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ASSESSING SECONDARY SCHOOL CHEMISTRY STUDENTS ATTITUDE TOWARDS THE 21ST CENTURY SKILLS: TOWARDS FOSTERING THE SUSTAINABLE DEVELOPMENT OF STEM EDUCATION

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ABSTRACT

This study assessed secondary school students' attitudes toward the 21st century skills which towards fostering sustainable development of STEM education Taraba State, Nigeria. The study used a descriptive survey design, the quantitative research method. The population of the study comprised of all government secondary school in Jalingo metropolis. The simple random sampling technique was used to select 120 students offering chemistry, 40 students from each school type (Science & Technology, Conventional and Science schools) of the three co-educational secondary schools in Jalingo metropolis for this study. The instrument used for data collection was an attitude scale questionnaire. The instrument was pilot tested to ascertain its reliability using Cronbach Alpha reliability coefficient; and had value index of 0.87. IBM Statistical package for social sciences (SPSS 22) was used in analyzing the data with descriptive statistics (mean and standard deviation) for the research questions; and t-test, ANOVA, Tukey HSD statistic at 0.05 level of significance to test the hypotheses. The result demonstrated that students have very high attitudes towards the 21st century skills; and there is no significant difference on students attitudes based on gender and school-types. The study concluded that students having positive attitudes towards the 21st century skills with no gender and school-types differences; was deemed important because it could help the students cope effectively and efficiently with life, university, and their future STEM careers for sustainable development.

Keywords: STEM Education, STEM 21ST Century Skills, Sustainable Development, Attitude, Gender, School type.

Introduction

In education view-point, the STEM acronym is mostly referred as the partial or full integration of the separate disciplines of Science, Technology, Engineering and Mathematics, including a focus on the 21st century competencies or skills (Fairhurst, Koul & Sheffield, 2023; Koul, Fraser, Maynard & Tade, 2018; Timms, Moyle, Weldon & Mitchell, 2018). Discoveries in

STEM fields drove huge advancements in human society in the 21st century. Researchers and economists predict accelerating job-growth in these fields as well for sustainable development. These new jobs will continue to require employees with knowledge and abilities in STEM and with an advanced set of general skills in critical-thinking, communication, and collaboration often referred to as "21st century skills" (Partnership for 21st Century Skills, 2011; 2015). While a small percentage of these future positions will be highly specialized and demand workers with graduate-level training, a much larger percentage will require workers with mid-level skills and STEM-related competencies (Carnevale, Smith, & Melton, 2011). The young people as viewed by Nguyen, Nguyen, and Tran (2020) are the future of society and agents for social change, and so it is crucial to provide education that not only equips them with knowledge and skills but also changes their attitudes and behavior towards sustainable development.

Education is considered to be the central element of sustainable development (Dannenberg & Grapentin, 2016); hence efforts should be made to improve, evaluate, or even develop existing education, including applying and assessing the application and development of STEM education. As education can enhance people's lives and contribute to sustainable development, the need for education that supports a more sustainable world has become more evident (UNESCO, 2018). Education is also critical for promoting sustainable development and improving the capacity of people to address environmental and development issues through Education for sustainable development (ESD). ESD is a vision of education that seeks to balance human and economic well-being with cultural traditions, as well as respect for the Earth's natural resources (Wals & Kieft, 2003; Wahono. & Chang, 2019). ESD emphasizes aspects of learning that enhance the transition towards sustainability. These aspects include future education, citizenship education, education for a culture of peace, gender equality and respect for human rights, health education, education for protecting and managing natural resources, and education for sustainable consumption. And as opined by Burmeister and Eilks (2013), all educational levels and domains are tasked with contributing to ESD, including STEM on science education in secondary schools. Research by Wahono and (Chang 2019) showed that science teachers have a very good attitude regarding STEM education and also noted that attitude is fundamental domain for the proper implementation as well as sustainability of STEM education. Research by Hacıoğlu (2021) also revealed that pre-service science teachers declared that STEM education help in developing their learning and innovation skills specifically, and the 21st century skills generally.

STEM in education is a global approach to learning and development that integrates that science, technology, engineering, and mathematics under one roof. Through STEM education, students develop key basic skills (such as problem solving, critical thinking, creative, collaborative etc.) by creating interdisciplinary study opportunities. STEM education also helps in providing a meaningful learning which inculcates the 21st

century skills in learners, and enables deep understanding and transfer of knowledge among disciplines. In the 21st century education, the importance of realizing interdisciplinary, personalized, inclusive, flexible, collaborative, student-centered, engaging and exciting teaching environment. Sari, Alici and Sen (2017) asserted that STEM instruction contribute to the national economy and educators attempt to develop integrated instructional programs; and their study revealed that problem-based STEM instruction is effective in students' learning and also it helps to develop their skills of the 21st century.

