Demystifying Teaching of STEM Subjects in Malawi Secondary Schools Through Application of Information and Communication Technology

Michael Zimba, Leroy Nyalugwe, Foster Lungu, Seyani Nayeja, Eliza Saizi and Noel Chitha

June 6, 2021

Demystifying Teaching of STEM Subjects in Malawi Secondary Schools through Application of Information and Communication Technology

[1]Michael Zimba, [2]Leroy Nyalugwe, [3]Foster Lungu, [4]Seyani Nayeja, [5]Eliza Saizi, [6]Noel Chitha

[1]mgmzimba@gmail.com,   [2]lnnyalugwe@gmail.com,   [3]fclungu@yahoo.co.uk,   [4]nayeja@gmail.com, [5]elizasaizi1992@gmail.com, [6]cmnmsowoya@gmail.com

Mzuzu University

Abstract

In this paper we propose an electronic based approach to teaching science, technology, engineering and mathematics (STEM) subjects in secondary schools in Malawi, with community day secondary schools as principal targets. We develop electronic modules for Malawi secondary school curricula, starting with Mathematics, Physics and Computer Studies, and the modules could be equally used either online or offline. The initiative proposed herein rationalizes into two main points: a) that Malawi, as a nation, need to continue with undisrupted provisions towards the right to education for the secondary school students, even in the presence of pandemics like COVID 19; and b) that STEM subjects and topics, which are often regarded as being difficult, and hence not well taught in a number of secondary schools in Malawi even though the curricula rate them as compulsory, needed a demystifying, leaner-friendly, repeatable approach to their teaching. The latter point becomes even more eminent noting that most teachers who handle these STEM subjects are often not adequate in numbers and qualification, particularly in community day and rural secondary schools. The proposal herein intends to address the first point in specific short terms during pandemic occurrences and the second point in both short and long term. Demonstrative screenshots of a prototype of the proposed solution are included in the paper.

Key terms: STEM; electronic module; leaner-friendly; demystifying.

1.   Background and Introduction

Globally, the United Nations (UN) Sustainable Development Goal (SDG) Number 4 advocates for ensuring **inclusive and equitable** quality education and promoting **lifelong learning opportunities for all** [United Nations, 2015]. The goal highlights the need to: a) ensure that all girls and boys complete free, equitable and **quality** primary and **secondary education** leading to relevant and effective learning outcomes; b) ensure that all learners acquire the knowledge and skills needed to promote sustainable development; and c) build and upgrade education (physical

or otherwise) facilities that are child, disability and gender sensitive and provide safe, nonviolent, and effective learning environment for all.

Regionally, the African Union Agenda 2063 [African Union, 2015] aspires for an Africa with well-educated and skilled citizens, underpinned by science, technology and innovation where a knowledge society is the norm and no child misses school due to poverty or any form of discrimination. It further declares that by 2063, African countries will be amongst the best performers in global quality of life measures. This will be attained through strategies of inclusive growth, job creation, increasing agricultural production; investments in science, technology, research and innovation; gender equality, youth empowerment and the provision of basic services including health, nutrition, education, shelter, water and sanitation. African children shall be empowered through the full implementation of the African Charter on the Rights of the Child. This includes the right to education. Therefore, the right to education by the citizenry of any nation is non-negotiable.

This is further exemplified by the Continental Education Strategy for Africa 2016-2025, or CESA 16-25 [African Union, 2016]. Relevant to this paper, strategic Objective 3 of the strategy is to *"harness the capacity of ICT to improve access, quality and management of education and training systems";* and Subsections b and f are to *"Promote the development of online contents taking into account African and local specificities,"* and *"Create mobile and online education and training platforms and accessibility to all students regardless of their circumstances"*respectively.

Nationally, the National Education Policy (NEP) [Government of Malawi, 2013], which is designed to respond to the Malawi Growth and Development Strategy II (and MGDS III) [Government of Malawi, 2017] and various related national education policies including regional and international protocols on education, attempts to define the provision of quality education in a holistic manner through: a) expanded access and equity; b) improved quality and relevance; and c) improved governance and management. The policy seeks to ensure: that equitable access to secondary education is increased; that there is an increase in the number of girls who equitably access, participate in, excel and complete secondary education; that equitable access to quality and relevant special and inclusive secondary education is enhanced; that the secondary school curriculum is relevant and responsive to the needs of the country; that secondary schools meet minimum infrastructure standards; and that the quality assurance and quality of secondary education is enhanced.

It is clear that global, regional, and national strategic documents all emphasize the need for continued progress towards the rights to education for children at all times. We need to be particularly creative and innovative in situations when Malawi is experiencing pandemics such as COVID-19 so that this right to education is not suspended. It is against this background that we propose to develop electronic modules for secondary school curricula that can be made easily accessible in both online and offline formats.

