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Promoting Quality Education: Implications of Awareness-creation, Support, and Interest in STEM Education among Private School Students in Ibadan, Oyo State, Nigeria

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Abstract
This qualitative study explored teacher librarians' awareness, support, and interest in promoting STEM (Science, Technology, Engineering, and Mathematics) among school children in Nigeria. The study adopted a qualitative approach with 30 secondary school students from Ibadan, Nigeria in a focus group. The 8-week discussion group was guided by predetermined questions about students' STEM perceptions and teacher librarians' roles. This also include the pre and post behaviour of the students. Findings revealed teacher librarians significantly impact STEM education by curating STEM collections, collaborating with educators, and facilitating STEM programs and hands-on activities. The study concludes that teacher librarians are important for effective STEM instruction by creating supportive, engaging learning environments. Recommendations include reviewing policies guiding school libraries and STEM education, providing teacher librarians with more STEM-focused training and professional development, and encouraging teacher librarians to regularly promote STEM learning experiences. This study emphasises the vital role of teacher librarians in improving STEM education quality in Nigeria.

***Keywords**: STEM, SDGs, Teacher librarian, Quality Education*

Introduction
In September 2015, the United Nations general assembly formally adopted the 2030 agenda for Sustainable Development which includes 17 Sustainable Development Goals (SDGs). The SDGs built on the Millennium Development Goals (MDGs) and aim to end poverty, protect the planet, and ensure prosperity for all as part of a new global sustainable development agenda (United Nations Development Programme, 2018). Each of the 17 SDGs has specific targets to be achieved by 2030. In addition, the SDGs present an urgent call to action by all countries and stakeholders to collaborate in tackling the pressing economic, social and environmental challenges facing the world. Generally, libraries of all types, as centers of research and education have a profound role to play in advancing the SDG agenda (Mensah, 2019). This article explored how teacher librarians in particular are using their expertise to enhance the promotion of quality education as regards SDGs with focus on STEM.

The SDGs Target 4.7 specifically calls for education to promote sustainable development and global citizenship in knowledge and skills (DuBoff, 2019). As centers of learning, secondary schools have a key role to play in educating youth to

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become sustainability change-agents. Integrating the SDGs into science, technology, engineering and mathematics (STEM) education can help catalyze this transformation (Babalola, Fakoyede, Ojobola & Abiona, 2023). STEM subjects provide the perfect gateway for introducing secondary students to sustainability issues and solutions. Mathematics can be used to analyze trends and projections related to SDG topics like renewable energy expansion, greenhouse gas emissions or income inequality. Students can apply technology and engineering design principles to invent solutions that advance sustainable production and consumption. In science courses, systems thinking and life cycle assessment activities allow students to comprehend interconnected SDG challenges surrounding food security, water scarcity and climate change (Mensah, 2019).

According to Mahmod (2019) project-based learning is an effective instructional approach for connecting STEM curriculum with sustainability. Secondary school students could be challenged to collaboratively design an energy-efficient home that utilizes renewable resources, aligned with SDG7 on clean energy. Alternatively, students may develop software applications to reduce food waste in schools, which could be linked to SDG12 on responsible consumption. Through such, hands-on projects can be connected to real-world issues. Likewise, students deepen their STEM knowledge while developing critical thinking skills to create innovative solutions for local sustainability problems. However, this would only be possible when more students are encouraged to take up STEM subject. Similarly, getting more students to take up STEM subjects and engage in innovative practices requires cross-disciplinary collaboration and flexibility.

Teacher librarians, as custodians of information and experts, are saddled with the responsibility of supporting school curriculum, enrich STEM teaching and encourage more students to take interest in stem subjects. The school library run by teacher librarians is a fertile ground for boosting quality of STEM education by providing the facilities, resources, and expert support which promote innovative thinking, self-directed study and a guided sense of adventure among students. This equips secondary students with the knowledge, skills required to become engaging citizens and future sustainability leaders (Costa, Ferreira & Pinho 2023). In addition, with the requisite support from the school library, STEM teachers can effectively teach key scientific and technical concepts through the lens of sustainable development goals. However, there is a paucity of studies on the role of teacher librarians in creating awareness, support, and stimulating interest in STEM education among private school students. This gap in literature is behind the current study

Research Questions (Pre-behavioural questions)

1. What is your understanding of Science, Technology, Engineering, and Mathematics (STEM) education?
2. How interested are you towards Science, Technology, Engineering, and Mathematics (STEM) education?
3. Do you think there are benefits or job opportunities if you take the subject related to Science, Technology, Engineering, and Mathematics (STEM) education very seriously?

