

Implementation of STEM Curriculum in Rural Secondary Schools in Zimbabwe: Limits and Possibilities

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Abstract

This study was carried out to establish views and sentiments of rural secondary school teachers on the preparedness of rural secondary schools to implement STEM curriculum. The purpose of the study was to expose challenges encountered by rural schools in implementing STEM curriculum with a view to stimulate stakeholders of education to address the challenges for the benefit of learners in rural schools. The theoretical perspective undergirding this study is multiculturalism. The study adopted a qualitative research approach, where a descriptive survey design was used. Data collection instruments employed in this study were the open-ended questionnaire and focus group discussion. A sample of 20 Science and Maths teachers was drawn from five (5) rural secondary schools in Zaka district. The study established that 90% of the participants considered rural secondary schools as ill-equipped to implement STEM curriculum. The barriers to implementation of STEM identified include lack of laboratories, STEM-trained teachers as well as lack of scholarships for students pursuing STEM subjects. The study concluded that rural secondary schools are incapacitated to implement STEM curriculum. Based on the findings of the study the following recommendations were made: Government should construct adequate laboratories in rural secondary schools as well as equipping them. The Ministry of education should train teachers to teach STEM curriculum and that government should adopt an all-inclusive approach in implementing STEM.

Keywords: STEM curriculum, implementation, rural secondary school, preparedness, physical infrastructure.

INTRODUCTION

The utility of Science and Mathematics gained momentum during the Second World War when scientists and mathematicians as well as engineers worked together with military to produce products that assisted to win the war (White, 2014). The launch of Sputnik by the then Soviet Union in 1957 also gave impetus to the utility of scientific and mathematical knowledge (White, 2014). These developments stimulated many countries to embrace Science, Technology, Engineering and Mathematics (STEM) in their curriculum. STEM is a contemporary educational movement that aims to equip students with scientific, technological, engineering and mathematical skills needed to drive development (Parawira, 2016). Zimbabwe started to implement STEM curriculum in recent years. The current study seeks to establish views and sentiments of rural secondary school teachers on the capacity of schools to implement STEM curriculum.

Background to the Study

STEM is an acronym which stands for Science, Technology, Engineering and Mathematics (white, 2014:1). Tsupros (2008) defines STEM education as an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply Science, Technology, Engineering and Mathematics in contexts that make

connections between school community, work and the global enterprise.

Implementation of STEM curriculum is viewed as the panacea to developmental problems confronting many nations. The school is viewed as a critical part of the broader STEM education ecosystem, targeting to boost economic development (Australian National STEM School Education Strategy, 2015). Similarly, Ejiwale (2013) stresses that; the essence of STEM education is to prepare the 21st century workforce with STEM education so that students can apply what they learn in the classroom in their future jobs. The nexus between STEM curriculum and development was aptly captured by Ride (in Thomasian, 2011:8) who said, "It is suicidal to create a society that depends on Science and Technology in which no one knows anything about science and Technology..., you need to generate the scientists and engineers starting in school." Gadzirayi *et al* (2016:4) also pointed out that a country's ability to innovate and compete in the global market is tied to the ability of the education system to prepare all learners in STEM. Thus Science and technology subjects have been increasingly emphasised across the world through the implementation of STEM curriculum. Besides preparing human capital, STEM curriculum also seeks to address gender disparities as well as limited participation of specific groups in STEM study and

occupations (International STEM High level Forum, 2015). Thus, STEM education is multicultural in nature in that it emphasises equality and equity.

In view of the envisaged impact of STEM education on development, Zimbabwe commenced implementing STEM curriculum in 2016. Dr Gandawa, the deputy Minister of Higher and Tertiary Education, Science and Technology Development said, "Education is important to equipping nations with the necessary skills to move forward and improve people's standard of living" (Sunday Mail 14/2/16). In addition Parawira (2016) opines that the critical skills needed to drive economic growth within the context of Zimbabwe's new economic blue print ZIMASSET, hinge on STEM education. Thus, this study seeks to explore among others support rendered to schools by the government in areas such as physical infrastructure, teacher development and financial support.

