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ASSESSING SCIENCE TEACHERS ATTITUDE, KNOWLEDGE AND APPLICATION OF STEM EDUCATION IN TARABA STATE

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ABSTRACT

STEM (Science, Technology, Engineering & Mathematics) education has benefits for students, such as increasing achievement and improving attitudes, motivation, interest toward STEM disciplines, and higher-order thinking skills. Providing STEM education and applying it in learning is influenced by teacher's knowledge and attitude. Assessment is necessary for every educational activity, including in the field of STEM education most especially the domains of Attitude, Knowledge and Application (AKA). The purpose of this study, is to determine science teachers' attitude, knowledge and application of STEM education in Taraba State, Nigeria. The study adopted descriptive survey research design. A sample of 120 teachers were used for the study. Results of the study revealed that science teachers have good attitudes regarding STEM education and are willing to collaborate with other teachers. But, the findings showed that science teachers do not have good knowledge regarding STEM education and their application is low. Based on the findings, it was concluded that Science teachers have good attitude in STEM education, though still having poor knowledge and low application. Therefore, it was recommended amongst others that school administrators and ministries should work together to ensure Science teachers' quality, motivation and confidence; who are closely linked to STEM disciplines to enable them have good knowledge and high application of STEM Education.

Keywords: Science Teachers, Attitude, Knowledge, Application, STEM education, Taraba State

Introduction

Educational system today is greatly experiencing change. Education, and particularly Science, Technology, Engineering and Mathematics (STEM) education, plays a crucial role in achieving the Sustainable Development Goals (SDGs). STEM is an accumulation of the knowledge components of science, mathematics, engineering and technology, which have become inextricably linked. STEM education seeks to elaborate and provide innovative solutions to solve global issues. The applications of scientific knowledge to create innovative programs is solely the mint of recent time science programs taught in schools today. In a report by Care, Griffin, and Wilson (2018) posited that educational institutions are required to be able to innovate in order to facilitate students to have the skills needed in the 21st century. Skills required in carrying out STEM-related tasks include cognitive, manipulative, technological, collaborative and communicative skills.

STEM education is one of the most prominent educational initiatives in the

twenty-first century (Huang, Jong, King, Chai & Jiang, 2022; Jong et al., 2021; Lau & Jong, 2022). As STEM education responds to societal needs, values and concerns, it is important to develop a rounded understanding of STEM philosophy and practice. The core feature of STEM is the use of science, mathematical, technical, engineering knowledge to solve daily or societal problems, making the learning of science, technology, engineering and mathematics more meaningful and contextual. STEM literacy has been defined by Bybee (2013) as:

i. Knowledge, attitudes, skills [and values] to identify questions and problems in life situations. Explain the natural and designed world, and draw evidence-based conclusions about STEM related issues;

ii. Understanding of the characteristic features of STEM disciplines as forms of human knowledge, inquiry, and design;

iii. Awareness of how STEM disciplines shape our material, intellectual, and cultural environments; and

iv. Willingness to engage in STEM-related issues with the ideas of science, technology, engineering, and mathematics as a constructive, concerned and reflective citizen.

Bybee (2013, P5.)

In a fast-changing world, with technology evolving at an unprecedented pace, competence is conceptualized as a developmental capacity rather than as a set of fixed skills (Marope, 2017). STEM competence as viewed by Zhang, Chia, and Chen, (2022) refers to an individual's ability to apply STEM knowledge, skills and attitude appropriately in his or her everyday life, workplace or educational context. It should not be confined and developed within the traditional boundaries of discrete bodies of knowledge (e.g. physics competence or computing competence). STEM competence covers both the 'know-what' (the knowledge, attitudes and values associated with the disciplines) and the 'know-how' (the skills to apply that knowledge, taking account of ethical attitudes and values in order to act appropriately and effectively in a given context).