STEM education according to Dong, Wang, Yang and Kurup (2020) deals with complex solutions which require a collective responsibility from everyone in society; and it helps to ensure future sustainability effectively using a suite of the 21st century skills such as adaptability, innovation, and complex communication. STEM education is aimed to educate the individuals who can respond to the needs of the 21st century with these regulations made in the field of education. Thus, interdisciplinary education programs are offered as an alternative to traditional education for the development of individual's 21st century skills (Davies & Ryan, 2011). The Partnership for 21st Century Skills [p21] (2011) illustrated the 21st century skills diagrammatically as follows:

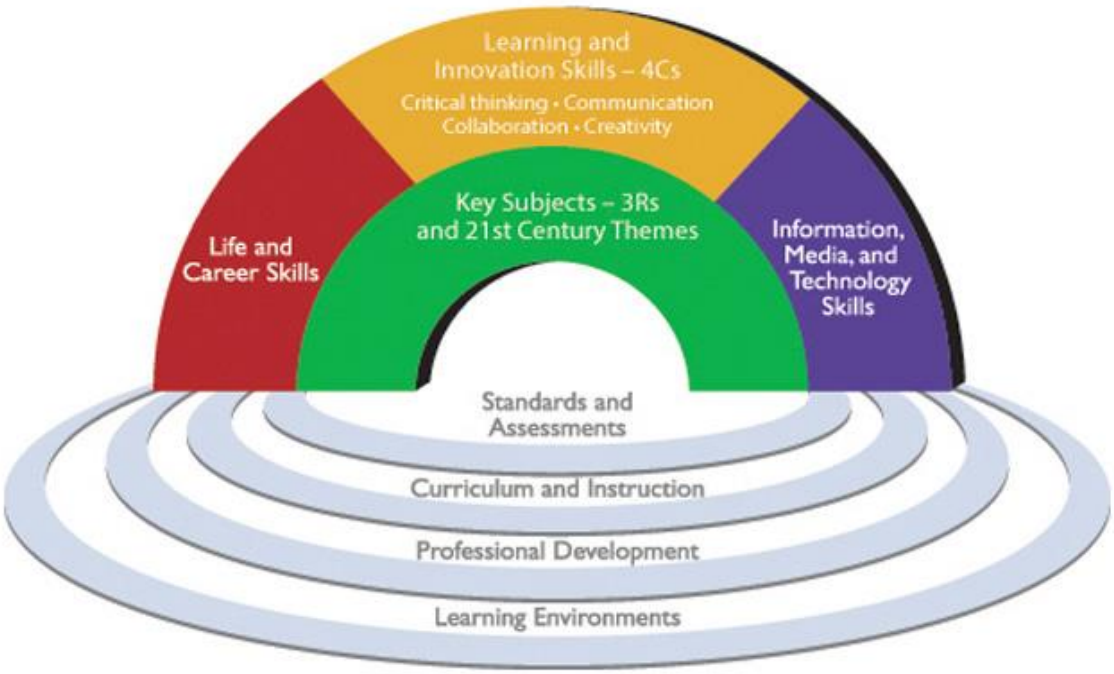


Figure 1: Partnership for 21st Century Skills

The 21st century skills by Partnership for 21st Century Skills (p21 2011; 2015) as coined from the works by these educators (Hacıoğlu, 2021; Sen, Ay & Kiray, 2018) are explained as follows:

1. Learning and Innovation Skills: With the school and non-school experiences, it is aimed to ensure that students are in an effective learning process. In addition to giving the knowledge to students, awareness should be raised in self-development and innovation in the changing world. The skills under this category includes the 4Cs; critical thinking, communication, collaboration and creativity skills.

i. Critical Thinking and Problem Solving Ability: Critical thinking involves effectively analyzing and evaluating assertions, evidence, and beliefs. In the 21st century, problem solving skills are effective in helping individuals solve unconventional situations with effective methods. It also helps in applying higher order thinking to new problems and issues, using appropriate reasoning as they effectively analyze the problem and make decisions about the most effective ways to solve the problem.

ii. Communication: The individual must express his/her ideas in various contexts by using verbal or written communication tools effectively. Effective communication skills gain importance in this direction. Communicating effectively in a wide variety of forms and contexts for a wide range of purposes and using multiple media and technologies.

iii. Collaboration: Individuals need to be able to work in a respectful manner with different teams in the educational environment and business life. With the collaborative education practices, students should be immersed in collaboration. Working with others respectfully and effectively to create, use and share knowledge, solutions and innovations.

iv. Creativity and Innovation: The ability to produce a broad idea to create new and useful ideas. This skill also helps in using knowledge and understanding to create new ways of thinking in order to find solutions to new problems and to create new products and services.

