

Shelves of Innovation: Empowering STEM Minds Through School Libraries

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Abstract

The STEM (Science, Technology, Engineering, and Mathematics) education plays a pivotal role in equipping students with the skills required for innovation and problem-solving in an increasingly technology-driven world. However, the effective delivery of STEM education often faces challenges such as inadequate resources, low student engagement, and a lack of interdisciplinary support. This study explores the critical role school libraries can play in optimising STEM education by serving as hubs for resource accessibility, collaborative learning, and technological integration. The paper discussed how school libraries, when equipped with digital tools, multimedia resources, and curated STEM-focused content, can bridge gaps in STEM education. It examines strategies such as incorporating makerspaces, hosting STEM-related workshops, and leveraging school librarians' expertise to foster inquiry-based learning. Additionally, the study investigates the impact of libraries as neutral spaces where students can access resources, collaborate on projects, and cultivate 21st-century skills such as critical thinking, creativity, and collaboration. The study underscores the importance of institutional support and capacity building for school librarians to enhance their ability to integrate STEM principles effectively. It also discusses innovative case studies where school libraries have successfully transformed into STEM learning hubs, improving student performance and fostering lifelong learning.

Keywords: *STEM Education, School Libraries, Shelves of Innovation*

Introduction

A school library or a school library media centre is an institution within a school where students, staff, and parents of public or private schools have access to a variety of resources. The mission of the School Library Media Centre is to provide equal access to books, reading, information and information technology to all members of the school community. The school library media centre uses all types of media, which can be automated and uses the Internet and books to collect information. School libraries differ from other libraries in that they function as student-centred centres that support, expand and optimize curriculum. It serves as a centre where all the materials used in the school are processed. The STEM education is a broad term used to group these academic disciplines; Science, Technology, Engineering and Mathematics. One of the librarian's responsibilities is to work with classroom teachers and integrate various literacy teaching methods into the school curriculum.

As such, school library programs are uniquely positioned to play a major role in STEM education and serve as a powerful hybrid space for STEM learning.

The STEM education, encompassing science, technology, engineering, and mathematics is at the heart of global innovation and economic advancement. As nations worldwide, including Nigeria and other African countries, aim to equip students with the skills necessary to thrive in the 21st century, the integration of STEM education into school curricula has gained increased attention. However, despite its significance, STEM education in many parts of Africa faces numerous challenges, such as insufficient resources, low student engagement, and limited access to technology. School libraries, often underutilized, possess the potential to play a transformative role in addressing these challenges and optimising STEM education.

Science, technology, engineering, and mathematics (STEM) encompass a variety of experiences and skills, each of which makes a significant contribution to inclusive education. Science gives students a deeper understanding of the world around them. It helps students to explore and think critically better. Technology prepares the youth to work in an environment full of hi-tech innovation. Engineering allows students to improve their problem-solving skills and apply knowledge to new projects. Mathematics enables people to analyse information, correct errors, and make informed decisions while developing solutions. The STEM approach to education fosters creativity and divergent thinking as core themes. It inspires and motivates the youths and young learners to create new technologies and ideas. With an emphasis on practice and innovation, STEM education provides an understanding of concepts and encourages the application of knowledge. In short, this objective can be formulated in two simple steps: 'learning and experience'. Students are free to apply what they learn and accept errors in a safe environment, which allows them to solve problems. Project-based learning and problem-solving help students develop a different mindset. It is about flexibility and curiosity that enables students to respond to real-world challenges.

The myriad of hats currently worn in schools by school librarians, from IT professionals to learning and technology integration partners, position them as natural and helpful partners for STEM education. School librarians are in a better position to guide young people interested in STEM on topics that can encourage their participation. Most importantly, school librarians are already trained to provide guidance to readers and select appropriate material based on reading and literacy level, special needs, and student interest level. Science, technology, engineering and mathematics (STEM) over the past decades has become a major challenge for education administrators and policymakers around the world today. Advances in innovation in all areas of work in the modern world have increased the need for a skilled workforce to meet the challenges of the twenty-first century. Thus, STEM education aims to develop the ability to solve people's problems and to think critically in solutions and proposals of new global problems emerging in various regions of the

modern world. This awareness led academic practitioners, including librarians, to recognize the importance and relevance of STEM in the holistic development of students from the outset. Therefore, school librarians need to work with the rest of the school staff to ensure that each student's educational aims and aspirations are relevant to the modern world demands.