Institutional Physical Infrastructure Support

Availability of physical infrastructure in schools is a key component to the provision of quality education (UNESCO, 2012). Research has shown that classroom is the most crucial area within the school where students spent most of their time and that overcrowding in classroom can stifle students' activities (Kruger & Whitmore, 2001). In the same vein Ejiwale (2013) lamented use of archaic facilities in schools which do not match the demands of STEM. The Malaysia Education Blue print (2013-2025) also indicated that one of the factors that compromise student outcomes in STEM subjects is limited infrastructure. The inadequacy of facilities to promote implementation of STEM curriculum in developed countries such as American (Ejiwale, 2013) implies that the situation could be worse in developing countries like Zimbabwe. A study by Gadzirayi *et al* (2016) on the status of STEM in Zimbabwe revealed that the state of education infrastructure in rural schools was deplorable. Against this backdrop it implies that schools should have well equipped laboratories for the successful implementation of STEM curriculum, a requirement which seemed far-fetched in Zimbabwean rural schools. Research in Zimbabwe Zvavahera (2015) revealed that 90% of schools in Mazoe district were not offering science subjects due to unavailability of laboratories. This study therefore seeks to establish the preparedness of rural secondary schools in Zaka district to implement STEM curriculum.

Teacher-Training in Teaching STEM Curriculum

The successful implementation of curriculum hinges on the quality of the implementers, teachers. In this regard the Australian National STEM School Education Strategy (2015) emphasised that quality teaching is a key factor to lift student engagement and performance in STEM education. A review of

research on teacher-quality done in America revealed that among those who teach Maths and Science, having a major in the subject taught had a positive impact on student achievement (CRS, 2005).

In respect of STEM curriculum, research has shown that many teachers are under-qualified to teach STEM subjects (Ejiwale 2013:13). Similarly Pasamietier and Maeroff (2011) cautioned that who teaches in STEM programme matters. A study by Thomasian (2011) in America revealed that one of the reasons for America's lag behind in STEM was lack of qualified Maths and Science teachers. The question this study seeks to address is: does Zimbabwe have adequate STEM-trained teachers in rural secondary schools? Research by Gadzirayi *et al* (2016) on the status of STEM in Zimbabwe revealed that the country had a critical shortage of STEM teachers as well as equipment and chemicals. One of the contributory factors to shortage of Maths and Science teachers in Zimbabwe is the poor economic environment prevailing in the country which has forced some teachers and other professionals to leave the country for greener pastures (Asante, 2012). Teacher factor is thus a crucial cog in the successful implementation of STEM curriculum.

Student-STEM Support

One of the goals of STEM education is to ensure that students finish school with strong foundational knowledge in STEM related skills (Australian National STEM School Education Strategy 2015, CRS, 2005). To achieve this goal a student should be inspired to take on more challenging STEM subjects. In Zimbabwe initiatives to motivate students to pursue STEM subjects include financial support for students pursuing science subjects at 'A' Level and STEM related campaigns (Dokora, 2015). The impact of such programmes on the uptake of STEM subjects has been questioned with some scholars such as Gadzirayi *et al* (2016) lamenting prioritisation of student support ahead of construction of laboratories and other infrastructural facilities. Margnison *et al* (2013) observed that STEM strong countries have developed strategic STEM policy frameworks which provide favourable conditions for all learners to study STEM subjects. Against this backdrop the question is: what is the situation with regard to student-STEM sponsorship in Zimbabwean rural secondary schools?

STEM-Affirmative Action Programmes

One of the goals of STEM education is to make all citizens technologically literate (White, 2014). This noble goal however can be missed if implementation of STEM curriculum discriminates certain groups. In this regard, Margnison (2013) suggests that in implementing STEM, governments should develop strategies that take into account the diversity of students' context, gender and ethnicity. Cognisant of the need to provide an inclusive STEM curriculum,

Dr Gandawa the Zimbabwean deputy Minister of Higher and Tertiary Education points out that STEM campaigns in the country were more aligned to woman to take up science subjects (Sunday Mail, 14/2/16). In the same vein, Gadzirayi *et al* (2016) recommended that the government should put in place mechanisms to mitigate social discrimination of students who learn in marginalised schools. This study therefore seeks to establish among others whether there are STEM-related affirmative action programmes in Zimbabwean rural secondary schools.