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4. Does the method of teaching STEM by your teachers affect your view towards Science, Technology, Engineering, and Mathematics (STEM) education?
5. Does your Science, Technology, Engineering, and Mathematics (STEM) teacher spur awareness in you?

Literature Review

The STEM education, encompassing science, technology, engineering, and mathematics, is increasingly acknowledged as pivotal for national development. In Nigeria, education plays a vital role in fostering or promoting innovation, improving individuals' standard of living, and driving economic growth. Nevertheless, regardless of its implication, Nigeria is still faced with challenges inhibiting the advancement and widespread implementation of STEM education. Moreso, the importance of STEM education in Nigeria is underscored by the growing demand for STEM professionals in the labour market. The rapid technological advancements across sectors like healthcare, energy, and communication amplify the need for individuals with a robust STEM foundation. Elevating Science, Technology, Engineering, and Mathematics (STEM) education can thus create employment opportunities, ultimately enhancing living conditions and reducing poverty (Michael-Onuoha, Nkiko & Okuonghae, 2020; Ezema, 2022).

In addition, STEM education plays an important role among students because it gives room for creativity and innovation. Hence, the role of Science, Technology, Engineering, and Mathematics (STEM) education is indispensable for a lifelong education. Preparing and training students with important abilities, skills and knowledge to think and analyze lessons critically, resolve complicated hitches, and bring in new technologies is assumed important in developing countries like Nigeria, where progress hinges on technological advancements. Moreover, Science, Technology, Engineering, and Mathematics (STEM) education encourages business mindset among students, and as such improves economic growth. Apart from economic benefits, STEM education also holds cultural and societal relevance in Nigeria. This helps many of the students to understand their environment and this also contributes to their enrichment (DuBoff, 2019).

School Libraries and Quality Education

School libraries are very necessary and important means for ensuring quality student education. Hence, the school libraries provide access to an array of information, resources, and technology, which reinforces the learning and academic achievement of secondary school students. Furthermore, provision of quality education requires that secondary schools are equipped with a serene learning environment, enabling independent or collaborative work on school assignments, research projects, and educational endeavors. The role of school libraries in education can be categorized into three major domains: information accessibility, promotion of literacy and learning, and technology support (Johnston, 2018; Phillips, Lee & Recker 2018).

1. Information Accessibility: School libraries serve as gateways to diverse resources like books, journals, databases, and multimedia materials. This information resources fosters student learning, broadens horizons, and nurtures critical thinking. Librarians play a crucial role in cultivating information literacy skills among students, information source evaluation, information synthesis, and adept technology use, which is vital for academic and personal development.

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2. Promotion of Literacy and Learning: School libraries champion literacy and learning by providing a platform to engage with various texts and media. It grants access to books spanning genres from fiction to non-fiction and graphic novels, nurturing a penchant for reading and enhancing reading comprehension. Additionally, school libraries orchestrate educational programs such as book clubs, author interactions, and writing workshops.
3. Technology Support: School libraries facilitate technology access, a cornerstone for learning and academic progress. Computers and digital devices enable students to complete assignments, undertake research, and access online resources. Librarians bolster students' technological aptitude and safety, priming them for future academic and professional accomplishments. As a linchpin in education and student learning, school libraries play a crucial role by providing information access, promoting literacy and learning, and offering technology support as essential components for 21st-century student skills.

Current State and Challenges of STEM Education

The state of STEM education in Nigeria is a pivotal concern for the government and stakeholders. Recognising the economic growth, job creation, and improved living standards stemming from STEM education, attention is focused on this domain. However, challenges mar the quality of STEM education, necessitating targeted interventions. One major obstacle is inadequate funding. The government's limited education budget compromises STEM education's quality and accessibility. Consequently, institutions often lack necessary resources—laboratory facilities, modern technology, and qualified educators—depriving students of practical STEM experience crucial for growth (Benson, Anyanwu & Onuoha, 2016).

