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The Teaching of Science, Technology, Engineering and Mathematics in Zambian Schools

A Snapshot Survey by Mukuba University, Itimpi, Kitwe

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Report to Committee on Education Science and Technology for National Assembly-November 2019

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Executive Summary

This report is a response to the Committee on Education, Science, and Technology (CEST) which commissioned a study on the 'the teaching of Science, Technology, Engineering and Mathematics in Zambian schools'. The report has discussed the teaching of Science, Technology, Engineering and Mathematics (STEM) subjects in schools that relate to sustainable development in Zambia. The policy and the legal framework for teaching STEM subjects in Zambian schools has existed since 1996, and it has provided a framework for creation of other policy documents. However, it has some flaws in the implementation phase due to several factors. Some of the factors have been noted in the CEST (2017) Report, amongst which are lack of coordination in policy development and implementation, inadequate funding, amongst others. Several measures have been put in place by the government to enhance the teaching of STEM subjects in schools as noted in this report. There is progress to demonstrate government's commitment towards the teaching of STEM in schools. Furthermore, the report highlights some efforts to improve STEM teaching through collaboration with local and international institutions. However, the progress made does not match with the many expectations that are represented in schools.

As one of the institutions transformed to provide excellence in STEM teacher-training, Mukuba University aims to improve curricula and research training in all its programs, thereby enhancing competitiveness in STEM subjects as an instrument for social and economic development of the country.

Thus, it is suggested that Government should honour its commitment in policy regulation, facilitating funding in STEM teaching activities, and research in order to achieve the desired aspirations of the country. Equally important, is the need for all stakeholders in the provision of the STEM education to cooperate with Government in ensuring that they undertake all mandated obligations.

1. Background and Introduction

1.1 Introduction

The teaching of Science, Technology, Engineering and Mathematics (STEM) is a very hot topic globally and in African due to the realisation of the significance of these areas to national and sustainable development. Particularly for Zambia, the challenge to develop and harness STEM, and innovative and sustainable solutions for teacher-training and teaching methodologies becomes a crucial area to address.

The Global Competitiveness report of 2019 produced by the World Economic Forum provides useful parameters that are useful for understanding the general workforce in the Zambian Context. The Table 1 below provides a picture of Zambia's workforce benchmarked against the highest performers in the global analysis. Overall, Zambia has been ranked 120th out of 141 countries that participated in the analysis.

Table 1- Global Competitiveness Report Indicators for 2019-Zambia's Workforce				
Indicator	Score 1(lowest) –7 (best)	%age Performance	Zambia's Ranking in Category	Highest Performer
Extent of staff training	3.6	*43.3*	109	Switzerland
Quality of vocational training	3.5	*41.0*	118	Switzerland
Skillset of graduates	3.8	*46.0*	96	Switzerland
Digital skills among active population	3.5	*41.7*	118	Finland
Ease of finding skilled employees	4.8	62.7	30	United States
Skill of current workforce	-	46.9	97	Switzerland
Critical thinking in teaching	2.8	29.8	119	Finland

As can be seen from the Table-1, Zambia's workforce does not compete well globally when considering the key parameters for sustainable development. A serious concern is that most items are showing a decrease in the competitiveness as compared to the past years. The only positive indicator is the *Éase of Finding skilled employees',* which is a surrogate measure, and hence does not directly contribute in measuring a specific skill-set. The application in STEM subjects', especially in teacher-training may not be very far from the general picture provided by this analysis.

1.2 Purpose and Objective

This purpose of this study is to undertake a study on 'The teaching of Science, Technology, Engineering and Mathematics in Zambian schools'. The study was necessitated by the request from the Committee on Education, Science, Technology of the National Assembly of the Government of the Republic of Zambia.

