science, Technology, Engineering and Mathematics (STEM): Implications for Instruction Readiness

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Abstract: The implementation of Science, Technology, Engineering and Mathematics (STEM) in secondary school has important role in scientific and technological advancement of a nation and students are the main receiver of the instruction. This study investigated the students' interest as an implication of students' readiness for STEM instruction in Gusau, Zamfara state. The study adopted descriptive survey design. Simple random sampling was used to select 100 students of SS 2 from private and public schools making total of 200 students. An instrument title Senior Secondary School Readiness for STEM Instruction was used to collect data. The instrument was validated and pilot tested which yielded reliability coefficient of 0.86. Three research questions were raised and answered and two hypotheses were stated and tested at 0.05 level of significant. The result of the study showed that senior secondary school students in Gusau, Zamfara state are ready for STEM instruction. There was no significant different between the responses of students based on gender and school type. It was therefore recommended that education stakeholder should expedite the implementation of STEM in senior secondary school to harvest students' readiness for better achievement.

Keywords: Students' interest, STEM instruction, Students' readiness.

INTRODUCTION

The word STEM as an acronym of Science, Technology, Engineering and Mathematics was developed by the National Science Foundation (Rberts, 2012). In this acronym, there is no boundary separating each subject. That is, it cannot be defined by individual subject rather by integration. Educators viewed STEM as the integration of Science, Technology, Engineering and Mathematics as a single unit of knowledge (Badmus & Omosewo, 2020). This inter-related disciplines in STEM seen as a body of knowledge. The technology and engineering which is the most priority of the world today required the recent knowledge of science and mathematics. Technology is an application of scientific knowledge while engineering is an application of technology and all these involve mathematics. This shows that STEM education enriches students' learning than studying individual subjects separately.

Engineering and technology play a crucial role in bolstering economy of a nation, fostering competitiveness in the global market. Roberts (2012) reported that over the past decade, China and India have grown as leading producers of engineers and technicians and this disconcerting to the United State business, industry leader and politicians alike because it is engineering and technological fields that help them drive the economy. These skills cannot be developed except from education system that really prepares students to fulfill these demands. Instead of simply promoting STEM-related field in post-secondary education, there should be a system that cultivates students' internal interest, serving as intrinsic motivation for pursuing STEM disciplines. In line with this, Ismail *et al*., (2023) found in their study that personal interest in STEM was one of the key motivators for students to pursue STEM-related disciplines in higher education. Cultivating the interest

of learners in STEM at both secondary and primary levels has the great potential to impart skills that can drive the nation's economy. Through exposure to STEM knowledge and practices, students will enhance their understanding and perhaps more students will participate in STEM related careers.

The primary significance of STEM education, besides enhancing the standard of living, is its role in enabling sustainable national economic growth. The learning and doing of STEM help develop 21st century skills and prepare students for a workforce where success results not just from what one knows but from what one is able to do with the knowledge (Sulai & Sulai, nd.). The essence of STEM education is to enable students think creatively and to use information obtained to create new things. It is not everything produce in larger industries that boost the economy a nation, things students could produce as a result of STEM education could contribute large extend to the economic growth. Saptura *et al*., (2020) posited that in this century, the ability to think creatively is one of the abilities students must possess to be able to solve various problems. Similarly, Isma'il and Cyril (2022) buttressed that, creativity is being recognized in recent times as an essential skill for success in the 21st-century STEM workforce, which has necessitated the need to prepare students in acquiring such skill. Hence, the learning pattern through the STEM approach has been proven to provide positive impacts in improving students' achievement in both academic and non-academic domains to wider level of imagination. The importance of STEM education could be understood through the following traits established by Roberts (2012):

1. STEM is an integrated: the curriculum centered on the principles from science, technology, engineering and mathematics. It enables students learn to apply previously obtained information to creatively address problem they have never before encountered.
2. STEM education is an inquiry-based: STEM classroom compel students to work together using questioning and answering techniques incorporated with research.
3. STEM incorporate instruction in soft skills needed for business and industry. Asking students to practice these skills promote their confidence and give them insight into their self-realization.
4. STEM is appealing: students enjoy classroom discussion and participation to solve a meaningful problem.
5. STEM education is fulfilling: teachers are able to perceive themselves as facilitators of the learning process and not merely instructors.