Outdated curricula present another hurdle. Failure to keep pace with evolving scientific and technological advancements hinders students' exposure to the latest innovations, restraining their potential and career prospects. Misalignment with labor market needs complicates employment prospects for STEM graduates. The dearth of qualified STEM educators is equally concerning. Schools and universities struggle to provide a comprehensive and high-quality STEM education due to the scarcity of trained educators. This impacts the quality of education students receive and dissuades them from pursuing STEM careers (Phillips, Lee & Recker, 2018).

Inadequate laboratory facilities impede practical learning, a cornerstone of STEM education. Insufficient resources hinder students' development of essential skills, limiting their career readiness. Despite these challenges, Nigeria has made strides. Initiatives like Tertiary Education Trust Fund (TETFUND) support STEM research, while private organizations foster STEM education awareness. The integration of technology enhances access, engagement, and learning efficacy. Yet, efforts persist in tackling teacher shortages, enhancing facilities, modernizing curricula, and bridging the gap between education and market demands (Benson, Anyanwu & Onuoha, 2016).

Research Methodology

The study adopted a qualitative approach using a focus group discussion. The population of this study is junior secondary school student in year two (JSS 2 / Basic

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8) from two private schools in Ibadan, Oyo State. A purposive selection of thirty (30) students, fifteen (15) students each in the schools, who were willing to participate actively in the study were selected. The focus group discussion lasted for eight weeks with activities and resources tailored across wide range of STEM topics, purposively selected by the teacher librarian to demystify the complexity or challenging idea towards STEM and to allow engagement through exploration in a self-directed manner. The subject selected was Integrated Science, also known as Basic Science which includes the aspect of Biology, Chemistry and Physics. Due permission was taken from the school principal in order to have the full support and access to the students, teachers and the school laboratory. The researchers with the support of the teacher librarian in the schools, engaged the students in experiments using items or materials easily found from their environment.

The following are the scheduled activities for the 8weeks:

Week	Activity	Remark
1	Pre Focus group discussion	General introduction and Sensitization Students from both schools were respectively grouped into 5; each group having 3 students each. A pre- focus group was conducted and recorded.
2	Nutrition	Test for food using various food items
3	Biodegradable and non-bio degradable (refuse and sewage)	Visit to Refuse dump site to identify biodegradable and non-biodegradable material, the importance and how to handle the materials.
4	Earth in space	Globe used to explain eclipse and change in day
5	Force	Demonstration of our force works using ballon.
6	Boiling point / evaporation	Convention & conduction using spoon, wooden spoon.
7	Identification of chemicals	Litmus paper used in identification of chemicals in easily accessible substances
8	Post Focus group discussion	Students in their respective groups had the last section of the focus group discussion which was also recorded. Closing remarks Refreshments

Presentation of Results and Discussion of Findings

The finding from the pre-focus group discussion showed that majority of the students have little knowledge of the word STEM, larger percentage of the students gave the meaning of the word based on the acronym and were able to relate it to their school subjects. The students also established interest in STEM as some found the acronym captivating, some assumed it is part of the achievement of science whereas to some STEM might be helpful in some unimaginable ways; considering the opportunities attached to it to extend to the subject areas that STEM covers.

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Likewise, the students' view of STEM based on their teachers' teaching methods is two sided that is, both negative and positive. Some of the participants assumed that STEM can lead to confusing idea and on the positive side; it might help to broaden ideas and knowledge. The students agreed to the fact that their awareness of STEM could enhanced by the teachers.

On the other hand, the post focus group discussion revealed a clearer understanding of the concept of STEM, students were able to give broad description of STEM and with this understanding, the participants were so excited and interested in STEM and in the light of these, they saw greater opportunities and benefits; career-wise, mentally, economically and socially. In respect to the students' view of STEM based on the teachers' teaching methods; the participants acclaimed it to be excellent and creative, the teaching is made real and easy to remember and apply. The teacher teaching method was found to be a boost to the awareness of STEM among the participants. It was observed that during the demonstration period that lasted for six (6) weeks, the students were more enthusiastic hoping that the session will not end. These sessions promoted individual participation, collaboration and team work among the participants.