Concept of STEM

Understanding STEM needs to be explored beyond the core idea of subjects in school. Although the acronym stands for "science, technology, engineering and mathematics." However, understanding the nature of the concept goes beyond the denotative meaning of STEM. In terms of goals and objectives, STEM education is based on a creative approach to reshaping the minds of students to solve new world problems. It promotes the use of critical thinking and action-based activity in the classroom and teaches students to model and develop solutions to a multitude of global problems. The main purpose of this concept is to develop and give students access to the core skills underlying the four different STEM disciplines that makeup STEM. To this end, Keener (2014) defines STEM education as:

“the deliberate integration of STEM and related practices to create a student-centred learning environment in which students explore and develop evidence-based solutions to real-world problems and phenomena ... Focus on the social, emotional, physical and academic needs of the student through the collaborative contributions of schools, families and community partners”.

From the above definition, it can be understood that STEM is more than just being a STEM expert. Alternatively, it is also designed to create a student-centred collaborative environment through a problem-solving and project-based approach aimed at developing students' problem-solving and critical thinking skills so that today's learners can maximize their productivity in the learning process in a dynamic society. However, this process was made possible through the collaborative efforts and contributions of school leaders, families and community partners. The idea behind STEM (Science, Technology, Engineering and Mathematics) teaching is about integrating different disciplines that students will use during their studies and work.

Classification of STEM

Over the years there have been different forms of STEM education in different countries depending on the curriculum structure, policies and teaching system of each country. In Nigeria, for example, the various components that makeup STEM subjects are taught separately in secondary schools, both junior and senior. We have it in the form of basic science, basic technology, computer science, and mathematics at the junior level, which serves as the basic foundation for the more complex variations of physics, chemistry, biology, technical drawing, and mathematics at the senior level schools.

Bybee (2013) categorised STEM into 4 categories (STEM 1.0, 2.0, 3.0 and 4.0), and each category is determined by the number of STEM components built into the class. Thus, in a STEM 1.0 class, all components of the STEM training are taught independently at the school, and this type of STEM training is practised at most secondary schools in Nigeria. The advantage of this STEM approach is that it gives students basic/essential knowledge about each component of STEM. STEM 2.0 offers students the opportunity to integrate 2 STEM Components into a learning scenario. It is a more advanced approach that allows students to use knowledge and skills from the STEM components to solve/tackle a problem or challenge. For example, a STEM 2.0 class could be a mix of mathematics and engineering, and students could be challenged to use their math and engineering skills to find solutions.

The same technique applies to STEM 3.0 and 4.0. Using this classification in STEM education for teaching students will systematically develop their problem-solving skills and the ability to combine and link different prior knowledge to provide results and solutions to different problems and challenges. However, within the Nigerian context studies show that there is still room for progress in STEM education in Nigeria. Providing tools to improve basic education, as well as organizing seminars and workshops to train and sensitize STEM teachers will enable them to be aware of new trends to inform this field.

Relevance and Importance of Stem on Learners Development

STEM education is essential for preparing students to solve complex problems, think critically, and drive innovation. It fosters a mindset of inquiry and experimentation, enabling learners to apply theoretical knowledge to real-world scenarios. According to Alade (2020), STEM education in Nigeria is particularly crucial for addressing pressing societal issues, such as climate change, healthcare challenges, and food security. However, to maximize its impact, there is a need for comprehensive support systems that enhance the delivery and accessibility of STEM education.

The relevance and impact of science, technology, engineering and mathematics (STEM) on student development can be attributed to the importance of STEM on student development, which can be attributed to the concept of STEM in general. The STEM idea is aimed at children or young people as the world evolves in terms of innovation, so it is necessary to attract the interest of children at every level. This will enable them to understand the situations around them and present them with real-life issues to learn more about the situation, as well as learn how to solve problems throughout life at a young age. The importance of STEM in student development are: **Creativity and Innovation:** Innovation and imagination combined with STEM can lead to new ideas and new developments. Without creativity and imagination, it would be impossible to visualize new developments in artificial consciousness or computerized learning. These advancements were made by people who discovered that if the human psyche can imagine them, the human brain can make them.

Experience: Without a little risk and experimentation, it would have been impossible to imagine the enormous amount of innovative developments that have taken place over the past decades. A lot of these developments have been made by people who have been told their ideas won't work, and they've said, "We have to try and see. This type of disposition can be improved through science, technology, engineering, and math (STEM). How can this be accomplished? Allow students to experiment and solve problems in teaching exercises.