The key element for having a successful implementation of integrated STEM model is the teachers, competencies (Nguyen *et al*., 2020). STEM integration requires interdisciplinary collaboration and teachers in the secondary schools are qualified to teach a specific subject. For teacher to be more competence in teaching integrated STEM model, it requires preparation and implementation of Inquiry-Based-Learning (IBL) and engineering design (Chiriacescu *et al*., 2023). Though, science teachers may have perception of possessing required competence to teach integrated STEM model in secondary school. The study conducted by Isma'il *et al*., (2019) to find out science perceived competency and competency knowledge in implementing integrated STEM at secondary schools reported that teachers perceived having high confidence in teaching STEM but their knowledge competency showed that they will only tend to put more weight in their respective area of specialization while other STEM concepts outside their subject areas will not be properly taught.

Apart from teachers' competence, another component of teacher that will determine effective implementation of integrated STEM model is teachers' readiness. Several studies revealed that teachers showed strong readiness in implementing integrated STEM model despite their inadequate competences (Asiroglu & Akran, 2018; Ramli *et al*., nd.; Rukoyah *et al*., 2019; Sulaeman *et al*., 2022). Sulaeman *et al*., (2022) claimed that most science teachers have known that STEM education as integrating technology, engineering and mathematics in science but few of them have experience in conducting STEM lesson. Ramli *et al*., (nd) pointed out that teachers that are not ready for the implementation of STEM education viewed that some things are need to put in place such as teachers training, the require materials and laboratory facilities to support STEM activities. Therefore, successful implementation of STEM education model highly depends on training of teachers to possess required quality (Ergul, 2021). Two basis for improving teachers' quality in STEM-based learning as suggested by Syafril *et al*., (2021) are (i) an effective curriculum and (ii) increased motivation and teacher assistance in implementing STEM.

Statement of the Problem

Despite recognizing the importance of STEM subjects, there is a glaring deficiency in their integration into the curriculum of secondary schools in Nigeria. To address this problem, it is imperative to lay a strong foundation, not only through a well-structured curriculum but also by ensuring that science teachers receive adequate training to effectively impart STEM knowledge. However, the success of STEM implementation is contingent upon the students' readiness to receive instruction in these subjects. Mere exposure to STEM education may not yield optimal results if students lack a pre-existing interest in each component of the STEM, that is science, technology, engineering and mathematics. Therefore, assessing the readiness of secondary school students to engage or receive STEM instruction becomes paramount. The significance of students' readiness lies in its direct correlation with learning outcomes, as reported by Birzina (2021). More so, a pre-existing interest in each of the component of the STEM acts as an important determinant of a students' readiness

to receive STEM instruction and apply the knowledge effectively. Consequently, this study seeks to delve into the interest of secondary school students in each of the specific components of the STEM as their readiness to receive integrative STEM instruction. By understanding secondary school students' interest, it will help to cultivate a positive predisposition towards STEM subjects among them for a more successful and impactful implementation of STEM education in Nigeria.

Research Questions

The following research questions guided the study;

1. Do students in public senior secondary schools have positive interest in the components of STEM?
2. Do students in private senior secondary schools have positive interest in the components of STEM?
3. Is there difference in senior secondary school students' interest in the components of STEM based on gender?

Hypotheses

The following null hypotheses were formulated for the study;

$H0_1$: There is no significant difference between private school students and public school students' interest in the components of STEM.

$H0_2$: There is no significant difference between female students and male students' interest in the components of STEM.

METHODOLOGY

The study adopted descriptive research design of survey type. The survey was carried out in Gusau local government in Zamfara State, Nigeria. The target population comprised senior secondary school year two (SS 2) students from both private and public schools. A total of two hundred (200) students, randomly selected, with one hundred (100) students from each school type, participated in the study. The instrument used to collect data was questionnaire titled "Senior Secondary School Readiness for STEM Instruction". This questionnaire was divided into two sections (A and B). Section A consisted of student information, while Section B comprised content intended to determine students' interest in science, technology, engineering, and mathematics.

The questionnaire was validated by two experts in the Department of Science Education at Federal University Gusau to ensure the instrument's content validity, clarity and alignment with research questions. The reliability test, conducted using Cronbach's alpha on the questionnaire, yielded a reliability coefficient of 0.86. This result indicates that the instrument is reliable for the study. Two research assistances were employed to administer the questionnaire in various schools. The collected data were analyzed using descriptive statistics; frequency, mean, and standard deviation, to address research questions raised and mean of 2.50 and above shows positive interest of students. While inferential statistic, specifically the t-test, was employed to test the hypotheses.

RESULTS

This section presented the analyses of the data gathered from the study. The data were presented based on the research questions and the hypotheses formulated.

Research Question 1: Do students in public senior secondary schools have positive interest in science, technology, engineering and mathematics?