With the increasing populace that seems to be unstoppable, the expansion of STEM into facets of society is the development that researchers and policy makers have been working tirelessly to incorporate in our educational system. Evident to this report, Havice (2015) extracts that the job market has experienced an unprecedented demand for individuals with training and degrees in STEM related fields. In this case, in order to maximize the effects of STEM, early interventions are vital and should also be considered when implementing integrated STEM Learning. Evenly, STEM teaching and learning goes beyond the mere transfer of knowledge. It serves the following purposes, which are in

line with the National Policy on Education by the Federal Republic of Nigeria (FRN, 2013):

i. Cultivate inquiring, knowledge and rational mind for the conduct of a good life and democracy;
ii. Produce scientist for national development;
iii. Service studies in technology and the cause of technological development;
iv. Provide knowledge and understanding of the complexity of the physical world, the forms and the conduct of life.

In light of the above, STEM education in the 21st century Nigeria is no more regarded as a story tale, it has been existing in this era for long; though teachers' applicability is not fully ascertained. It integrate four disciplines, namely: Science, technology, engineering and mathematics. Cooper and Heaverlo, (2013) pointed out that the 21st century is a technology age and in this age STEM education play an important role in shaping the culture and economic development with a viewpoint of innovativeness, creativity and problem solving. According to Sari, Alici, and Sen, (2017), many researchers argue that STEM instruction contribute to the national economy and educators attempt to develop integrated instructional programs. The findings by Sari et al (2017) revealed that the students' attitudes towards STEM disciplines, STEM career interests in STEM-related occupations significantly increased using a problem-based STEM instruction. In fact, Wei and Maat, (2020) recently predicted in their study that STEM will be the main occupation in the future; hence stated that STEM education is an educational program that needs to be implemented to fulfill the ideal future of the nation's interest.

STEM education according to English, (2016) is a unique approach in the context of the interrelationships between Science, Technology, Engineering and Mathematics. According to Moore et al (2014), STEM education has an attempt to combine all or two of the STEM disciplines in certain units (e.g. chapters or concepts) based on interdisciplinary relationships and real world problems. Instead of using conventional didactic teaching approaches, successful STEM education programs usually adopt constructivist student-centered approaches with a strong emphasis on learners' active participation (Sari, Alici, & Sen, 2017; Wan et al., 2021; Weng et al., 2022). Hence, STEM education has the characteristics of student-centered learning. Thus, STEM education as viewed by Sujarwanto, Madlazim, and Ibrahim, (2019) aimed to prepare students to face the development of science and technology, be ready in the world of work, and be able to solve problems. STEM education has benefits for students, such as increasing academic achievement in science and mathematics (Acar et al., 2018; Herdem & Ünal, 2018; Kartal & Tasdemir, 2021), improving attitudes, motivation, and interest toward STEM disciplines (Herdem & Ünal, 2018; Karakaya et al., 2020; Lee et al., 2019; Kartal and Tasdemir, 2021; Wahono and

Chang, 2019a; Wong), promoting conceptual understanding (Margot & Kettler, 2019), and improving higher-order thinking skills and technological literacy (Aldahmash et al., 2019; Herdem & Ünal, 2018).

STEM education is also a learning approach that removes the traditional barriers that separate science, technology, engineering, and mathematics from each other and integrates them into students' learning experiences (Vasquez, Sneider, & Comer, 2013). The success of STEM education is influenced by how it's been implemented within the framework of the learning model. Besides, teachers' ability in STEM education also determines its' success since they are one of the main factors in Education, as well as STEM education. This shows that, teachers play a vital role in the success of any STEM education. And, STEM education in schools is considered to provide more opportunities in life. However, teachers are facing instructional challenges because of the interdisciplinary nature of the STEM curriculum and the current typical school structure. As noted by McMullin and Reeve, (2014), teachers' beliefs, knowledge base, and understandings are the driving force for overcoming instructional challenges in STEM education.