Collaboration: Fomunyam (2020) noted that STEM education can be taught to students of all levels. Trainees with varying degrees of ability can collaborate in groups to find answers to questions, record information, write reports, present, etc. The outcome of students is the ability to work with others and to thrive in a team environment.

Information Application: In STEM education, students are provided with lots of information and have channelled skills that they can use. This encourages learners to learn because they understand that the abilities they believe in can be used immediately and in a way that affects them, their friends and family. Their ability to apply their vision to new information and emerging challenges will benefit them when they enter the workforce.

Empowers Technology Use: The STEM learning for kids shows the power of innovation and development. So when students learn about new developments, they will be ready to accept them, rather than hesitate or regret them. This will give them an edge in the global market as the world gradually focuses on technology.

Develops Critical Thinking and Problem-solving Skills: The STEM education shows students how to solve problems using their basic thinking skills. by participating in stem learning meetings, students learn to analyze problems and then organize a solution.

Supports Adaption: To live in everyday life, students need to be able to apply their findings to different situations. stem education encourages them to channel the ideas they discover to focus on different aspects of a problem or problem.

The Role of School Libraries in Education

Traditionally, school libraries have been viewed as spaces for quiet reading and study. However, their role in education has evolved significantly over time. Modern libraries serve as dynamic learning environments that support interdisciplinary learning, provide access to diverse resources, and encourage collaboration. As information hubs, they are uniquely positioned to complement STEM education by providing students with access to books, journals, multimedia content, and digital tools that promote scientific literacy and technological skills.

The word "library" essentially refers to a centre responsible for collecting and organizing knowledge in various formats that users can read, study, consult and search. It can also be considered as the institution responsible for collecting, processing and storing the recorded knowledge for reading, studying and consultation. (Aina 2004). However, there are different types of libraries, their

classification depends on the ownership and the purpose for which they were created. In relation to this study which is 'school libraries', it is an educational institution in a primary or secondary school. They complement and reinforce the learning of the pupils of the school. An ideal school library is designed for children who want to read and for children with reading disabilities and difficulties. The main purpose of a school library include; encouraging students to read; developing students' ability to learn from books without teachers; breaking down the rigid divisions that school time-table often create between different subjects; and providing social training (Ralph (1962) cited by Aina (2004))

In the modern world, fundamental changes have taken place in the development and promotion of scientific and technological innovations, which have also directly or indirectly resulted in various changes in the functions of various sectors of life, and the school library is not exempted from this development. The ideal school library for the 21st century has gone beyond the traditional routine of collecting and organizing knowledge. Instead, it is now a social space where students and patrons can share their knowledge and ideas. Bamigbola 2013 noted that constantly evolving technological innovations have changed the functions and services of the library, and for a library to remain relevant in the modern world, said library must be dynamic in the range of services that it offers its users. Therefore, radical changes in the development and advancement of new trends in science and technology have also forced a refocus on STEM subjects.

Moreover, the school library helps in the optimisation of STEM education through the provision of access to well-informed physical and digital resources, not only for reading and finding resources but also as a place of informal knowledge learning designed to impact children and young people. at school; reinventing school library role in the community and leveraging on its resources and public trust to enhance community learning and encourage critical thinking, problem-solving and participation in STEM (STEM and Public Libraries, 2015). Libraries are one of the common informal learning spaces where information can be classified, and also available to the local community which makes it more interesting and creates opportunities for low-income people to get a platform to learn and participate in STEM.

Transforming School Libraries into STEM Hubs

To optimize STEM education, school libraries must be transformed into active STEM learning hubs. This transformation involves several key strategies:

1. Enhancing Resource Availability

School libraries must be equipped with STEM-focused resources, including textbooks, scientific journals, instructional videos, and digital tools. Providing access to these materials ensures that students can explore STEM concepts beyond the classroom. For instance, Eze and Adamu (2019) highlight the importance of

integrating e-libraries and online databases into school libraries to improve resource accessibility.

2. Creating Makerspaces

Makerspaces are collaborative workspaces where students can engage in hands-on STEM activities. These spaces provide tools, such as 3D printers, robotics kits, and coding equipment, that allow students to experiment, build, and innovate. According to Adebayo (2022), makerspaces in school libraries can significantly enhance students' interest in STEM by fostering creativity and problem-solving skills.

3. Leveraging Technology

The integration of technology into school libraries is crucial for modern STEM education. Libraries can provide access to computers, internet connectivity, and STEM-related software. Additionally, virtual reality (VR) and augmented reality (AR) tools can be used to create immersive learning experiences, such as virtual science experiments and interactive engineering simulations.