The objective of the study is to investigate and report on the following issues:

i. Adequacy and Effectiveness of the Policy and Legal Framework governing the teaching of Science, Technology, Engineering and Mathematics in Schools;

ii. Measures Government has put in place to enhance the teaching of Science, Technology, Engineering and Mathematics in Schools;

iii. Progress Made in Teaching of Science, Technology, Engineering and Mathematics in Schools

iv. The Role that Mukuba University is playing to enhance quality teacher-training and the teaching of Science, Technology, Engineering and Mathematics in Schools

v. Challenges faced in training teachers of Science, Technology, Engineering and Mathematics in Schools

vi. Suggest the way forward

1.3 Methodology and Strategy for Undertaking the Study

The methodology for undertaking the study would be a combination of the following aspects:

i. Review of past literature and documents related to the teacher-training in STEM subjects and the teaching of STEM in schools.

ii. Conducting snap-shot surveys due to the limited time given to undertake the study

iii. Undertaking interviews in selected schools, colleges and Universities

iv. Individual experiences and knowledge drawn from the participating researchers

The choice of the methodology has been made to suit with the limited time given to undertake this study.

2. Findings from the Study

The findings are presented based on the proposed areas as provided under Section 1.2

2.1 Adequacy and Effectiveness of the Policy and Legal Framework governing the teaching of Science, Technology, Engineering and Mathematics in Schools

2.1.1 Global and Regional Policy Framework

At a global scale, the significance of the STEM subjects in Education has been captured in the 2030 United Nations Sustainable Development Goal 4, on Quality Education (UN, 2030). The objective is to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'.

The African Union Agenda for 2063 highlight the critical role that STEM, and Information and Communication Technology (ICT) areas will perform for its member states. The Southern African Development Community (SADC) countries have held several fora and agreed on areas of cooperation aimed at improving the status of STEM for the benefit of all member states.

2.1.2 The Zambian Context

In Zambia, early policy document was developed in 1996, as the Science and Technology (Committee on Science and Technology Report-Mukuba, 2017).

Zambia's 7NDP plan has clearly stated the directions of the STEM teacher training and development. Figure 1 is an extract from the same document.

Figure 1: Zambia's 7NDP Articulating STEM and Curriculum Development

An excerpt from the 7NDP provides Strategy 4 and Strategy 5, which reads as follows.

Strategy 4: Continuous review of curriculum

The Government, in collaboration with stakeholders, will undertake continuous revision of curricula at all levels of education to enhance the relevance of the education system for the labour market. This will include a focus on important contemporary global market skills needs, such as science, mathematics, technology, innovation, entrepreneurship and strategic leadership training. Programmes:

 a) Curriculum and materials development;

b) Pre-service and in-service teacher training provision;

c) Curriculum assessment and evaluation enhancement;

d) Standards monitoring enhancement;

e) Curriculum framework standardisation; and

f) Training equipment provision.

Strategy 5: Enhance the role of science, technology and innovation Programmes to prioritise research in education institutions will be enhanced, to promote productivity, innovation and competitiveness in the economy. Research and innovation will drive the creation of new products and new ways of producing existing products efficiently.

Programmes:

 a) Science and technology human capital development;

b) Science and technology infrastructure development;

 c) Science, technology and innovation (STI) financing;

d) STI quality assurance enhancement; and

 e) STI coordination enhancement

A drawback observed is that the 7NDP does not provide a path and guideline for other policy and legal frameworks for Ministries and other institutions.

2.1.3 Other Policy documents in STEM areas

I. Zambia Education Curriculum framework 2013

For Zambia the most up-to-date philosophical framework is given in the 'Zambia Education Curriculum framework 2013' (ZECF)

The key competencies expected to be exhibited by a Zambian secondary school graduate are;

    i. communicating effectively in both speech and writing;

    ii. understanding, interpreting and applying mathematical, scientific and technological concepts;

    iii. applying the knowledge, skills, positive attitudes and value systems of vocational and life skills in real life. (ZECF 2013: 39)

II. The National Science and Technology Policy

The Government of the Republic of Zambia formulated the National Science and Technology Policy in 1996 and its main objective was to embed Science and Technology as part of the culture of the key sectors to promote competitiveness in the production of a wider range of quality goods and services.