The success of the STEM education depends on teachers' beliefs, attitudes, their knowledge and applicability in adapting to instructional implementation of STEM concepts. Hence, the results from Dong et al (2020) indicated that Chinese STEM teachers encounter higher-level intrinsic challenges to instructional implementations based on their beliefs and knowledge. And, teachers who utilize their experience of teaching science as their main discipline and then attempt to integrate STEM using mathematics and engineering are likely to encounter higher level intrinsic challenges in implementation. Also, the findings by Hasanah and Riandi, (2020) revealed that 93% of respondents stated that the STEM education program is effective to increase their competence, 70% of respondents stated that they're still implementing STEM education in class; and after implementing the STEM approach in the classroom, students' ability to collaborate, communicate, be critical, and be creative are well improved. And, as noted by Kartal and Tasdemir (2021), teachers' characteristics, perceptions, and attitudes related to STEM influence teachers' implementation of integrative STEM approaches and, as a result, shape the learning environment.

However, the study by Abdullah, Hamzah, Hussin, Kohar, Rahman and Junaidi (2017) claimed that findings from the previous studies show that the number of students graduating from the STEM field is decreasing. Abdullah et al (2017) hinted further that, the results from the critical findings are presumed to encounter a possible shortage of STEM workforce in the future. Additionally, teachers' attitudes, knowledge and applicability in the teaching-learning process is in no doubt some of the influential factor bringing these recorded downfall in the educational system in Nigeria and Taraba State in particular. And, as noted by Sujarwanto et al (2019), teachers' attitudes

towards STEM is one factor contributing poor interest by students. Indeed, positive attitudes can lead to positive behaviours because non-measurable attitudes can be expressed through behavior. Generally, as opined by Lucietto, Russell and Schott (2018) teachers are people who are ideally adapted to implement STEM education, and they play a significant role in educating students. And, in examining students' perceptions of STEM subjects and career interests, in an exploratory study carried out by Zhang et al (2022) among secondary students in Hong Kong; the results revealed a need to stimulate students' interest in STEM education and search for ways to make a connection between STEM subjects and future careers through STEM teaching in the classroom.

Research studies by Wahono and Chang (2019a) in their report, assessing teachers' attitude, knowledge and application on STEM, revealed that science teachers have a very good attitude, a moderate-level category in the application, and a low level category in knowledge regarding STEM education. Wahono and Chang, (2019b) also developed and validated a survey instrument (AKA) towards attitude, knowledge and application of STEM which is also relevant to the domains of survey in present study. Similar studies by Wei and Maat, (2020) examined the attitude of Primary school teachers towards STEM education; and results revealed that the attitude of the primary school mathematics teacher was moderate and there were no significant difference in the attitude of the primary school mathematics teacher by gender. Further report by Kartimi, Ari, and Dindin (2021) on assessing the elementary teacher readiness towards STEM-based contextual learning in 21st Century Era; revealed that elementary school teachers were ready to implement STEM-based contextual learning. According to Kartimi et al (2021), the main problem faced by the teachers to implement STEM-Based contextual learning was the difficulty of integrating the subjects and providing contextual aspects related to students' real life. STEM education in Africa is lagging. As such, teachers are involved in fight of this befalling standards. It is noted that, the teacher is important in a nation for economic development as no nation can rise without good caliber of teachers. The recent responsibility of teachers in our educational system is more extensive now than in the past and this might be as a result of the various challenges bedeviling the nation and in Taraba State (study area) in particular where there exists a gap on empirical researches related to science teachers' attitude, knowledge and application of STEM education. In order to fill this gap, there is need to explore on science teachers' attitude, knowledge and application of STEM education in Taraba State, Nigeria.

Domains of Attitudes, Knowledge and Application (AKA) of STEM education

Learning design that connects interdisciplinary in STEM education is a complex activity. Those complex activities as observed by Kelley and Knowles (2016), require that Science teachers make efforts for

students to understand how to apply or implement STEM in real-world problems. According to Urban, and Falvo (2016), the teaching role in STEM education can be viewed from domains of attitudes, knowledge, and application (AKA) of STEM in learning; and these three domains (attitude, knowledge, and application) have an opportunity that is closely related to each other.