4. Empowering Librarians as STEM Facilitators

School librarians play a critical role in supporting STEM education. By undergoing professional development and training, librarians can become facilitators of STEM learning. They can guide students in using digital tools, conducting research, and accessing reliable information. As observed by Okonkwo and Ibrahim (2020), trained librarians can bridge the gap between students and STEM resources, making learning more effective.

Ways of Optimising Stem Education Through School Libraries

The school library can optimise STEM education for her users by developing and upgrading these three aspects of the school library which are; personnel, facilities as well as services and programmes.

Library Personnel

Training and sensitizing library professionals and para-professionals on the relevance and importance of STEM and building partnership with organizations and successful individuals in the field of STEM

Library Facilities

Make space for STEM in designing of activity space in the library (Makerspace) and provision of facilities and equipment that can reinforce STEM learning

Library Services and Programmes

Organising library programmes and services that promote STEM career, sourcing for resources and materials that can help motivate STEM in students and preparation for technology curriculum

Case Studies and Best Practices

Several successful initiatives demonstrate the potential of school libraries to optimize STEM education in Africa:

1. The eLibrary Project in Nigeria

The eLibrary Project, launched in Lagos, aims to equip school libraries with digital resources and internet connectivity. By providing access to e-books, scientific

journals, and online tutorials, the project has improved students' performance in STEM subjects and fostered a culture of independent learning (Olatunji, 2021)

2. South Africa's FunDza Literacy Trust

Although primarily focused on literacy, the FunDza Trust in South Africa incorporates STEM content into its library programs. It provides students with STEM-themed books and organizes interactive workshops to spark interest in science and technology (Ndlovu, 2020).

3. Ghana's Makerspace Libraries

In Ghana, several school libraries have been transformed into makerspaces where students can learn coding, robotics, and engineering. These spaces have encouraged collaboration and innovation, as noted by Mensah et al. (2021).

Benefits of Optimising STEM Education Through School Libraries

The transformation of school libraries into STEM hubs offers numerous benefits, including:

1. Increased Access to Resources

Students in underserved communities often lack access to STEM resources. By equipping school libraries with STEM materials, students can explore new concepts and develop skills that are essential for success in STEM fields.

2. Improved Student Engagement

Interactive learning environments, such as makerspaces and digital labs, increase students' interest in STEM subjects. According to Akinyemi and Obiora (2022), students who engage with hands-on activities are more likely to pursue STEM careers.

3. Bridging the Digital Divide

In many African schools, the digital divide remains a significant barrier to STEM education. School libraries can help bridge this gap by providing access to computers, the internet, and digital tools, ensuring that all students have equal opportunities to learn.

4. Fostering Lifelong Learning

School libraries cultivate a culture of inquiry and independent learning. By promoting STEM education, they prepare students to become lifelong learners who can adapt to a rapidly changing world.

Conclusion

The role and place of STEM in the overall development of learners cannot be overemphasized and there is a need to develop and prepare them for the future. Hence, it is important for educational practitioners at all levels including librarians in Nigeria to acknowledge the place of STEM in the development of learners. For STEM education to be optimized through the school library, measures have to be put in place to train qualified personnel in the field of STEM and provide adequate technological equipment and facilities to reinforce STEM learning in Nigerian schools.

Optimising STEM education through school libraries is a transformative approach that addresses many of the challenges faced by African educational systems. By equipping libraries with STEM resources, creating interactive learning environments, and empowering librarians, school libraries can become central to fostering innovation, critical thinking, and problem-solving skills among students. As Nigeria and other African countries strive to build knowledge-based economies, investing in school libraries as STEM hubs is a strategic and sustainable solution that ensures no student is left behind. Collaborative efforts from policymakers, educators, and stakeholders are essential to unlocking the full potential of school libraries in driving STEM education forward.

Recommendations for Policymakers and Educators

1. To maximise the impact of school libraries on STEM education, the following recommendations should be considered:
2. **Invest in Library Infrastructure:** Governments and stakeholders should allocate funds to equip school libraries with modern resources and technologies.
3. **Train Librarians:** Professional development programmes should be implemented to train librarians as STEM facilitators.
4. **Promote Partnerships:** Collaborations with NGOs, private organisations, and tech companies can provide additional resources and support for school libraries.
5. **Incorporate STEM Programmes:** Schools should integrate library-based STEM programmes into their curricula to encourage interdisciplinary learning.

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