2. Knowledge, Media and Technology Skills: The skills that individuals should have in the 21st century are (i) access to a wealth of information, (ii) adaptation to rapid changes in technologic tools, and (iii) contributing by working individually and in collaboration.

i. Knowledge Literacy: Accessing and evaluating knowledge critically and competently, managing the flow of knowledge from various sources.

ii. Media Literacy: Understand how and why media messages are created; understanding and using the most appropriate media creation tools and features to bring media products to the market.

iii. ICT (Information and Communication Technologies) literacy: Using technological tools as a means of researching, organizing, evaluating and transmitting information. In information management the students use skills of accessing, analyzing, synthesizing, creating and sharing information from multiple sources; while for effective use of technology the skills of creating the capacity to identify and use technology efficiently, effectively and ethically as a tool to access, organize, evaluate and share information are formed.

3. Life and Career Skills: In today's global competition, students need to be careful to improve their life and career skills in highly competitive life and work environments. Developing skills for becoming self-directed, independent learners and workers who can adapt to change, manage projects, take responsibility for their work, lead others and produce results, and social and inter-cultural skills. In social and intercultural skills; the students need to have content knowledge, social and emotional competencies in order to be able to take place in real life and in future working environment. Cultural awareness skills helps in developing cultural competence in working with others by recognizing and respecting cultural differences and work with others from a wide range of cultural and social backgrounds.

The 21st century skills pertain to the knowledge, skills, and attitudes needed by children and the youth to fully engage in and contribute to the development of society (Lin et al., 2021). Binkley et al. (2012) summarized that 21st century skills could be classified into four groups, including ways of thinking (e.g., creativity and innovation, critical thinking, problem solving, and learning to learn), ways of working (e.g., communication and collaboration), tools for working (e.g., information and ICT literacy), and living in the world (e.g., citizenship, life and career, and sense of responsibility). Chai et al. (2020a) reviewed frameworks for 21st century skills and noted that most of the frameworks emphasized the importance of engaging students in creative thinking, critical thinking, and authentic problem solving. In addition, classroom-based and out-of-classroom learning communities should support students in building communication and collaboration skills in the problem-solving process, which contributes to growth in learning and innovation (Chai et al., 2020b). Tsai et al. (2013) expressed that the essence of education in the 21st century has to be epistemologically shifted from reproduction of knowledge to production of new knowledge through creativity and innovation. Exemplary science education can also offer a rich context for developing many

21st-century skills, such as critical thinking, problem solving, and information literacy. These skills not only contribute to a well-prepared workforce of the future but also give all individuals life skills that help them succeed (NSTA, 2011). And, Stehle and Peters-Burton (2019) noted that inclusive STEM high schools provide environments that support the development of 21st Century skills; yet more can be done in the area of teacher professional development to improve instruction of high levels of 21st Century skills.

There is a need therefore to arm students with non-cognitive, or 21st Century, skills to prepare them for a more STEM-based job market. Hence, integrating STEM 21st Century Skills with content, and determining students' attitudinal levels plays an important role in any nation sustainable development. The development of positive students' attitudes toward the STEM 21st century skills cannot be over-emphasized due to the roles they play in the society for sustainable national development; though can be influence by some factors such as gender and school-type differences. The purpose of this present study therefore, is to identify student attitudes toward STEM 21st century skills at secondary school level; and also ascertain if there exists gender and school-type differences in Jalingo metropolis, Taraba State, Nigeria.

Research Questions

1) What are students overall attitudes toward STEM 21st century skills?
2) Is there any significant variation in attitudes between male and female students towards STEM 21st century skills?
3) Is there any significant variation in attitudes between students at different school-types towards STEM 21st century skills?

Research Hypotheses

To guide the study, these null hypotheses were also tested at; 0.05 level of significance:

$H0_1$: There is no significant difference between female and male students' attitude towards STEM 21st century skills.

$H0_2$: School type has no significant influence on students' attitude towards STEM 21st century skills.

Research Method

The descriptive survey method through the administration of questionnaire which was designed to answer the research questions. The questionnaire was for students to respond to by indicating their perceived correct options on their attitudes towards STEM and society. The population of the study comprise of all government secondary school in Jalingo metropolis. For the purpose of this research work, the population narrowed down to government secondary schools to be randomly selected. The criterion used for this selection is that, they must have offered Physics, Chemistry, Biology and Mathematics in the school certificate examination.