The first domain surveyed in this study is attitude towards STEM. There are several notions of attitude. Maio and Haddock, (2014) defined attitude as an assessment of an object that can be stated with certain conditions such as pleasant or unpleasant, good or bad. Perloff (2016) defined attitudes as a show of mental and emotional entities that characterize one's actions and thoughts. On viewing attitude, Pryor, Pryor and Kang, (2016) stated that attitudes are feelings towards a habit or object that is raised through negative, positive, or neutral expressions. While, Sujarwanto et al (2019) defined attitude towards STEM as the teacher's level of curiosity towards STEM education, the teachers agreement to apply the integration of STEM during learning, and what the teacher thinks about STEM education. Attitude has become an important area of educational research because numerous studies have linked students' attitudes towards the STEM domains to students' achievements in mathematics and other science subjects (Fulmer et al., 2019; Gokhale & Machina, 2014; Kazár, 2014; Offor, Bubou, & Gumus, 2020). In line with this, Offor et al (2020) in evaluating teachers' influence on students' attitudes towards STEM subjects from selected secondary schools in Bayelsa State revealed that the identified variables (teachers' pedagogical content knowledge (PCK), mastery of content knowledge, enthusiasm, and temperament) influenced students' attitudes toward STEM subjects from selected secondary schools in Bayelsa State, Nigeria. In this study, attitude is operationally defined as Science teachers' cognitive knowledge level or awareness about STEM education activities in secondary schools in Taraba State.

The second domain surveyed in this study is knowledge about STEM. Sujarwanto et al (2019) defined STEM knowledge as all the information that the teacher has about the characteristics of STEM, the advantages, and the disadvantage of STEM and the integration between disciplines in STEM. Application is an action involving an idea or procedure in an activity to achieve a certain goal. The application of STEM in this study means the efforts made by teachers during learning to involve students in integrated STEM activities. In this study, knowledge is operationally defined as Science teachers' cognitive knowledge level or awareness about STEM education activities in secondary schools in Taraba State.

The third domain surveyed in this study is application of STEM. According to Wahono and Chang, (2019a), the terms application, practice, and implementation are words that have the same relative meaning. Meanwhile, practice is the actual application

or use of an idea, belief, or method, as opposed to theories relating to the practice. Implementation is the process of putting a decision or plan into effect or execution. In this current study, the term 'Application' is preferred rather than practice and implementation. The term application is more appropriately applied to describe the teacher's STEM performance in the classroom. Application of STEM education as operationally defined in this study as the use, practice, implementation, realization or performance of STEM activities by Science teachers.

Statement of the Problem

STEM education seeks to develop and provide innovative solutions to global issues, in particular those directly related to teachers knowledge, applicability and attitudes towards which currently there are limited researches. There is, currently, limited research into the prerequisite knowledge, skills, attitudes, values and experiences in the applicability of effective STEM education. This is especially true for STEM education, since the concept of STEM as a connected and potentially integrated field of study, is relatively new. At the education level, Science teachers become one of the important aspects of the implementation of STEM education. Then, it is necessary to research attitudes, knowledge, and application of STEM in learning by the Science teacher.

Also, not much is known about the development of STEM education since its introduction into the educational system of the country. As such, the present study sought to carry out similar study in Taraba State to investigate science teachers' attitude, knowledge and applications of STEM education in the state. Though, based on previous reviews findings have shown that there is no research work that was carried to assess science teachers' attitude, knowledge and application of STEM education in Taraba State. Prior to this, teachers might likely have various competency in relation to science – technology, science – mathematics, or science – technology – engineering, which the present research paper intends to find out teachers attitudes, applications and knowledge of STEM education in Taraba State. It is in this view that the present study sought to answer the following questions: What are the Attitude of Science Teachers towards STEM education in Nigeria? How can Knowledge of Science Teachers bring improvement on Students' Academic Progress and Achievement? What is the level of Science teachers' ability in the application of STEM education in Nigeria? This research attempted to empirically find answers to the questions posed in this study.

Research Questions

1. What are the attitudes of science teachers based on their response to STEM education in Taraba State?
2. What is the knowledge level of science teachers in response to STEM education in Taraba State?

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3. To what level is the application of STEM education among science teachers in Taraba State?