Statement of the Problem

Implementation of STEM curriculum in both developed and developing countries has been found to be hindered by a number of challenges. Ejiwale's (2013) study in America revealed that poor condition of laboratory facilities as well as lack of STEM trained teachers militated against smooth implementation of STEM. Research in Zimbabwe also revealed that the state of educational infrastructure to support STEM is deplorable (Gadzirayi *et al*, 2016; Zvavahera, 2015). It is against this backdrop that the researchers embarked on this study to establish the preparedness of rural secondary schools in Zimbabwe to implement STEM curriculum.

Limitations of the study

The study was limited to Zaka District focusing on rural secondary schools only. Therefore generalizability of findings is limited. The purposive sampling technique employed to select schools and teachers brought in some bias which would not have been the case if probability sampling techniques such as random sampling were used. The study adopted a qualitative approach; mixed method approach where qualitative and quantitative methods complement each other could have been used to generate valid and reliable data.

Theoretical Framework

The current study is anchored in multiculturalism. Banks (1996) views multicultural education as a progressive approach for transforming education that critiques and addresses current shortcomings and discriminatory practices in education. It is grounded in the ideals of social justice education, equality and a dedication to facilitating educational experiences in which all students reach their full potential (Banks, 2001). Zimbabwe being a multicultural society on the basis of factors such as gender, social class, race and ethnicity should embrace multiculturalism when implementing STEM to prevent disadvantaging certain social groups. As highlighted by Margnison *et al* (2013) STEM education should take into account the diversity of students' contexts such as gender, ethnicity and race. In this study the researchers also explored the extent to which STEM implementation in Zimbabwe caters

for learners from diverse backgrounds, thus multiculturalism was found an appropriate lens to unpack the research topic.

Research Question: What is the status of STEM implementation in rural secondary schools?

METHODOLOGY

The methodology adopted for this study was qualitative. A descriptive survey design was adopted. Sidhu (2002:107) views a descriptive survey design as a method of investigation which attempts to describe and interpret what exists at present in the form of conditions, practices, processes, trends and beliefs. The researchers found the descriptive survey a suitable design to explore the status of STEM implementation in rural secondary schools. A sample of 20 Maths and Science teachers was purposively drawn from four rural secondary schools with a population of 35. An open-ended questionnaire was administered by the researchers as well as conducting focus group discussions with the participants.

RESEARCH FINDINGS

The following are the main research findings which emerged from the collected data:

1. Rural secondary schools lack physical infrastructure to support implementation of STEM curriculum
2. Rural secondary schools lack STEM-trained teachers to implement STEM curriculum
3. Government sponsorship of students doing STEM subjects is biased against rural secondary school learners
4. Implementation of STEM reproduces and perpetuates social inequalities

DISCUSSION OF FINDINGS

The State of Physical Infrastructure

The study established that all the four (100%) rural schools sampled had no laboratories. All the 20 (100%) participants concurred that lack of infrastructure militated against implementation of STEM curriculum in their schools. The situation of physical infrastructure was described by one of the participants as follows: "*My understanding is that STEM subjects cannot be taught in ordinary classrooms, we need laboratories*".

The finding of this study relating to infrastructure to support STEM affirms previous studies (Ejiwale, 2013; Gadzirayi *et al* 2016; Zvavahera, 2015). The study also revealed that the sampled schools were offering Intergrated Science a less challenging subject instead of pure sciences because of lack of laboratories.

When the researchers interrogated participants on the deplorable state of educational infrastructure, various reasons were proffered which include poor economic situation in the country. Five (25%) of the

participants indicated that the government was facing financial challenges to support educational programmes due to economic sanctions imposed on the country by the Western countries. On the other hand 15 (75%) of the participants maintain that the government should consider construction of laboratories in rural schools a priority area if implementation of STEM curriculum is to be inclusive. Judged against the tenets of multicultural education as espoused by Banks (1996, 2001), the finding of this study with respect to educational infrastructure falls short of the principles of multiculturalism. Multicultural education is grounded in the ideals of social justice and equity Banks *et al.* (2001). As suggested by Gadzirayi *et al.* (2016), it should be laboratories first in all schools before implementation of STEM curriculum.