The simple random sampling technique was used to select 120 students offering chemistry, 40 students from each school type (Science & Technology, Conventional and Science schools) of the three co-educational

(since gender is a variable considered in the study) secondary schools from among the total number of secondary schools in Jalingo metropolis for this study.

The data of this study are obtained through the use of an 11-items attitude scale questionnaire adopted from Mahoney (2010) on a sub-dimension titled Students' attitudes towards the 21st century skills was used as instrument for data collection. A closed ended question was used which consist of five points scale as follows: Strongly agree (SA), Agree (A), Undecided (U), and Disagree (D), strongly disagree (SD) answer. The questionnaires comprises of two section "A" contains the bio data of the respondents with two variables: gender (male or female) and school type (Science & Technology, Conventional and Science schools) while section "B" contains the 11-items questionnaire. In order to ensure a good return of questionnaires, the researcher used direct delivery techniques (DDT) i.e. questionnaires was given to the students by hand; and was collected from the respondents as soon as they were filled.

Within the scope of the research, the data obtained from the scale were checked and the incomplete or erroneous collected data were extracted; and if the obtained data was suitable for analysis was also checked. The data was then analyzed by using the non-parametric tests since the data did not exhibit a normal distribution trend. IBM Statistical package for social sciences (SPSS 22) was used in the analysis of the data. Descriptive statistics (mean and standard deviation) was used in answering the research questions; while the hypotheses were tested with t-test and Analysis of variance (ANOVA) at 0.05 level of significance. A Tukey's Honest Significance Difference (HSD) test was also run following a one-way ANOVA to help assess and interpret the statistical significance differences between pairs of group means. Since the scale used in the collection of quantitative data is 5-Likert, the scale options, the points awarded and scoring intervals or range used during the analysis of the data are as follows: Strongly Disagree=1 (1.00-1.80), Disagree=2 (1.81-2.60), Undecided=3 (2.61-3.40), Agree=4 (3.41-4.20), and Strongly agree=(4.21-5.00) respectively. The decision of accepting or rejecting the research question was taken as follows: Decision =5+4+3+2+1/5 =3.00. Therefore, the attitudinal mean of 3.00 (60%) and above is taken as agree (positive) while mean below 3.00 is considered as disagree (negative).

Presentation Results

Students overall attitudes toward STEM 21st century skills

Answering research question 1: What are students overall attitudes toward STEM 21st century skills?

The answer to research question one is presented in Table 1.

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Table 1: Descriptive Statistics on overall students' attitudinal scores toward STEM 21st century skills.

	Items	N	Mean	Std.Dev.	Rank
1.	I am confident I can lead others to accomplish a goal.	120	4.0750	.95409	8
2.	I am confident I can encourage others to do their best.	120	4.1917	.98130	5
3.	I am confident I can produce high quality work.	120	4.1167	.89050	7
4.	I am confident I can respect the difference of my peers.	120	3.9750	.86445	11
5.	I am confident I can help my peers.	120	4.2333	.83750	4
6.	I am confident I can include others' perspectives when making decisions.	120	4.0417	.89251	9
7.	I am confident I can make changes when things do not go as planned.	120	4.0000	1.05321	10
8.	I am confident I can set my own learning goals.	120	4.3250	.82158	2
9.	I am confident I can manage my time wisely when working on my own.	120	4.3583	.83812	1
10.	When I have many assignments, I can choose which ones need to be done first.	120	4.1500	.87591	6
11.	I am confident I can work well with students from different backgrounds.	120	4.2917	.86380	3
	Overall Total		4.1599	.89754	

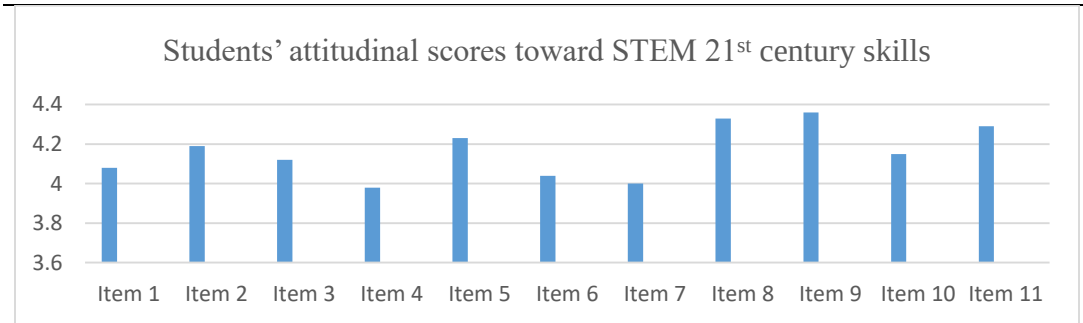


Figure 1: Students' attitudinal scores toward STEM 21st century skills.