Research Method

The study adopted descriptive survey design. The survey conducted focused on the domains attitudes, knowledge, and application (AKA) of STEM Education by Science teachers. The study was conducted in Jalingo Metropolis the capital city of Taraba State with a target population of 723 secondary schools Science teachers who teach Science-related courses, Technology-related courses, Engineering-related courses and Mathematics. However, a sample of 120 Science teachers (72 males and 48 females) were selected were randomly selected to respond to the questions in the survey. The assessment, within this study, includes three domains, namely attitudes, knowledge, and applications (AKA) regarding STEM education adopted from Wahono and Chang, (2019b). The instruments used for the study were Teachers attitudes on STEM education Questionnaire (TASEQ), Teachers Knowledge on STEM education Questionnaire (TKSEQ) and Teachers Applicability of STEM education Questionnaire (TASEQ) respectively. The instruments were taken to three experts for face and content validation; which gave an average agreement rate of 78.67% which means that the instrument is valid and suitable for data retrieval.

In order to establish the reliability of the instrument, a pilot test was carried out to pre-test the research plan. This was done with a view to further validate and ensure that the instrument was suitable and the research is reproducible. A pilot test was carried out with 20 science teachers in secondary schools outside the study area. The aim of the pilot test is to establish the reliability of the research instrument and workability of the research design and procedure. The analysis of instrument reliability level was conducted after obtaining data from the respondent test result, using Cronbach's Alpha method with reliability indexes of 0.81, 0.83 and 0.79 for Attitude- TASEQ, Knowledge- TKSEQ, and Application- TASEQ respectively. The Cronbach's alpha values of each domain or construct were all over 0.70; where scale reliability was evaluated similarly to Cronbach's alpha, with values greater than 0.6 considered acceptable, and values between 0.7 and 0.9 considered good. The Attitude- TASEQ, Knowledge- TKSEQ, and Application- TASEQ instruments were all valid, good and reliable for data collection. In this case, three different research questions were used to guide the research findings. Data collected were analyzed using Mean, standard deviation to answer research questions one and two; and Pie-Chart (frequencies & percentages) to answer research question three. Results from data analyzed were presented and discussed.

Presentation of Results and Discussions

This research produced data on Science teachers' attitudes, knowledge, and application of STEM education in Taraba State as shown as follows:

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Attitude of Science Teachers toward STEM education

Attitudes toward STEM were measured using 10 items or statements from the instrument, Teachers attitudes on STEM education Questionnaire (TASEQ); and teachers were asked to determine the level of agreement/disagreement in answering research question one, the results are presented in Table 1.

Answering Research Question 1: What are the attitudes of Science teachers based on their response to STEM education in Taraba State?

Table 1: Attitudes of Science Teachers Regarding STEM education in Taraba State.

S/N	ITEMS	Mean	Std. Deviation	Decision Mean≥3.00
1	I am willing to collaborate with other subject teachers	3.34	1.26	Accepted
2	I am ready to attend STEM education workshops/courses	3.88	1.18	Accepted
3	I believe that STEM education can attract students	3.68	0.77	Accepted
4	I believe that the quality of education can be improved through STEM education.	2.99	1.39	Rejected
5	I really enjoy doing the STEM teaching and sessions	3.40	1.19	Accepted
6	I do not find it difficult to implement STEM education	3.13	1.11	Accepted
7	I am ready to use new teaching methods	3.50	1.29	Accepted
8	I set my goals in STEM education	3.84	1.43	Accepted
9	I customize the teaching methods based on aspects of students' need	4.35	0.85	Accepted
10	I keep trying to get the effectiveness of STEM education.	3.03	0.97	Accepted
	Average Mean	3.51		Accepted
	Valid N (listwise)	120		

Results from Table 1 indicates that all the items were accepted in the criterion point of Mean≥3.0, though only item number 4 was rejected (Mean=2.9917) that is below the Criterion point of 3.0. Generally, the results from Table 1 showed that majority of the Science teachers in Taraba State have good attitude towards STEM education.