The mission of this Policy was to promote and exploit Science and Technology as an instrument for developing an environmentally friendly indigenous technological capacity for sustainable socio-economic development in order to improve the quality of life in Zambia. The strategies for achieving this broad policy objective include:

(i) recognising gender concerns;

(ii) changing institutional structures;

(iii) ensuring that research is guided by national developmental goals;

(iv) establishing a mechanism for increased innovation, transfer, diffusion and

commercialisation of technology, especially for small and medium scale

industries, with emphasis on indigenous technology;

(v) putting in place efficient facilities to formulate and enforce standards and

undertake quality control testing and assessment of industrial products;

(vi) developing appropriate training which imparts practical skills and application

of knowledge to develop prototype, products and processes in changing

environment of market technology;

(vii) establishing a comprehensive data bank which is easily accessible at

strategic locations by scientific, management and industrial users; and

(viii) providing incentives and targeted promotions for the furtherance of the impact

of science and technology to economic development in the key sectors.

2.1.4 Lessons Learnt

With the review undertaken so far, it can be seen that the policy and legal framework for teacher-training in STEM and related fields has been provided. However, there were serious challenges in the implementation of the policy when changeover of government and revision of the said policy documents.

Sixth National Development Plan (6NDP, 2010), had not matched with the Science and Technology landscape and therefore, had not been very effective. The consequences of not having an up-to-date Policy had been detrimental to the advancement of Science and Technology in the country. For example, most of the technical colleges in the country rebranded with a focus on business-related programmes taking centre stage, and projects to improve the technical.

2.2 Measures Government has put in place to enhance the teaching of Science, Technology, Engineering and Mathematics in Schools

2.2.1 At National level.

i. Funding

Government directly supports Science and Technology Research through monthly grants to

institutions.

ii. Special Fund for Youth Innovation

Government equally administers Science, Technology and Innovation Youth Fund through the National Science Technology Council (NSTC). This fund is aimed at empowering the youth, to enable them to develop and apply scientific and technological innovations for employment and wealth creation.

iii. Establishment of centres of excellence

Through the NSTC, Government is initiating the establishment of centres of excellence which are meant to enhance student's access to hands-on experiments and up to date literature on STEM subjects.

The following are some examples:

- The construction of modern libraries and purchase of books at Nkandabwe (Southern Province) and Kasempa Secondary (North-western Province) Schools.
- of Africa Centre of excellence in mining being hosted at CBU- a collaboration being funded by the World Bank
- Solar energy Centre of Excellence at the University of Zambia - being funded by UNDP. Its main objective is to promote the transfer of renewable energy technology from China to Zambia using the South to South cooperation model

iv. Encouraging Junior Engineers initiatives

During the Junior Engineers, Technicians and Scientists (JETS), Government, through NSTC, adopts some of the projects that emanate from these clubs for possible funding. The NSTC also identifies outstanding pupils with projects and awards them.

The programme "Zambian Genius" which has been airing on ZNBC Television on Wednesday 17:30 hours and Sunday 19:30 hours by Samuel Machisi the presenter, is one example of showcasing junior involvement in STEM.

v. Support in Gender Activities

To encourage active participation of girls in STEM subjects, government supports Girls Science Camps by providing books and mentorship to girls who take part in this activity.

The programme "Zambian Genius" which has been airing on ZNBC Television also aims to motivate the girls in taking up STEM careers.

2.2.2 Creating and Supporting Specialised Institutions for STEM

Mukuba University was created as a public institution that Government is using to enhance the teaching of STEM subjects. Some of the areas of support and progress have been highlighted in Section 2.3

2.2.3 Creating Fast Track programmes

In an effort to increase the number of highly qualified educators for STEM subjects in rural areas, Government sponsored teachers under the fast track programmes. For example, between 2012 and 2015, 400 teachers were sponsored to do their studies at UNZA while 1600 at DMI. Graduates from these programmes are now able to teach STEM subjects.