2.   Problem to be addressed

The problem discussed in this paper is two-fold. Firstly, when a pandemic occurs, governments usually take containment measures that often end up suspending rights to certain socio-economic provisions. For instance, the Malawi Government closed all schools and colleges on 23rd March 2020, due to the COVID 19 pandemic. The closure of schools, necessary as it was, left most, if not all, secondary school students idle. The right to education for these students was indefinitely suspended. In such situations, there is need for immediate and innovative interventions. Secondly, STEM subjects are usually regarded as hard subjects by most secondary school students, particularly girls. Consequently, such subjects are seldom well covered by secondary school teachers, who are usually not adequate in both numbers and qualification to teach those subjects. Therefore, making curricula and teaching materials easily available electronically, in learner-friendly and repeatable format, can greatly enhance the quality of STEM education in secondary schools, particularly community day and rural secondary schools.

3.   Proposed solution

We propose to develop electronic modules for the Malawi secondary school curricula. We will start with Mathematics, Physics and Computer Studies as pilot subjects. The initiative proposed herein is premised on the two points of rationale: a) that Malawi, as a nation, needs to continue to provide for the right to education for the secondary school students, even in the presence of pandemics like COVID-19; and b) that certain subjects and topics, particularly STEM subjects, are cocooned in artificial myths of being difficult, and, worsened by the inadequacy of teachers, are hence not well taught in a number of secondary schools in Malawi even though the curricula rate them as compulsory.

To inspire students, particularly female students, the initiative will be appropriately championed by two of authors of this paper, male and female, who are current students of Mzuzu University and have recent experience of with the secondary school curricula. Their presence not only entrench contemporary thinking into the development of the modules, but also demonstrates the

desire for inclusiveness. Furthermore, three of the other authors of this paper participated in the development and validation of a number of the current secondary school curricula. From their knowledge and experience, the three authors bring into the proposed solution a rich loading of content and pedagogical relevance.

4. Rationale behind the proposed solution

The spontaneous short-term goal of the initiative is to enable continued provision of secondary education in Malawi in pandemic times by developing ICT-enabled, innovative leaner-friendly, illustration-rich, curriculum-faithful electronic modules (e-modules) that could easily be utilized online and offline by secondary school students and teachers. The long-term goal of the initiative is to demystify the teaching of STEM subjects in secondary schools by provision of demonstration-enriched and easy-to-follow e-modules. To optimise the potential impact this approach, the initiative also proposes appropriate orientation and training of secondary school teachers in the use of the e-modules.

The proposed solution is based on a theory of change (TOC) that if secondary school students and teachers are empowered with adequate knowledge (content and methodology) and skills in the use of ICTs, and provided with the appropriate teaching materials they should be able to address their current problems. The current problems facing secondary school education are exacerbated by limited application of Science, Technology, Engineering and Mathematics (STEM). This TOC assumes that training and experiential learning could foster knowledge and skills in the secondary school teachers.

5. Design methodology and roll out plan

The proposed initiative broadly decomposes into three main tasks: a) develop e-modules for STEM subjects, rich in content and pedagogy, and appropriately aligned to the secondary school curricula; b) create, update and maintain tools, platforms and applications to host and support the e-modules; c) orient secondary school teachers for effective utilization of the e-modules and associated ICTs.

In order to speed up the analysis, design, and implementation of the initiative and in order to get some portion of the system developed quickly enough and into the hands of the users for evaluation and feedback, the initiative will follow the rapid application development (RAD) methodology. This results in an improved version of the system that can be released, after

incorporation of the users' feedback, from previous iterations. **Figure 1** illustrates the RAD methodology. An iteration is estimated at a 2-month cycle. Output from the first iteration is demonstration in Section 5.1
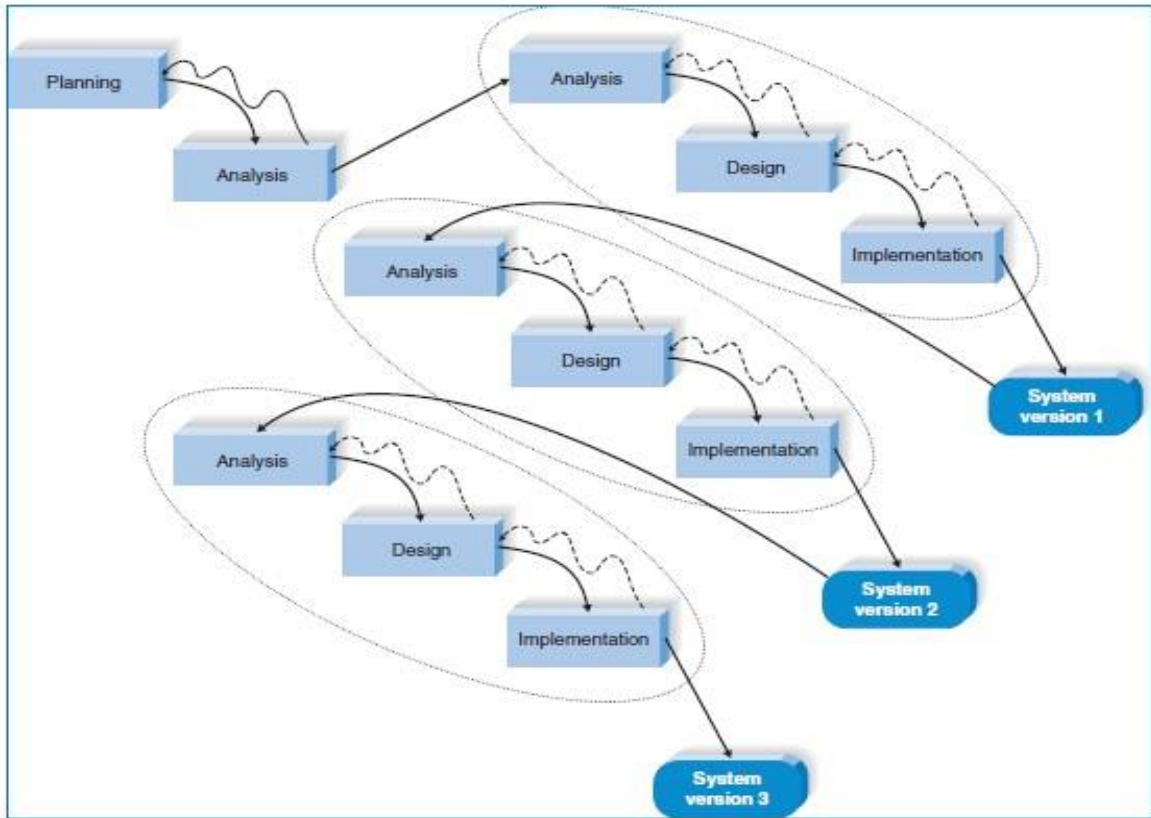