The descriptive statistics result in Table 1 and graphical representation in Figure 1 shows the attitudinal mean scores of students' towards the STEM 21st century skills. Ranking students' attitudinal mean scores in an ascending order of 1-11, the results show: Item 9- Managing time wisely, (4.36); Item 8-Setting learning goals, (4.33); Item 11-Working well with students from different backgrounds (4.29); Item 5-Helping my peers (4.23); Item 2- Encouraging others to do their best (4.19); Item 10- Giving priorities to assignments (4.15); Item 3-Producing high quality work (4.12); Item 1-Leading others to accomplish a goal (4.08); Item 6- Including others' perspectives in decision-making (4.04); Item 7- Making changes when things go unplanned (4.00); and Item 4- Respecting peers differences (3.98).The result shows mean range of 3.975-4.292 on a 5-scale which is quite high. The students 'strongly agreed' to items ranked 1-

4; while they 'agreed' to items 5-11.The overall attitudinal mean score= 4.160 (83.2%) with a standard deviation of 0.898.This result demonstrated that the students have very high attitudes towards the STEM 21st century skills. Hence, students overall attitudes toward STEM 21st century skills is very high or positive.

Students' attitude towards STEM 21st century skills based on gender

Research question 2: Is there any significant variation in attitudes between male and female students towards STEM 21st century skills?

The answer to research question two is presented in Table 2 and Figure 2.x

Table 2: Descriptive Statistics on comparison results regarding students' variation in attitudes towards the STEM 21st century skills according to gender.

	Sex	N	Mean	Std. Deviation	Std. Error Mean
Attitude towards 21st century skills	Male	72	46.0417	5.25260	.61902
	Female	48	45.3333	6.45222	.93130
Mean difference			0.70833		

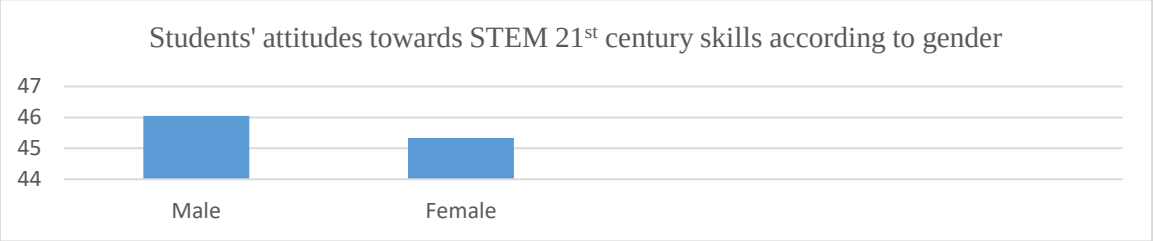


Figure 2: Variation in students' attitudes towards the STEM 21st century skills according to gender

The descriptive statistics result in Table 2 and graphical representation in Figure 2 shows the attitudinal mean scores of students' towards the STEM 21st century skills based on gender. The shows male students have mean= 46.042 (SD=0.619); while the female students have mean=45.333 (SD=0.931); which seems to be in favour of the male students with a mean difference of 0.708. To verify if the difference is statistically significance, this was tested with $H0_1$ using an independent t-test presented in Table 3.

Testing $H0_1$: There is no significant difference between female and male students' attitude towards STEM 21st century skills.

In line with the second research question and hypothesis one, an Independent t-test was used in order to determine the status of attitude levels of the secondary school students towards the STEM 21st century skills in relation to their genders. The findings obtained from the analysis are presented in Table 3.

Table 3: Independent Samples t-test results regarding students' attitudinal level towards the STEM 21st century skills according to gender

	Levene's Test for Equality Variances		t-test for Equality of Means				
	F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. Error Difference
Equal variance assumed	1.686	.197	.660	118	.511	.70833	1.07339
Equal variance not assumed			.633	86.524	.528	.70833	1.11826

Table 3 shows the inferential statistics; an independent t-test results regarding students' attitudinal level towards the STEM 21st century skills according to gender, at 0.05 level of significance. This is to t compare the mean differences in the scores of male and female students' attitude towards the 21st century skills. The independent t-test result (using equal variance assumed) shows F=1.687, T=.0660, Df=118, and p=0.511>0.05; not significant. Therefore, $H0_1$ 'there is no significant difference between female and male students' attitude towards the STEM 21st century skills'; is hereby retained. Hence, there is no significant difference between female and male students' attitude towards the STEM 21st century skills.