2.3 Progress Made in Teaching of Science, Technology, Engineering and Mathematics in Schools

2.3.1 Facilitated for Funding through African Development Bank some schools

Government procured a loan from African Development Bank to fund an initiative called Support to Science and Technology Education Project at the Copperbelt University, Mulungushi University, Mawagali College, NORTEC, Nkumbi College and Kabwe Institute of Technology to run from 2015 to 2019. Among the objectives of the project are to:

    i. Provide training equipment

    ii. Rehabilitate infrastructure

    iii. Train out of school youths

    iv. Train lecturers

    v. Construct infrastructure

    vi. Procure furniture

This project has yielded good fruits and it is unfortunate that it is coming to an end this year, 2019. For instance, at NORTEC alone, the project has seen the training of about 800 out of school youths in various Science and Engineering skills. This is quite remarkable as most of these youths have now been empowered with necessary skills for their survival. Thirty four lecturers at NORTEC have also benefited from this project by way of capacity building:

Seventeen are based at the Copperbelt University and the other Seventeen are at the University of Zambia. This too is very remarkable as these lecturers will be acquainted with the necessary skills and latest pedagogical concepts thereby ensuring effective teaching of Science, Technology, Engineering and Mathematics.

In primary and secondary schools the government is striving to enhance the teaching of Science, Technology, Engineering and Mathematics through infrastructure development, procurement of apparatus and chemicals, human resource development and allocation of funds.

2.3.2 Implementation of Skills Development Fund

The government has now implemented the long awaited Skills Development Fund. Through this fund, Trade Schools and Colleges such as NORTEC are being funded by the Government of the Republic of Zambia (through the Ministry of Higher Education) to ensure effectiveness in the teaching and learning of STEM subjects.

2.3.3 Government Accomplishment at Mukuba University

I.   Infrastructure Development and other procurement

In April 2019, the Republican President, H. E. Edgar C. Lungu commissioned infrastructure under Phase I. The infrastructure included the Library, Lecture Theatre, two Classroom blocks and two student Hostel blocks.

H. E. President Edgar Chagwa Lungu during commissioning ceremony

Student Self-Catering Kitchenettes

Construction of Two Kitchenettes commenced during the period under review. The total project cost is K192,394.00

III.   Main Car Park

Construction of Phase II of the main Car Park commenced during the period under review. The total project cost is K420,881.64.

Phase II Car Park under construction

IV. **Labelling of various infrastructure**

Labels for the new hostels and other buildings were procured during the period under review, at a cost of K57,680.00.

Labelling of various infrastructure in progress

V. **Financing of Student Education through loans**

Total grants received as at April 2019 were ZMW **1,332,006.25**

During the period under review, the Higher Education Loans and Scholarship Board sponsored Eighty Three (83) first year students. The students are on 100% sponsorship.

2.3.4 Facilitated for the development of STEM centres of learning

Government has transformed several STEM centres of learning. A few are mentioned here:

- Mukuba University which was transformed from COSETCO
- Kasempa Secondary school
- Mukandabwe Sec School in Sinazongwe District

2.4 The Role that Mukuba University is playing to enhance quality teaching of Science, Technology, Engineering and Mathematics in Schools

2.4.1 Development of new Curriculum in STEM programs

In order to meet the demand for high skill set in STEM and ICT areas, Mukuba University has developed new curriculum at undergraduate and postgraduate levels.