Findings in this research as shown in Table 1, revealed that many of the science teachers are willing to collaborate with other teachers. The results from the study also shows that science teachers believe that education can be improved through STEM education. Hence, results from the present study reveals that Science teachers in Taraba State have good attitude towards STEM education. This finding supports that of Wahono and Chang, (2019a) who revealed that Science teachers in Indonesia have a very good attitude regarding STEM education. This findings contradicts Wei and Maat (2020) whose results revealed that the attitude of the primary school mathematics teachers in Hulu Langat district, Malaysia towards STEM education was moderate. But, as noted by Wei and Maat (2020), positive attitudes can lead to positive behaviours such as being more motivated and confident in the implementation STEM education. And,

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Dailey, Bunn, and Cotabish, (2015) opined that high-quality STEM teachers are more successful in providing STEM education effectively and students will enjoy studying STEM according to STEM objectives. This result is inconsistent with the previous research by Bagiati and Evangelou, (2015) who revealed that teachers are worried and less confident when asked to teach STEM in the classroom. The behavior of STEM teachers in delivering their teaching would be affected if their attitude towards achieving the goal is not in line with their understanding. On top of that, as observed by Wei and Maat (2020), positive attitudes such as confidence and motivation will improve with the attainment of STEM education targets by science teachers.

Knowledge of Science Teachers about STEM education

Knowledge of Science teachers toward STEM education were measured using 5 items or statements from the instrument, Teachers knowledge on STEM education Questionnaire (TKSEQ); and teachers were asked to determine the level of agreement/disagreement in answering research question two.

Answering Research Question 2: What is the knowledge level of Science teachers in responds to STEM education in Taraba State?

Table 2: Knowledge of Science Teachers regarding STEM education in Taraba Satate.

S/N	ITEMS	Mean	Std. Deviation	Decision Mean≥3.0
11	I have good knowledge regarding STEM education	1.47	0.87	Rejected
12	I make improvisation of the teaching equipment to assist students learn better	1.96	1.10	Rejected
13	I make sure my students have moderate knowledge of STEM education	2.47	1.32	Rejected
14	Am aware of the teaching difficulties of STEM in our schools	2.90	1.58	Rejected
15	I make sure the curriculum suits my students learning abilities	2.94	1.32	Rejected
	Average Mean	2.35		Rejected
	Valid N (listwise)	120		

Results from Table 2 indicates that all the items were rejected at the criterion point of Mean≥3.0. It means that Science teachers out of the selected 120 teachers have poor knowledge level of STEM education in Taraba State. Hence, it was found the respondents do not have good knowledge regarding STEM education in the selected study areas. It support findings by Wahono and Chang (2019a) who believes that teachers in Indonesia have good knowledge regarding STEM education. Teachers have an important role to play in preparing learners to face advances in technology and science

that occur in society. According to Rinke, Gladstone-Brown, Kinlaw, and Cappiello, (2016) Science teacher preparation in STEM education is an important factor. Thus, in the context of STEM education, teachers play a role in preparing students to face the development of technology and science in society; and provide appropriate knowledge about STEM. Regarding aspect of knowledge as observed by Sujarwanto et al (2019), more than 50% of the respondents have adequate knowledge of the term STEM; which almost contradicts the present study. Mostly, good knowledge will lead to a good attitude. People who have good knowledge of something, especially if something is really good, will most likely have a good viewpoint or attitude; and this argument is reasonable as opined by Wahono and Chang, (2019a) because attitude is rooted in familiarity and awareness embedded in strong knowledge and skills. Hence, Karisan, Macalalag, and Johnson, (2019) noted that STEM knowledge and expertise of the 21st century will then be passed on to educators, whether pre-service teachers or teachers who have taught in schools to understand and accept STEM education sincerely. Therefore, the results indicated that the Science teachers have poor knowledge of STEM education which requires follow-ups for adequate awareness of STEM objectives and activities for its effectiveness in schools.

Application of STEM education by Science Teachers

Application of STEM education by Science teachers were measured using 5 items or statements from the instrument, Teachers Applicability of STEM education Questionnaire (TASEQ) in a 5-Likert scale; and teachers were asked to determine the level of their applicability in answering research question three.

Answering Research Question 3: To what level is the application of STEM education among Science Teachers in Taraba State?