Figure 1: Rapid application development (RAD) methodology to system development

5.1   First iterative output as a demonstrative prototype

In Figure 2, we present screenshots from a sample Mathematics emodule that was developed during the experimental first iteration. The topic under discussion is "Travel graphs". The screenshots illustrates the richness (in both content and pedagogy) and leaner-friendliness of the emodule. It should be clear from the illustration that students would easily follow the lesson on their own, even without the presence of teachers. This is an important aspect realising the fact that a good number of secondary schools in Malawi do not have adequately qualified STEM teachers.

Figure 2 : **Screenshots from a sample Mathematics emodule**

6.   Progress tracking (and success) metrics

In this section, we describe the key performance metrics for the proposed solution under the following three perspectives: namely main outcomes, expected outputs and auxiliary success factors.

6.1 Main Outcome

The main outcomes of the proposed solution include empowering secondary schools to continue offering quality education to their students in difficult times, such as during pandemics like COVID-19. It also empowers schools challenged with shortage of qualified teachers in certain STEM subjects.

6.2 Expected outputs

Specific outputs of the proposed solution include: a) development of functional and responsive eLearning platforms; b) STEM subject e-modules; c) Trained or oriented STEM teachers sampled from all education divisions; and d) Students sampled from all education divisions, utilizing the emodules. The specific values to these variables would always be negotiated during the development of the implementation plan.

6.3 Auxiliary success factors

Imperatives to achieving the results are strategic and win-win collaborations between the Ministry of education, secondary schools, and Mzuzu University. Such collaborations would foster well-fused mentorship of secondary school staff and build a critical mass of necessary skills for e-learning in secondary schools in Malawi.

7   Conclusion

In this paper we have presented an electronic based approach to teaching STEM subjects in secondary schools in Malawi, with community day secondary schools as principal targets. The developed electronic modules for Malawi secondary school curricula could be equally used online or offline. The proposed solution could not only enable Malawi, as a nation, continue with undisrupted provisions towards the right to education for the secondary school students, even in the presence of pandemics like COVID 19, but also allow secondary school teachers to successfully teach STEM subjects and topics, which are often regarded as being difficult. The

latter point becomes even more eminent noting that most teachers who handle these STEM subjects are often not adequate in both numbers and qualification, particularly community day and rural secondary schools. Through screenshots of a prototype of the proposed solution, we have demonstrated that the emodules are demystifyingly leaner-friendly, illustration-rich and curriculum-faithful.

8   References

[African Union, 2015]. Agenda 2063. The Africa We Want. Retrieved from:

http://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf accessed on 11/10/20.

[African Union, 2016]. Continental Education Strategy for Africa 2016-2025. CESA 16-25. Retrieved from:

https://au.int/sites/default/files/documents/29958-doc-cesa_-_english-v9.pdf,   accessed   on 11/10/20.

[Government of Malawi. 2013]. National Education Policy (NEP). Retrieved from: https://planipolis.iiep.unesco.org/sites/planipolis/files/ressources/malawi_national-education-policy.pdf accessed on 11/10/20.

[Government of Malawi, 2017]. Malawi Growth and Development Strategy (MGDS) III 2017-2022. Retrieved from:

https://malawi.un.org/en/42159-malawi-growth-and-development-strategy-mgds-iii-2017-2022

accessed on 11/10/20.

[United Nations, 2015]. General Assembly Resolution 70/1 Transforming our world: the 2030 Agenda for Sustainable Development. Retrieved from:

https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf accessed on 11/10/20.