Table 1: Mean response of public senior secondary school students on their interest in STEM (n=100)

STEM Components	Mean	SD	Remark
Science	3.58	0.473	Positive interest
Technology & Engineering	3.46	0.481	Positive interest
Mathematics	3.24	0.622	Positive interest
Grand Mean	3.43		

Source: Fieldwork, 2023

The Table 1 presents the mean responses of public senior secondary school students regarding their interest in STEM subjects. In the Science category, the mean score of 3.58 (SD = 0.473) indicates that, on average, students showed a positive interest in this particular STEM component. Moving on to Technology & Engineering, with a mean score of 3.46 (SD = 0.481), students exhibited a positive interest in this aspect of STEM. Lastly, in Mathematics, the mean response of 3.24 (SD = 0.622) revealed a positive interest among the students. Overall, the grand mean of 3.43 indicated that, students in public senior secondary schools in Gusau Local Government expressed positive interest in science, technology & engineering, and mathematics.

Research Question 2: Do students in private senior secondary schools have positive interest in science, technology, engineering and mathematics?

Table 2: Mean response of private senior secondary school students on their interest in STEM (n=100)

STEM Components	Mean	SD	Remark
Science	3.57	0.459	Positive interest
Technology & Engineering	3.46	0.481	Positive interest
Mathematics	3.24	0.622	Positive interest
Grand Mean	3.42		

Source: Fieldwork, 2023

The Table 2 presents the mean responses of private senior secondary school students regarding their interest in STEM components. Examining the Science category, private school students, on average, expressed a positive interest with a mean score of 3.57 (SD = 0.459). Similarly, in the Technology & Engineering category, students demonstrated positive interest, as indicated by the mean score of 3.46 (SD = 0.481). Regarding Mathematics, private school students exhibited positive interest, with a mean score of 3.24 (SD = 0.622). Considering the overall responses, the grand mean of 3.42 across all STEM components indicates that, on average, private senior secondary school students expressed positive interest in science, technology & engineering, and mathematics.

Research Question 3: Is there difference in senior secondary school students' interest in science, technology, engineering and mathematics based on gender?

Table 3: Mean response of students on their interest in STEM components based on gender (n= 96 Male, 104 female)

STEM Components	Male			Female		
	Mean	SD	Remark	Mean	SD	Remark
Science	3.54	0.528	Positive interest	3.61	0.397	Positive interest
Technology & Engineering	3.46	0.484	Positive interest	3.46	0.479	Positive interest
Mathematics	3.24	0.620	Positive interest	3.24	0.624	Positive interest
Grand Mean	3.41			3.44		

Source: Fieldwork, 2023

The Table 3 presents students' mean responses to their interest in STEM components based gender (96 males, 104 females). On the interest in Science, both male and female students expressed positive interest, with mean scores of 3.54 (SD = 0.528) and 3.61(SD = 0.397), respectively. In the Technology & Engineering aspect, positive interest was evident for both males and females, as reflected by mean scores of 3.46. The comparable standard deviations (0.484 for males and 0.479 for females) indicate similar levels of variability in responses across genders. On Mathematics, positive interest was observed among both male and female students, each with a mean score of 3.24. The standard deviations (0.620 for males and 0.624 for females) indicated comparable variability in interest levels for both genders. Considering the overall grand mean, males had a mean score of 3.41, while females had a slightly higher grand mean of 3.44. This indicates an overall positive interest in STEM components for both male and female students in Gusau Local Government.

Hypotheses Testing

$H0_1$: There is no significant difference between private school students and public school students' interest in science, technology, engineering and mathematics.

Table 4: T-test analysis on students' response on their interest in STEM components based on school type

STEM Components	School Type	N	Mean	df	t	Sig.
Science	Public School	100	3.58	198	0.121	0.903
	Private School	100	3.57			
Technology & engineering	Public School	100	3.46	198	0.000	1.000
	Private School	100	3.46			
Mathematics	Public School	100	3.24	198	0.000	1.000
	Private School	100	3.24			

Source: Fieldwork, 2023

The t-test analysis results, as presented in Table 4, revealed that, for the science component, the t-test yielded a t-value of 0.121 with a corresponding p-value of 0.903. Since that the p-value greater than the significance level of 0.05, thus, there is no significant difference in the interest in science between students in public and private schools. Therefore, the null hypothesis was accepted for science. In respect to technology and engineering, the t-test resulted in a t-value of

0.000 and a p-value of 1.000. This outcome indicated no significant difference in interest between students in public and private schools for technology and engineering, leading to the acceptance of the null hypothesis. The analysis of mathematics interest produced a t-value of 0.000 with a p-value of 1.000, indicating no statistically significant difference in interest between public and private school students for mathematics. Consequently, the null hypothesis was accepted for mathematics. On the whole, the t-test analyses conducted across STEM components consistently affirmed the null hypothesis, indicating that there is no statistically significant difference in interest between students attending private and public schools across science, technology, engineering, and mathematics.