Students' attitude towards STEM 21st century skills based on School types

Answering research question 3: Is there any significant variation in attitudes between students at different school-type towards STEM 21st century skills?

The answer to research question three is presented on Table 4 and Figure 3.

Table 4: Descriptive Statistics on students' attitude towards STEM 21st century skills based on School-types.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Science & Tech	40	45.6500	5.97237	.94431	44.7399	48.5601	30.00	55.00
Conventional	40	45.1000	6.52333	1.03141	43.0137	47.1863	27.00	55.00
Science	40	45.5250	4.60762	.72853	44.0514	46.9986	36.00	54.00
Total	120	45.7583	5.74657	.52460	44.7196	46.7971	27.00	55.00

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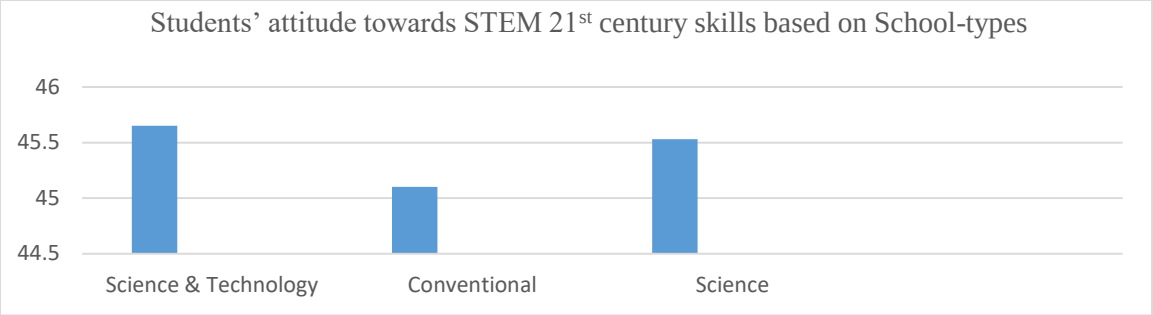


Figure 3: Variation in students' attitudes towards STEM 21st century skills based on school-types

Table 4 shows descriptive statistics on comparison results regarding STEM attitude levels according to School-types. Based on school types, in Science and technology schools' (Mean=45.650, SD=5.972); Conventional schools (Mean=45.100, SD=6.523); and Science (Mean=45.525, SD=4.608); with a total mean of 45.758 and standard deviation of 5.747. The result also shows that Science and technology schools' scored highest (Mean=45.650), followed by Science (Mean=45.525), and lastly Conventional schools (Mean=45.100); as also shown graphically in Figure 3. To verify if the difference is statistically significance, this was tested with $H0_2$ using an inferential statistics of an ANOVA and Tukey HSD as presented in Tables 5 to 7.

Testing $H0_2$: School type has no significant influence on students' attitude towards STEM 21st century skills.

In line with the third research question and hypothesis two, an ANOVA and Tukey HSD used in order to determine the status of attitude levels of the secondary school students towards the STEM 21st century skills in relation to their school-types. A Tukey's HSD test was run following a one-way ANOVA to help assess and interpret the statistical significance differences between pairs of group means (Science and technology. Conventional and Science schools); at 0.05 level of significance. The findings obtained from the analysis are presented in Table Tables 5 to 7.

Table 5: One-way ANOVA on comparison of students' attitude towards STEM 21st century skills according to school types

	Sum of Squares	Df	Mean Squares	F	Sig.
Between Groups	51.317	2	25.658	.774	.464
Within Groups	3878.675	117	33.151		
Total	3929.992	119			

Table 5 shows the ANOVA result on comparison of students' attitude towards STEM 21st century skills according to school types. The result shows F=10.774, Df=117, and p=0.464>0.05; not significant. But a post hoc tests was carried out using Tukey HSD to

help assess and interpret the statistical significance differences between pairs of group means in multiple comparisons as presented in Table 6 and a homogenous subsets of means of groups (school types) in Table 7.

