

## **Challenges faced by Biology Secondary teachers when using instructional methods that promote Science Technology, Engineering and Mathematic (STEM) Education in Zimbabwe.**

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### **Abstract**

*The study sought to determine the challenges faced by Biology Secondary teachers in Zimbabwe when using instructional methods that promote Science Technology, Engineering and Mathematic (STEM) Education and the possible solutions to the challenges. The sample was composed of fifty secondary schools in Harare that offer Biology at Ordinary and Advanced level. Two Biology teachers per school were involved and the total number of Biology teachers was one hundred.*

*Data was collected using questionnaires administered to both Ordinary and Advanced level biology teachers. One lesson at Ordinary and Advanced level was observed at each of the fifty schools. The obtained results indicate that Biology teachers in Zimbabwe are still using more the traditional teaching method that is teacher centered rather than the current student-centered approach that promotes STEM education due to a number of challenges they are facing. These challenges include lack of digital classrooms, lack of consistent power supply, lack of fully equipped biology laboratories and lack of teachers who have the necessary skills such as computer skills. In order for STEM Education to be successfully implemented in Zimbabwe at secondary school level these issues must be addressed.*

### **Introduction**

STEM education is an approach to teaching and learning that integrates the content and skills of Science, Technology, Engineering, Mathematics and their application within the Society. STEM Education is an instructional strategy that aims to equip learners with scientific, technological, engineering and mathematical life skills that are essential in real life outside school (Clyton & Moses, 2017). STEMS education main goal is to prepare the learners to learn, apply, integrate, interpret and communicate information from STEM subjects in such a way that it has real life application and relevance in the 21<sup>st</sup> global world. Learners must engage in inquiry, logical reasoning when solving global challenges and real-life problems. Critical thinking, evidence-based argument, collaboration and creation of new technologies are inherent in STEMS education. STEM education ensures that life skills like problem solving and critical thinking are enhanced in students early. Herrell and Jordan (2008) stated that the purpose of integrating technology in teaching is to enhance learning and teaching as it supports both learners and teachers. Pitler, Hubbell, Kuhn and Malenoski (2007) emphasized on the need to have a clear understanding of the changes that must be done in regards to instructional methods used if the learning needs of our 21<sup>st</sup> century learners are to be satisfied.

### **The purpose of the study**

The purpose of the study was to determine the challenges faced by Biology Secondary School teachers when using instructional methods that promote Science Technology, Engineering and Mathematic Education in Zimbabwe and possible solutions to the challenges.

### **Significance of the research**

Findings of this research study may be used to inform the relevant stakeholder how STEM teaching may be improved in Zimbabwe.

## Literature review

The successful implementation of STEM education relies primarily on educators with a good understanding of STEM-based instructional methodologies. These STEMS based instructional methodologies reflect the actual teaching and learning environments subjected to the learners and the competences the learners will actually acquire. These STEM based instructional methodologies are endowed with pedagogical-content-knowledge, skills and attitudes to integrate science, technology and mathematics in the teaching and learning of STEM subjects, that address the knowledge, skills and attitudes of a 21<sup>st</sup> century global citizen, since development in the 21<sup>st</sup> century is hinged on STEM subjects. STEMS proficient learners be able to engage in critical thinking, problem solving and develop new technologies to solve societal problems. STEM teachers link theoretical constructs that are taught to practical, real-world context, recognizes that teaching and learning needs to occur in multiple contexts, assists students become self-regulated learners is a facilitator of learning, promotes active learning and embrace the use of ICTs as a critical tool in the process of teaching and learning.

Zimbabwe, in Africa leads the general literacy rate, however its Education system has not focused on STEM literacy and methodologies. Currently, nearly 28% of high school learners declare interest in STEM related subjects, but 57% of these learners will lose interest in these subjects by the time they graduate from high school (MoPSE, 2013).