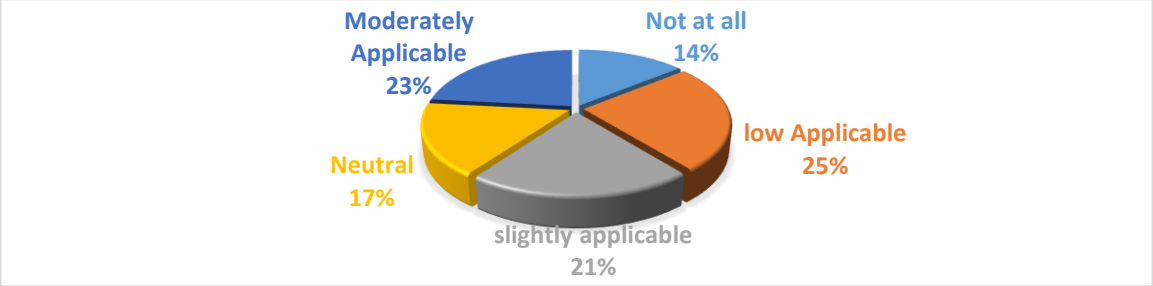


Figure 1: Science Teachers Responses on Application of STEM education in Taraba State.

Results from Figure 1 above shows that majority of the respondents have low application of STEM education as shown 30(25%). Also, 28(23%) have moderate application, 25(21%) have slight application, 20(17%) and 17(14%) shown neutral and not

at all. The results gives an average percentage of 20% of Science teachers STEM education application which is quite low.

As shown in Figure 1, Science teachers have low applicability of STEM education. In this response, it contradicts the findings of Wahono and Chang (2019a) who purports that teachers have moderate applications of STEM education. However, science teachers cannot implement STEM education if their application capability is poor. As such, Kartimi, Ari and Dindin (2021) on the elementary teacher readiness towards STEM-Based contextual learning in 21st Century Era. Is likely to be rejected by this present study as their result revealed that elementary school teachers were ready to implement STEM-based contextual learning. However, as noted by Sujarwanto et al (2019) there have been efforts to try to integrate Engineering and Technology in STEM learning through engineering design (English & King, 2015; Tati, Firman & Riandi, 2017), utilizing learning software (Alan, Zengin, & Kececi, 2019), and implementing integrated project-based and STEM teaching (Siew & Ambo, 2018). The results by Sujarwanto et al (2019) pointed out that Science teachers strongly agreed to apply STEM education in learning and are sure that students would get added value when applying STEM education. As noted by Sujarwanto et al (2019), only few teachers know how to apply STEM education. And, as observed by Ruiz et al (2014), though STEM education has been tried to be adapted in several countries, the percentage of teachers who know how to apply in learning is still small. The results indicated that the Science teachers have low applicability of STEM education which requires follow-ups for adequate implementation. This research implies that there is a need to increase the understanding the interrelationships between aspects of STEM, and need to develop STEM-based learning models to support the application of integrated STEM in Science learning in order to improve the attitudes and knowledge level of Science teachers towards STEM education in Taraba State.

Conclusions and Recommendations

Based on the findings of this study, it was concluded Science teachers in Taraba State have good attitude in STEM education, but they do not have good knowledge of STEM education; and the applicability of STEM education in secondary schools in Taraba State is low. The differences in knowledge and the application of STEM education may have resulted from the educational background and teaching experience of the Science teachers; though no much differences in attitudes. The goal of STEM education is believed to be achieved when Science teachers demonstrate positive attitude, good knowledge and high application or implementation of this educational transformation.

Based on the conclusions drawn from the study, the following recommendations were made:

i. School administrators and ministries should work together to ensure Science teachers' quality, motivation and confidence who are closely

linked to STEM disciplines to have good knowledge and high application in STEM Education in secondary schools.

ii. There is need for heads of schools and ministries to organized seminars and workshops to create awareness for science teachers to enable them have adequate knowledge and realized the impact of STEM education in Secondary school system.

iii. There is constant need to get experts to supervise both the service and pre-service school teachers to ensure they apply STEM education in their curriculum practices in schools.

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