Table 6: Tukey HSD Post Hoc Tests for Multiple Comparisons of students' attitude towards STEM 21st century skills according to school types

Dependent Variables: Total Tukey HSD Multiple comparison test

(I)School Type	(J) School Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Science & Tech	Conventional	1.55000	1.28746	.453	-1.5063	4.6063
	Science	1.12500	1.28746	.658	-1.9313	4.1813
Conventional	Science & Tech	-1.55000	1.28746	.453	-4.6063	1.5063
	Science	-.42500	1.28746	.942	-3.4813	2.6313
Science	Science & Tech	-1.12500	1.28746	.658	-4.1813	1.9313
	Conventional	.42500	1.28746	.942	-2.6313	3.4813

***The mean difference is significant at the 0.05 level

Table 7: Tukey HSD Homogenous Subsets of students' attitudes towards STEM 21st century skills according to school types

Tukey HSD[a] Homogenous subsets

School Type	N	Subset for alpha= 0.05
		1
Science	40	45.1000
Conventional	40	45.5250
Science & Tech	40	46.6500
Sig		.453

Means for groups in homogeneous subsets are displayed
a. Uses Harmonic Mean Samples Size=40.000

Table 6 shows the Tukey HSD Post Hoc Tests for Multiple Comparisons of students' attitude towards STEM 21st century skills according to school types. All the mean differences for school types (science & technology, conventional and science schools) multiple comparison results shows that all the mean difference for the three groups is not significant at the 0.05 level. This because the p-values .453, .658; .453, .942; and .658, .942 (for Science & technology; Conventional; & Science schools respectively) is greater than the α-value 0.05 (p-value> α-value, 0.05; Not significant). Hence, no mean difference is significant at the 0.05 level as shown in Table 6.

Also, a Tukey HSD test was carried out for the means groups in homogeneous subsets of

science, conventional and science and technology schools to determine the subset for α-value=0.05 as shown in Table 7. Table 7 also shows how means for groups in homogenous subsets are displayed using harmonic mean samples size of 40. The result shows for a subset alpha=0.05, total p-value for the different school types is 0.453. The total p-value (0.453) is greater than the α-value 0.05 (p-value> α-value, 0.05; Not significant). Therefore, $H0_2$ 'School type has no significant influence on students' attitude towards STEM 21st century skills; is hereby retained. Hence, School type has no significant influence on students' attitude towards STEM 21st century skills.

Discussion of Findings

Based on the results presented, the summary of the findings are hereby presented and discussed accordingly as follows:

i. Students' have high positive attitude toward STEM 21st century skills.
ii. There is no significant difference between female and male students' attitude towards STEM 21st century skills.
iii. School type has no significant influence on students' attitude towards STEM 21st century skills.

When the findings related to the first research question of the study were analyzed, it showed that students' attitude toward the 21st century skills (Ranking ascending: Managing time wisely, Setting learning goals, Working well with students from different backgrounds, Helping my peers, Encouraging others to do their best, Giving priorities to assignments, Producing high quality work, Leading others to accomplish a goal, Including others' perspectives in decision-making, Making changes when things go unplanned, Respecting peers differences) were positive. According to the descriptive results obtained, the attitudes of the secondary school students in towards STEM 21st century skills were generally at the level of "I agree" which means they generally showed a high positive attitude. There are researches that depict some level of similarities in terms of result such as Aydın et al. (2017) and Balçin et al., (2018). Ibrahim, and Şeker (2022) noted that students' attitudes towards the STEM 21st century skills component were more positive than other components; and the highest attitude level demonstrated by the students was towards the 21st century skills. This findings also supports Hacıoğlu (2017; 2021); and Hacioglu and Gulhan (2021) whose results revealed that pre-service science teachers stated that STEM education helped them to develop creativity, communication, collaboration, critical thinking, and problem-solving skills, which are mentioned as fundamental skills. In addition, they have mentioned that the process contributed to the development of responsibility, decision-making, entrepreneurship, analytical thinking, global world awareness, sustainability awareness, career awareness, cultural awareness, and productivity skills among the life and career skills.

These researchers (Hacıoğlu, 2017; Hacıoğlu, 2021; Hacioglu & Gulhan, 2021) also ascertained that the STEM education provided to the development of the 21st

century skills of pre-service science teachers. And, one of the goals of STEM education is to contribute to the skills expected from an individual living in the 21st century to develop the skills that individuals should possess in daily life and career processes (Lin et al. 2018; Lin et al. 2021; NRC, 2012). Stehle and Peters-Burton (2019) asserted that communication and collaboration are the core 21st Century skills that facilitate knowledge construction and real-world problem solving, while student self-regulation creates efficiencies resulting in improved knowledge construction and real-world problem solving; and ICT provides tools to support communication and reflection which leads to knowledge construction and real-world problem solving.