The following programmes have been developed and submitted for accreditation to the Higher Education Authority (HEA) as shown in Table-2:

	Bachelors Programmes	Programme code
1.	Bachelor of Science in Mathematics and Statistics	BSc. MAT400
2.	Bachelor of Science in Biochemistry	BSbC-400
3.	Bachelor of Science in Biology	BSc. BIO100
4.	Bachelor of Science in Information Systems and Digital Business	BSc-ISDB400
5.	Bachelor of Science in Environment and Climate change	BSc. ECC1002019
6.	Bachelor of Science in Physics	BSc Physics-200
7.	Bachelor of Science in Chemistry	BSc Chemistry-400
8.	Bachelor of Education Guidance and Counselling	BEd.GC
9.	Bachelor of Education: Primary Science	BEd.PS
	Masters Programmes	Programme code
1.	Master of Science in Ecology: Biodiversity and Ecosystems	MSc. ECO500
2.	Master of Science in Biochemistry	MSBC-600
3.	Master of Science in Physics	MSc Physics-600
4.	Master of Science in Chemistry	MSc Chemistry-500
5.	Master of Science in Information Systems	MSc-IS600
6.	Master of Education, Educational Management and Administration	MED-EMA-600
7.	Master of Education in Quality Assurance	MEdQA-600
8.	Master of Education in Science Education	M.Ed-Sc-600

Table-2:Proposed STEM programmes for 2020-Mukuba University

2.4.2   Funding the Staff Development Programme

Some Staff at Mukuba University have received assistance to upgrade their qualifications at local and international centres of learning in STEM. Currently, 40% of staff are undergoing various training in their respective fields.

2.4.3 Improvement of Quality Education in STEM

Several measures are being undertaken to ensure that quality is maintained at MKU. Some of these are:

I.   **Engagement of External Examiners**

This ensures that the programmes being offered are of acceptable and relevant international standard in the STEM specialisations

II.   **Incorporating modern pedagogical tools in the Teaching of STEM**

Some staff have adopted methodologies that expose learners to hands on experiences (e.g.Cooperative learning). Such methodologies make teachers to be facilitators who accompany learners to new discoveries and reflections rather than memories.

In shifting from the traditional-based methods of teaching to student-centred learning, the University is trying to promote quality teaching of STEM by exposing students to the informatization of the classroom by integrating new technologies in their pedagogies.

III.   **Incorporating E-learning Tools**

The University has started incorporating learning management systems such as MOODLE to enhance quality in teaching and administration of course records. By so doing, staff are getting equipped in the provision of and administration of elearning in STEM.

2.4.4 Provision of Open and Distance Learning

The provision of ODL programmes offer an opportunity to STEM subject teachers through Open and Distance Learning (ODL). This programme gives opportunities to primary and

secondary school teachers to be able to upscale their qualifications so that they effectively contribute to quality teaching and learning.

2.4.5   Expanding on research participation and publication of scholarly work amongst staff

The following research activities are on-going;

1. Overweight and Obesity in Relation to type 2 Diabetes Mellitus. The Case of Kitwe District, Copperbelt, Zambia. Given Chipili et al,
2. Quantum Mechanics Symbology: How does it affect students' understanding of Introductory Quantum Mechanics concepts? Case of Mukuba University, Kitwe, Zambia. Kwaleyela Kwaleyela et al
3. Digital Transformation (DT) in Higher Education: Case of Zambia. Shemi A P, Daka-Lifelo Zita, Chimanga-Kashale
4. Modeling Social Media Network Adoption for Effective Teaching and Learning in Higher Education Context. Shemi A P, Kalenga R, Mushabati, D
5. The Practicality of the interplay between Curriculum and Pedagogy in bringing about quality education: A case of selected provinces in Zambia. Simango, B.; Lungu Josephine; Sakala J.; Mukonde B
6. An Investigation On The Educational Impact Of Load Shedding: A Case Of The Major Mining Towns In Zambia. Gerald Banda
7. Plant Remedies Used To Treat Poisonous Snake Bites In Zambia. The Case Of Luapula And Northern Provinces. Chibuye Bitwell et al
8. An Investigation Of The Contribution Of Mathematics To Secondary Teachers Diploma Physics In Zambia. Chilufya J M
9. Investigating The Quality And Relevance Of Mathematics And Science Teacher Education In Zambia Chisha Eliphas
10. Biological Control Of Pests In Zambian Plantations. Chungu Donald et al
11. Ecological And Health Risks Of Dust Emmited From Surface Tailings Around Kalulushi Mining Area, Zambia - A Pilot Study. Kabumbu C Sr, and Kapongolo E
12. Quality Assurance Of Open And Distance Learning In State-Owned Colleges Of Education In Zambia. Lifuka Evans