This prompted the Zimbabwe Government to announce the 2009 “STEM Education” campaign to motivate and inspire learners to enroll in STEM subjects at Advanced level. This campaign focused only on the learners. Learners who took up STEM subject at Advanced level had their school fees paid by the government. A group of students actually visited the United States of America to have hands on experience in regards to STEM subjects. This was meant to try and motivate the Zimbabwean STEM students. Parents and the learners were very excited about this development. However, this campaign did not address the need to transform the current traditional Science, Mathematics and Technology (SMT) teachers into a new Science, Technology, Engineering, and Mathematics Teachers (STEM) who will have the pedagogical-content-knowledge and STEM based instructional methodologies, who can then educate learners in a STEM way. The STEM teacher should be able to use STEM based instructional methodologies that will foster problem solving creativity, critical analysis, teamwork, independent thinking, initiative, effective communication and digital literacy in students. The 21<sup>st</sup> century teaching and learning has become more and more technologically complex and pedagogically challenging for the traditional Biology teachers. The traditional instructional methodologies are dominated by the lecture method that is teacher centred and promotes rote learning greatly limiting the teachers’ capability to implement STEM education. STEM education advocates for teaching methodologies that are student centred. The teacher assumes a new role of being a facilitator of learning rather than an authority of learning. These traditional methods of teaching that are teacher centred have long been replaced methods of teaching that are student centred such as the Constructivism, connectivism and excellence theories of learning. Currently, Zimbabwe Education system has more of Science, Mathematics and Technology (SMT) teachers in schools due to a number of reasons such as when the teacher was trained, but lacks STEM educators who can teach learners using STEMS methodologies. A transition from Science, Mathematics and Technology (SMT) teacher to a Science, Technology, Engineering, mathematics and Society (STEM) teacher is inevitable if students are to learn STEMS subjects. The task that Zimbabwean education system has is to Transform Science, Mathematics and Technology (SMT) teachers into Science, Technology, Engineering, Mathematics and Society Teachers (STEM). The Government and Ministry of Tertiary and Higher Education partnered to create a joint national strategy to invest funds in STEM advocacy, increasing youth STEM engagement and reaching demographics underrepresented in STEM subjects. STEM grants selection programme by ZIMDEF was rolled out in 2016 (Morris, 2002). This initiative did not address the need to retrain the current teacher.

What separates STEM education from the traditional science and mathematics education is the blended learning environment showing learners how the scientific method can be applied to everyday life. It teaches learners computational thinking and focuses on the real- world applications of problem

solving. As such, STEM education begins while learners are very young facilitated by STEM educators.

### Research questions

The study was guided by the following research questions:

1. What are the challenges faced by Biology teachers in using instructional methods that promote STEMS Education?
2. Which instructional methods do Biology teachers use during the teaching and learning of Biology?

### Methodology

The purpose of the study was to determine the challenges faced by Biology Secondary School teachers when using instructional methods that promote Science Technology, Engineering and Mathematics Education in Zimbabwe and possible solutions to the challenges.

A questionnaire for biology teachers was administered to determine the challenges they face when using instructional methods that promote Science Technology, Engineering and Mathematics (STEM) Education. Lesson observations were done in order to determine the instructional methods that teachers are using and the logic behind the use of those instructional methods.

### Results and discussions

**Table 1.** Distribution of biology teachers by age

Age (years)	Number	Percentage (%)
Below 26	9	9
26-35	37	37
36- 45	43	43
46-55	11	11

Tables 1 show the age ranges of the respondents. Table 3 shows the age ranges for teachers, 20 percent are below the age of 26; another 20 percent are between the age of 26 and 35. 30 percent in the age range 36-45, and also 30 percent in the age range 46-55. The majority of the respondents were aged above 35. The apparent diversity of the maturity of the respondents reflects several implications in the study's findings. Sixty percent of the teachers are above the age of 36, meaning they probably were trained before Advanced Educational Technologies and computers were introduced into the education system and when there was no formal training in the teacher training colleges. This has a negative impact on the successful integration of Advanced Educational Technologies in the process of teaching and learning. Most of these older teachers are the ones whom were found not to have the necessary ICT competence. Also, they are the ones who had negative attitudes towards the use of ICTs in the process of teaching and learning of biology.