The STEM in education is both a curriculum and pedagogy which means that knowledge must be explicit covering various disciplines and going beyond the disciplines. Teachers are to facilitate STEM as student-led process that will enable them solve challenges (Margot and Kettler, 2019), which was the objective of the practical session in this study. The pre and post focus group discussion session conducted before and after the practical session is to build a foundation from the perspective of STEM knowledge among the participant. It was observed that the student knew a little but demonstrated a good mental knowledge to handle the discussion during the pre-focus group discussion session. The practical session revealed a great sense of confidence and good understanding of the concepts in the topic treated which is, as a result of achievement of STEM skill in the participant. However, STEM learning skill demonstrated include collaboration, critical thinking, communication and creativity during the learning process. Therefore, it can be deduced that quality education should be hinged on STEM learning skills for a sustainable development goal.

According to Association for the Development of Education in Africa (ADEA), report on situational analysis of the status of STEM education at Basic Education in Africa (ADEA in UN policy brief, 2022), STEM education can be used for evaluating pedagogical practices in order to ensure continuous improvement in quality education. Teacher librarian as learning facilitators and instructional designer needs to possess advanced skill for adequate implementation of STEM learning skills. Teachers play a role in developing STEM talent in the students they either promote or hinder its implementation.

The STEM education is not a well-defined experience in schools despite the fact that STEM programme provides opportunities, supports, understanding and experiences required by students to maximize their potential (Phillips, Lee & Recker, 2018). The focus group discussion corroborated this as the participant

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mentioned that majority of the teachers fail to demonstrate STEM teaching skills in their teaching methods. This might be in agreement with Leisseig, Slavit, Nelson and Seidel (2016) findings, that teachers need support in planning and implementing STEM for students' academic success and this support should be an ongoing professional development programmes. However, it was also noticed that there are inflexible curricular challenges whereby, teachers found it difficult to integrate STEM curriculum into the existing curricular. Some felt their domain study did not integrate well with STEM discipline (Margot et al. 2019). Similarly, apart from flexible curriculum challenges, for adequate implementation, it was also observed that more time is required, as teachers are saddled with increased workload when STEM is to be considered. There should be time to plan with other subjects and prepare the material as well as presenting it for student.

Conclusion

In Nigeria, STEM education's value in shaping a prosperous future is undeniable. Its role in innovation, employability, and societal progress underscores the urgency of addressing current challenges. School libraries complement STEM education by providing essential resources, fostering literacy, and offering technological support. While Nigeria grapples with funding, outdated curricula, teacher shortages, and facility constraints, concerted efforts, like government initiatives and private sector engagement, aim to enhance STEM education's quality. The journey toward a robust STEM education system requires investment in teachers, resources, and curricula to empower students for a future characterised by scientific and technological advancements.

Recommendations

This study recommends the followings:

1. Ministry of education and librarians should see to reviewing policies guiding school libraries and STEM education collaboratively for a better result.
2. Teacher librarians should be equipped with more STEM-focused trainings by their professional associations to ensure professional development.
3. The management of secondary schools should encourage teacher librarians to regularly promote STEM learning experiences among the students.

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Appendix I

GROUP	Understand STEM as	Interest towards STEM	STEM Subject Benefits/ opportunities	View of STEM based on teacher's teaching method	Teachers boost awareness of STEM
Group 1	Science, technology and Mathematics, essential to help with everyday life in technological age.	Very interested as boring subjects are more interesting	STEM increases the way we learn science subjects and increases knowledge and understanding in the future	It affects me negatively, different approaches by individuals to a concept, may be confusing to me	It makes me want to learn more about science and technology, identifying peculiarities in the various subjects and using different teaching

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					methods(experiments) makes the learning fun
Group 2	Subjects topics capture daily activities that makes everyday activities easy and gives Fast way of solving problem	interested with the name STEM and it helps to solve problems in a creative way	Different categories of career will depend on STEM benefits and more job opportunities	It affect positively helps in experimenting, broaden knowledge, and other learn from such experiences	As a result of the awareness i can apply what is taught in my day to day activities, not only that my teacher brings out creativity in me through researching on assignments
Group 3	STEM is about using technology and science in our daily life activities in our environment. It's a description of how we live what we do and how we work	Am interested; daily activities are made easier and faster. Later in future i may need it.	It gives opportunities of various job in science, technology/ engineering; which help in day to day activities	Am now interested in learning Basic science because of the approach	Very well. Teaching is adaptable. Natural things in the environment are used in teaching to learn better
Group 4	It's the application of what we are taught in school to our daily activities.	Am interested; it can help widen knowledge of other subjects, making boring subjects easier and expose to more opportunities	Several opportunities, STEM is in the area that covers different aspects of life.	Am now positive about science, i don't like it before, but qualified teachers helps simplify topics.	At all, my maths teacher doesn't carry us along, only technology teacher makes me have a feel of STEM
Group 5	The acronym shows its meaning which is multidisciplinary approach of	Am very much interested, i feel it can help me. Am indifferent.	Under STEM is a 4 umbrella which is for all careers chances.	Yes positive view, no more boring class and there is improved knowledge	It spurs my interest, enlightens and encourages to the extent of relating it