Ibrahim and Şeker (2022) relating to the reform initiative in the curriculum which integrated STEM education; it was aimed to raise innovative individuals with advanced innovation skills, high scientific creativity, analytical thinking, qualification that can help students get themselves employed in the fields of STEM profession, and to achieve high potential power of the national economy in global competition. Hence, STEM education or learning environments that focuses on the partial or full integration of the separate disciplines of science, technology, engineering and mathematics, including a focus on 21st Century skills or competencies to solve problems (Ibrahim & Şeker, 2022; Koul et al., 2018; Timms et al., 2018; Yang & Baldwin, 2020) is needed in the 21st century Nigeria for sustainable development.

The present study also aligns with the popular framework designed by the Partnership for 21st Century Skills [P21] (2011; 2015). Describing the skills, knowledge, and expertise students must master to succeed in work and life, the framework combines content knowledge, specific skills, expertise, and literacies. P21 believes that the "base" of 21st century learning is the acquisition of key academic subject knowledge, and that schools must build on that base with additional skills including Learning Skills (”4Cs”Critical thinking, communication, collaboration, and creativity), Life Skills (Flexibility, initiative, social skills, productivity, leadership), and Literacy Skills Information literacy, media literacy, technology literacy). However, according to Buckle, (2023), the 21st century skills refer to the knowledge, life skills, career skills, habits, and traits that are critically important to student success in today’s world, particularly as students move on to college, the workforce, and adult life. Also, as viewed by Buckle, (2023), the STEM skills are really needed in the 21st century in carrying out STEM-related tasks include cognitive, manipulative, technological skills and collaboration and communication skills; and in light of the rapid rate of progress in the STEM fields, all learners need to be engaged in continuing professional development or continuous enhancement of such competencies.

When the findings related to the second research question and hypothesis one of the study were analyzed, it was revealed that there was no significant difference between the students' attitudes towards 21st century skills based on their gender. This showed that

both sexes have positive attitudes towards 21st century skills. The finding of this study supports the results of the studies of previous researcher (Ibrahim & Şeker, 2022). According to Ibrahim and Şeker (2022), STEM education can contribute to encouraging girls to learn and develop other skills, such as STEM literacy and math skills in low-income countries; since the goal of the convergence of STEM disciplines is to improve the capabilities of students in the "four C's" of the 21st century: critical thinking, creativity, communication, and collaboration.

The findings related to the research question three and hypothesis two of the study were analyzed on students' attitudes towards 21st century skills based on school types, the overall revealed that; students' attitudes towards STEM 21st century skills is not based on school type differences . This shows that there are no differentials on students' attitude towards STEM skills based on the school type (Science & Technology, Conventional and Science schools). Though, school type is an important predictor of the success of STEM 21st century skills, using STEM education according to Huang, Jong, King, Chai, and Jiang (2022) helped close the gaps through an important educational initiative for cultivating students' 21st century skills. Huang et al. (2020) explored ways to promote students' 21st century skills through an integrated STEM-based curriculum, and the quantitative result showed that the participants' (secondary students from a government-subsidized school) creative thinking, collaboration, and perseverance improved.

Conclusion

Based on the result from the study, the following conclusions can be drawn:

Students have positive attitude towards 21st century skills. This finding is paramount because for students to be creative thinkers and problem solvers, they need the 21st century STEM skills necessary to function effectively in society and in the workplace for sustainable development.

There was no significant difference between female and male students' attitude towards 21st century skills. This showed that both sexes have positive attitudes towards the 21st century skills; and there was no gender differences.

Also, school type (Science and Technology, Conventional and Science) has no significant influence on students' attitude towards 21st century skills. This showed that students in different types or category of school have positive attitudes towards the 21st century skills; and there was no school-type differentials.

However, honing on the 21st century skills as concluded by this study, it is essential to ensure that students are prepared for higher institution, career, and civic life. And, as viewed by Buckle (2023) which is also applicable to this study, the 21st century learning strategies and implementation entails that curriculum planners, school administrators and educators build a staff capacity to demonstrate 21st century skills in support of student learning; develop strategies to support teachers with implementation of 21st century skills; assess

students' and equip educators with data to proactively identify and support students who are off track. Hence, STEM education sought to develop and provide innovative solutions to global issues, in particular those directly related to the 2030 Sustainable Development Goals. The time has come for the education sector to rethink traditional curriculum boundaries, where knowledge and skills are segregated according to subjects. The International Bureau for Education (IBE) and United Nations Educational, Scientific and Cultural Organization (UNESCO) has led discussions to identify and make explicit the competences that transcend knowledge areas with a view to assisting member states to develop competency-based curricula that prepare young people with the required competences to live sustainable, fulfilled and healthy lives in the rapidly changing world of the 21st century (IBE-UNESCO, 2017; Ng, 2019) in a gender- and STEM-learning friendly classroom environments.

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