13. Quality Assurance Of Open And Distance Learning In State-Owned Colleges Of Education In Zambia. Lombe Annette

14. Assessing The Contribution Of Curriculum In Creating Climate Change Awareness Among First Year University Students In Zambia. Mwewa Susan

15. A Comparative Study On Robust Speech Recognition Using Mel Frequency Cepstrum Coefficients And Linear Predictive Coding: A Case Of Zambia. Pamba John, & Mufungulwa George

16. Open and Distance Learning Practices in Zambian Higher Education system: Challenges and Improvements. Kaluwasha, H; Shemi A P , Chanda L Maliwatu,J,

17. 21st Century Competencies in Zambia's Primary Education: An ICT perspective. Luchembe D, Shemi A P

18. Investigation of School Experience in Secondary School Education: Challenges and Improvements. Shemi A P, Chanda, L; Kaluwasha, H, Maliwatu, J

19. An Investigation of ICT integration in Secondary Education: Case of Mukuba School Experience Program. Chanda L, Pamba, J., Shemi A P

20. Implementation of Biogas Project: Case of Mukuba. Lombe A; Mwandira, G; Mbalushi, J

2.4.6 Establishment of Quality Assurance Management Unit

The objective of this unit is to ensure that quality is maintained in all academic processes of the University. Several areas are incorporated such as:

- Linking the University Strategic plan with the Academic Development processes of the University
- Curriculum Development and Assessment
- Revising of existing curriculum and /programmes, improvement of old programmes and development of new programmes etc.
- Review of School Teaching Practice/Industrial attachment programme
- Adhering to the accreditation process of the Higher Education Authority
- Ensure that the ODL programmes, and Affiliated programmes adhere to quality norms established by the University

2.4.7 Undertaking Conferences/Workshops/Seminars

This will to improve teaching and learning of the programs

2.4.8 Improvement of School Experience Programme/Industrial Attachment

The School Experience Programme aims at enhancing the quality of teaching by making students have hands on experience of teaching by attaching them to different secondary schools and mentors countrywide for School Experience. This exercise gives students the chance to be able to apply the modern teaching methodologies to real life situations. With the critique and guidance of their mentors about their progress, students sharpen their teaching skills to become effective teachers.

Similarly, students to be enrolled in pure sciences will be required to go for Industrial attachment to enable them to experience practical work in various companies and organisations so that they sharpen their skills.

2.4.9 Introduction of Entrepreneurship and Innovation in the curriculum

In response to the requirement by the HEA to register for a programme, the University is developing entrepreneurial courses to be integrated into every programme. This is aimed at equipping students with skills to be able to become self-employers.

2.4.10 Introduction of Research component in every programme

In order to enhance the development of research skills among learners, the University has incorporated aspects of research methods in all programmes. As such, the course prepares students to be able to carry out research and be able to solve problems related to the teaching and learning of STEM subjects.

2.4.11 Establishing Partnerships and Collaboration with International Institutions that offer STEM subjects

Mukuba University has signed MOU with Marondera University of Agriculture Science and Technology to enhance STEM teaching.

2.4.12 Encouraging staff to participate and affiliate with professional bodies in STEM

This includes professional bodies such as Home Economics Association of Zambia (HEAZ), Zambia Association of Mathematics Education (ZAME) and Zambia Association of Science Education (ZASE).