$H0_2$: There is no significant difference between female students and male students' interest in science, technology, engineering and mathematics.

Table 5: T-test analysis on students' response on their interest in STEM components based on gender

STEM Components	Gender	N	Mean	df	t	Sig.
Science	Male	96	3.54	198	-1.124	0.262
	Female	104	3.61			
Technology & engineering	Male	96	3.46	198	-0.084	0.933
	Female	104	3.46			
Mathematics	Male	96	3.24	198	0.023	0.981
	Female	104	3.24			

Source: Fieldwork, 2023

The Table 5 reveal the results of the t-test analyses conducted on students' responses based on gender. For the science component, the t-test revealed a t-value of -1.124 and a p-value of 0.262. Since the p-value is greater than the significance level of 0.05, it revealed no significant difference in the interest in science between male and female students. Consequently, the null hypothesis was accepted for science. For technology and engineering, the t-value was -0.084, and the p-value was 0.933. This indicated no significant difference in interest levels between male and female students in technology and engineering, leading to the acceptance of the null hypothesis. The t-test result for mathematics also showed a t-value of 0.023 and a p-value of 0.981. Like the other STEM components, there is no statistically significant difference in interest between male and female students for mathematics, supporting the retention of the null hypothesis. On the whole, the t-test analyses across STEM components consistently affirmed the null hypothesis ($H0_2$), indicating that the interest in science, technology, engineering, and mathematics does not significantly differ between male and female students.

DISCUSSION

The findings of this study shed light on the important aspect of students' readiness for STEM instruction, emphasizing the central role of their interest in science, technology, engineering, and mathematics (STEM) components. Readiness for STEM education is linked to the deliberate actions students take to acquire knowledge and skills in these disciplines. The results of this study revealed a positive and enthusiastic attitude among science students in senior secondary schools in Gusau Local Government, irrespective of their gender and the type of school they attend, indicating a promising readiness for STEM instruction. The alignment of students' positive attitudes with their readiness for STEM instruction resonances the observations made by Birzina *et al*., (2021), who emphasized that secondary school students are inclined towards learning STEM subjects when presented in innovative ways. This convergence of findings stressed the universal potential for students to engage in STEM education when taught using innovative strategies.

Examining the mean responses, it was revealed that students exhibited a higher positive interest in science compared to technology and engineering. This difference can be attributed to the students' familiarity with subjects such as Physics, Chemistry, and Biology. The familiarity with these subjects may have likely influenced their attitudes. This finding is in agreement with the results of a study by Odufuwa *et al*., (2022), who revealed that senior secondary students generally possess positive perceptions of STEM science subjects and career choices in STEM. However, the emphasis on science subjects is more pronounced than in career choices related to technology and engineering. The gender aspect of the study adds an interesting dimension to the discussion. While there is no significant difference between male and female responses, it is interesting to note that female students exhibited a slightly higher mean response than their male counterparts. This result is not in the same direction with the result of Odufuwa (2022), who reported significant differences between male and female responses, with males displaying higher mean responses. The variance in results indicated that gender dynamics in STEM interest and readiness may vary across different locations.

Implications of the Findings on Students Readiness for STEM Instruction

The findings of this study revealed a conducive environment for the implementation of STEM instruction in Gusau Local Government, given the positive interest demonstrated by senior secondary students in science, technology, engineering, and mathematics. This implies a timely opportunity for education stakeholders in Gusau to promptly integrate

STEM into the curriculum, utilizing students' existing interest for more effective learning outcomes. To maximize this readiness, stakeholders should customize STEM initiatives to align with local context, by improving the appeal of technology and engineering concepts, and ensure inclusive practices that encourage both male and female students.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, it is concluded that senior secondary students in Gusau Local Government showed readiness for STEM instruction, as evidenced by their positive interest in science, technology, engineering, and mathematics. To capitalize on this positive interest, the study recommended that education stakeholders should expedite the implementation of STEM in secondary schools in order to harvest their readiness for better achievement. Aligning with the findings of Winarso (2016), who emphasized the positive impact of students' readiness on their activeness and academic performance, the swift integration of STEM education can further empower students and contribute to improved learning outcomes.

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