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	learning. Our everyday life is STEM				in measurement during cooking activities

Pre- Focus Group Discussion

Post- Focus Group Discussion

GROUP	Understand STEM as	Interest towards STEM	STEM Subject Benefits/ opportunities	View of STEM based on teacher's teaching method	Teachers boost awareness of STEM
Group 1	I can define it as it relates to subjects; Science Technology Engineering and Mathematics. It's an approach that can help in several things /ways of how to process things. Like calculating faster, it can help in exposure to the world we are in	Very interested, there is a world of endless space in the world of STEM which makes it the easiest route that can be used in our day to day activities.	Yes there are benefits in STEM, all that we learn from STEM opens us up to several job opportunity. Likewise, it provides better job opportunities and good profiled Mathematician, scientists, technologist engineers are made through the impact of STEM.	The way the basic science teacher teaches make it interesting and we are more ready to practice the subject again on our own	Our Teachers does, science, maths, technology - they make us to be eager to know more about the subjects
Group 2	STEM can be used to solve problems and can be used to solve day to day activities, it can be used for several other things, to	It teaches us to understand our day to day activities e.g. all the experiment that we did teaches us how substances can be affected by chemicals, how to improve our day to day living and how to solve problems when in	Lots of benefits if STEM is taken serious and so many job opportunity emerged from the knowledge of STEM	Best method is used in Basic science, it makes it more real and I understand better as the subject becomes clearer.	Yes in the aspect of Basic Science, the way she teaches and did practical helps such that if am joining a science class at the

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	improve economy and standard of living and to understand what is good for us. e.g what is good to eat.	trouble			senior level I won't find some of the.basic things in science difficult because of what I have been taught in junior school
Group 3	STEM, the Science is the systematic study in order to improve man's living, it can be used to improve human way of living e.g building the hydro-electrical engine to reduce mining of petroleum.	It has been so interesting, we learnt a lot of things doing practical, using materials and substances around us.	STEM gives opportunity of several career and makes one to come up as mentally sound and physically sound.	The basic science teacher in particular gives practical which serves as a reminder to what has been taught.	All the practical we had in Basic science class will help us in the higher class; to enable us to work hand in hand with our teachers and make us to excel better.
Group 4	STEM is the application of science and technology and Mathematics to solve human problem e.g. using it to provide solution to human problems and natural occurrences that could happen to man (such	It is interesting; making science and mathematics interesting to learn. It makes it more fun to learn.	Because of the involvement of science and technology, it makes me to be able to determine good qualities	Our teacher is creative, she does practical and makes us to understand the lessons better than only theory that can be boring. With this, it makes the subject to stick to our mind.	Yes when we were doing the practical, it was so interesting and it spur the awareness of STEM in us. All of this will help us later in life and again teaching theory with practical.

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	as biodegradable)				
Group 5	It is the basics of science, it is what push us to learn about the future and it helps to understand nature and other things we need to know especially when it comes to environment.	STEM has marked my scientific journey, it has also proven to me that it is not only theory that we need, practical is needed to realize facts or discover things	Benefits to scholarship as student, the little knowledge of STEM can be used in day to day activities as well as used to understand and control climate change	Yes, the method help us student to remember what has been taught. Also I will like to suggest that teachers teaching subjects related to STEM should come together to identify areas where the students are good and put them through to be able to do that which they are best at doing.	Our basic science teacher motivates us, makes us to understand concepts better and she allows us to do it by ourselves; by this we can well be able to perform better because it will not be new to us again. (b) I see this as a better way of understanding STEM and I wish more practical can be used in other STEM subjects like we had in Basic science. Our teacher allows us to identify apparatus and explain how to use materials/ substances during class.