2.5 Challenges faced in training teachers of Science, Technology, Engineering and Mathematics in Schools

2.5.1 Weak Policy and Legal Framework

At national level, the Ministry of Higher Education has been responsible for the overall coordination and implementation of Science, Technology, Engineering, and Mathematics. Previous studies such as the 2017 Committee on Education, Science and Technology (CEST) report on regarding policy highlight this inadequacy. Although it has been noted that there are fruitful developments in many sectors such as agriculture, health, energy, education, manufacturing, mining and Trade and Industry, regarding the teaching of Science, Technology, Engineering and Mathematics in Schools, it has been noted that there is lack of coordination as well as lack of clear policy across Ministries in Zambia.

2.5.2 Lack of Sufficient Funding

It has been noted in previous studies and committee reports (CEST, 2017) that STEM and ICT development are costly ventures and require massive investments in infrastructure, human resource development, commercialisation and transfer. The successful implementation of science and technology programmes depended on several factors, such as funding levels, disbursement mechanisms and financial information. Although, Government expenditure on Science Technology and Innovation programmes had shown an increase since 2002, the level of funding to the sector was still low, especially for research and development activities and this had made it very

difficult for institutions to fulfil their mandates. The National Policy provides for 3 percent of GDP to be availed to Research and Development. However, only about 0.6 percent of Zambia's GDP was availed to Research and Development in 2014 (African Science and Technology Indicator Survey (ASTII) African Innovation Outlook 2014).

2.5.2 Poor or lack of infrastructure especially STEM laboratories

It is well known that the cost of education in STEM and ICT is very expensive. However, most institutions of learning lack modern facilities for laboratory and research. The Government funding for the realisation of quality education is very low even for the 2020 budget. There are STEM laboratories at Copperbelt University and Mukuba University developed to provide undergraduate and postgraduate level of education, however, the equipment is either non-existent or very outdated.

Much as there is desire to scale smart systems in Zambia, there is little support to provide a foundational base to train would-be developers of such systems.

2.5.3 Shortage of teachers and trainers in STEM subjects

There is dire need of teachers of STEM and ICT in Zambian schools. The rural areas are experiencing a rather serious shortage as most teachers prefer to live in the affluent areas such as Lusaka or the Copperbelt province.

2.5.4 Lack of Coordination amongst Stakeholders

There are several educational projects being undertaken in the country at different levels. However, the inability to coordinate these activities has cost the country a lot of revenue. For example, the outcomes of JETS projects have received little attention in comparison with the excitement and motivation that surrounds the development and implementation of such projects in schools.

2.5.5 Cultural attitude that discourage training and application of STEM

Cultural attitudes, especially in rural areas tend to have a negative bearing on the teaching of STEM subjects as they tend to support boy education rather than that of girls. Seemingly, such cultural attitudes promote early marriages among teenagers.

2.5.6 Gender issues

Gender issues have often been cited (Christie et al., 2017) to be a barrier to effective teaching as STEM subjects are often considered to be gender inclined. Accordingly, women tend to shun STEM for fear of not being able to succeed. This scenario creates gender imbalances in terms of enrolments for STEM subjects.

2.6 Suggested way forward

Based on the foregoing discussion, the following recommendations are made:

2.6.1 Government

I. **Provide and facilitate the implementation of policy for enactment of STEM in schools.**

It is necessary that Government provide and facilitate for the implementation of relevant policies in STEM teacher-training and improvement of the learning environment.

II. **Increase funding and investment in STEM/ICT training and research**

Currently, the infrastructure is outdated and does not cater for the pure/blended STEM programmes that have been developed. Government can facilitate for provision of infrastructure, student and staff-exchange programmes and purchase of modern equipment to address the various needs represented in rural and urban schools/colleges/universities.

III. Development of Innovation Parks in STEM related areas to enhance some aspects that are articulated in the 7th National development plan such as entrepreneurship, productivity, and innovation (7NDP, 2017).

IV. Increase the funding of STEM associations and clubs in schools

V. Consideration of Tax rebate system which encourages the corporate world to partner and collaborate with universities in offering needed laboratory and materials for training and research in STEM. Such corporations could in turn obtain tax rebate due to their involvement in public projects.