**Table2.** Challenges faced by Biology teachers when using STEM methodologies

Factors Identified	Frequency	Percentage	Rank
Inadequate Advanced Educational Technologies resources	77	77	2
Unreliable source of power	65	65	3
Lack of Laboratory equipment	53	53	5
Lack of digital classrooms	80	80	1
Teachers computer illiterate	33	33	4

The use of Advanced Educational Technologies is vital when teaching biology using the STEM methodologies. A 21<sup>st</sup> teacher must have the necessary skills to use Information communication technologies (ICTs) well within the digital classroom of the 21<sup>st</sup> century. Digital classrooms connect the classroom the whole world and create an environment for learning to become student centered.

The teacher assumes a new role of becoming a facilitator of learning. According to teachers lack of Advanced Educational Technologies in schools hinders them from effectively teaching biology in a STEM way. Both students and teachers may not have access to research on the Internet and in most schools the chalkboard and the prescribe textbook are still the greatest tool within the classroom. In such a situation teacher will concentrate on completing the syllabus so that they meet the immediate need of the pupils, which is passing examinations. In some cases, the teachers said they are not able to use the Advanced Educational Technologies since they were never exposed to them during their training and this applied only to the older teachers. The young teachers expressed concern over the lack of electronic boards or smart boards in their classroom. This means that they have no option but to use the chalkboard and the textbook. Digital classrooms in most schools are non-existent and, in most cases, the whole science department had one projector. Teachers were not very keen in preparing a lesson using Advanced Educational Technologies due to unreliable source of power. This means that in order for the lesson to proceed without any problems due to lack of power they have to use the traditional methods of teaching. Teachers in most schools said lack of laboratory equipment and chemicals means that the student cannot have a hands on approach when learning biology. Biology is a practical subject that requires hands on approach.

### Teaching methods in use

The ways students acquire knowledge during learning experience at school depend on the methodology of teaching being applied by their teachers. During these learning experiences students must acquire knowledge, skills and the desired attitudes. There is no one teaching method said to be the panacea for all teaching all subjects. The methods to be employed varies with variables such as age of students, time needed to complete the syllabus in preparation of examinations and availability of resources. Biology lessons require hands-on-approaches and student-centered approaches if students are to learn it in a STEM way an aspect that is critical in the 21<sup>st</sup> century.

**Table 3.** Teaching methods used during the lessons observed

Teaching method	Number of teachers using this method in the observed lessons at Ordinary Level	Number of teachers using this method in the observed lessons at Advanced Level
Lecture	83	66
Group work	5	32
Problem solving	1	2
Demonstration	11	15
Carrying out experiments	0	9

The lecture method was the widely used teaching method. This type of method does not promote STEM education in the process of teaching and learning of Biology. This most widely used teacher centered method does not require the use modern teaching tools such as the computer. Generally, the student is not active and does not develop the skills needed in the 21<sup>st</sup> century digital world. Skills such as critical thinking, creativity and innovation are suppressed. Rote learning prevails in such learning environments. Teachers stated that this was the most convenient method to use in the current environment where electricity is not readily available, resource needed to have a digital classroom are not available and laboratory materials are not available. At Ordinary level most teachers indicated that the students sit for an alternative to practical examination paper hence less emphasis on real practical approach during the teaching and learning of biology.

### Conclusions

The obtained results indicate that Biology teachers in Zimbabwe are still using more the traditional teaching method that is teacher centered rather than the current student-centered approach that promotes STEM education due to a number of challenges they are facing. These challenges include lack of digital classrooms, lack of consistent power supply, lack of fully equipped biology laboratories

and lack of teachers who have the necessary skills such as computer skills. In order for STEM Education to be successfully implemented in Zimbabwe biology at secondary school level these issues must be addressed.

### Research recommendations

The study makes the following recommendations if STEM Education is to be successfully implemented in Zimbabwe:

1. All biology teachers who don't have the necessary ICT skills to handle a 21<sup>st</sup> century digital classroom must attend ICT workshops offered in the various institutions of higher learning in Zimbabwe.
2. Biology is a practical subject hence at Ordinary level it is necessary to have a practical examination rather than an alternative to practical paper.
3. Schools must have fully equipped Biology laboratories and power supply should always be available. May be schools should look at utilizing renewable energy such as solar to achieve this.

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