Availability of STEM-trained teachers

Teacher-factor has been found to be a key component in the implementation of STEM (Pasametier & Maeroff, 2011; Ejiwale, 2013). This study found out that all the 20 (100%) Maths and Science teachers sampled were qualified to teach the subjects. However, when the researchers interrogated the participants on their ability to teach STEM subjects, 18 (90%) of the sample indicated that they were not trained to teach STEM curriculum. Thus one participant said; *“Yes most of us majored in Maths or Science at College, but with the thrust of the new curriculum on STEM, I feel we should be in-serviced in STEM teaching”*.

Another respondent also said; *“We read about STEM in print and electronic media, but we have never attended a workshop to that effect, so we are not comfortable to implement the curriculum.”*

The sentiments expressed by the participants indicate that the sampled rural secondary schools lack STEM-trained teachers. In this regard Ejiwale (2013) advised that professional development should be encouraged to equip teachers with management skills and update their knowledge in the modern trend of teaching STEM education. In the context of Zimbabwe, although the Minister of Education Dr. Dokora indicated that the Ministry was stepping up training of Science and Maths teachers to meet objectives of STEM curriculum (Dokora, 2015), the benefits of the intervention had not yet been realised in rural secondary schools. Against this backdrop the researchers argue that the government should embark on training teachers in teaching STEM curriculum.

Student-Sponsorship in STEM subjects

Student-support is a critical aspect in inspiring the uptake of STEM subjects by students (Australian National STEM Education Strategy, 2016-2026). This study established that there were no students in the sampled schools sponsored by the government to pursue STEM subjects. When the researchers probed

on why there were no students sponsored to study Science subjects at ‘A’ level, all the participants concurred that STEM sponsorship was biased against rural learners. In one of the focus group discussions, one respondent said,

“As we told you earlier on, we are incapacitated in terms of infrastructure and equipment to implement STEM, we offer our students Intergrated science instead, unfortunately this does not allow our students to pursue STEM subjects at ‘A’ level”.

In view of this finding the researchers argue that national programmes such as STEM sponsorship should be all-inclusive to prevent talent strangulation. In this regard Margnison *et al.* (2013) observed that STEM-Strong countries develop strategic STEM policy frameworks which provide favourable conditions for all learners. The researchers thus suggest that Zimbabwe can borrow a leaf from such countries in order to implement STEM curriculum in a non-discriminatory manner. It implies that the government should embrace affirmative action programmes in the implementation of STEM. Aleman and Renn (2002) view affirmative action as a range of voluntary and mandatory activities in the area of education and employment which seek to promote women and minority groups. It is a known fact that there is a gap in development between urban and rural areas, a gap that is titled against rural areas. Against this background it is imperative that policy developers take this into cognisance lest the social inequalities can be perpetuated to the detriment of rural areas (Haralambos & Holborn, 2010). With regard to the status of STEM in rural secondary schools, this study found out that there were no affirmative action programmes targeting to promote STEM among rural learners. In this regard Margnison (2013) cautioned that when implementing STEM, governments should develop strategies that take into account the diversity of students’ context, gender and ethnicity. The finding of this study in respect of absence of STEM-affirmative programmes confirms Beatty’s (2011) observation that many students are left behind in STEM programmes no matter how talented and potentially eager, those who fail to access elite schools fail to recognize their potential. In the context of Zimbabwe Gadzirayi *et al.* (2016) advised that the government should put in place strategies to prevent social discrimination of students learning in under-resourced schools. The absence of affirmative action programmes in the sampled schools implies that the goal of STEM education to make all learners technologically literate (White, 2014) may not be achieved.

CONCLUSION

The aim of this study was to determine the preparedness of rural secondary schools to implement STEM curriculum. The study established that rural secondary schools face challenges to implement

STEM which include lack of laboratories, equipment and STEM-trained teachers. The study concluded that rural learners lag behind in terms of opportunities to study STEM curriculum, a situation which if not addressed will perpetuate the urban-rural dichotomy in terms of development.

RECOMMENDATIONS

Based on the findings of the current study the following recommendations were made;

- Government and other stake holders in education should mobilise resources to construct laboratories in rural secondary schools and equip them.
- Government should invest in training teachers to teach STEM subjects
- Government should implement STEM-related affirmative action programmes in rural schools

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