VI. Government to encourage and spearhead a proactive approach to corporate social responsibility, particularly in relation to STEM activities.

VII. Strengthening patenting and commercialisation of scientific and technological innovations

2.6.2 Mukuba University Response

I. Undertake periodic curriculum review to ensure the capturing of emerging issues in STEM.

II. Increase in STEM entrepreneurial and innovative training at undergraduate and postgraduate levels

III. Increase involvement in STEM research activities and scholarly publications. This will allow the publication and dissemination of the name of Mukuba University and the country on the global map.

IV. Expanding the provision of ODL learning for STEM programmes

V. Spearhead hosting of Conferences, Seminars and Short courses that showcase research activities undertaken staff and students in STEM specialisations

VI. To engage in promoting STEM activities in some schools and communities. For example, the mentoring of JETS participants, supporting STEM clubs in primary and secondary schools.

VI. Engage in community sensitisation of the environment and the need to care for natural resources and preservation of life.

VII. Improve the demystification of Gender stereotypes in STEM areas among students in schools and Colleges.

VIII. Collaborating with other national and international groups/institutions with similar vision of promoting training and teaching of STEM subjects.

For example the memorandum of understanding with Marondera University was signed to enhance cooperation Agriculture Science programmes.

IX.   Increase our participation in STEM related professional bodies locally and internationally.

X.   Incorporate modern methods of learning using elearning tools

2.6.3 Industry Collaboration and Partnerships

Encourage collaboration and partnerships with local and international companies to fund some projects that government is unable to take up. Areas such as materials and laboratory equipment, Book purchase or online access to STEM materials, provision of free educational resources or Mass Open and Online Classes (MOOC) in STEM.

2.6.4 Community

To facilitate community participation through partnership in research, training and information dissemination about the STEM activities in schools. For example, the University could partner with schools in the promotion of Continuous Professional Development (CPD).

3.0   Summary and Conclusion

The paper has discussed the teaching of STEM subjects in schools and related areas that relate to sustainable development in Zambia. The policy and the legal framework for teaching STEM subjects in Zambian schools is generally provided, although it has some flaws in the implementation phase due to inadequate funding. This feature has been noted in the CEST, 2017 Report. Several measures have been put in place by the Government to enhance the teaching of STEM subjects in schools as noted in this report. There is progress to demonstrate government's commitment towards the teaching of STEM in schools. Furthermore, the report highlights some efforts to improve STEM teaching through collaboration with local and international institutions. However, the progress made does not match with the many expectations that are represented in schools.

As one of the institutions transformed to provide excellence in STEM teacher-training, Mukuba University aims to improve curricula and research training in all its programs,

thereby enhancing competitiveness in STEM subjects as an instrument for social and economic development of the country.

Thus, it is suggested that Government should honour its commitment in policy regulation, facilitating funding in STEM teaching activities, and research in order to achieve the desired aspirations of the country. Equally important, is the need for all stakeholders in the provision of the STEM education to cooperate with Government in ensuring that they undertake all mandated obligations.

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United Nations SDG.

Zambia's Sixth National Development Plan -2011-2015, 2010.

CEST-Committee of Education Science and Technology,-2017-Republic of Zambia

African Science and Technology Indicator Survey (ASTII) African Innovation Outlook 2014

Zambia Education Curriculum framework (ZECF)2013

APPENDIX

UNITED NATIONS -SDG 4 QUALITY EDUCATION

Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Targets

- By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and Goal-4 effective learning outcomes
- By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre primary education so that they are ready for primary education
- By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university
- By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship
- By 2030, *eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations*
- By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy
- By 2030, ensure that *all learners acquire the knowledge and skills needed to promote sustainable development*, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and *appreciation of cultural diversity* and of culture's contribution to sustainable development
- *Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all*
- By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries
- By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially the least developed countries and small island developing states