Bring the Students Back: ICTs, Math and Science Education in African Secondary Schools

Issue at-hand

Africa is yet to become a major player in the technological and scientific revolution that has swept the world over the last five decades. One of the main reasons for this state of affairs is the poor teaching of mathematics and science in African secondary schools which deprives the continent of a critical mass of graduates with mathematical and scientific knowledge, skills and competencies that are needed to compete at the global level.

A growing body of research on the continent has now identified the key factors affecting the teaching of mathematics and science in secondary schools in Africa and these are: lack of basic infrastructure such as laboratory and equipment, lack of teachers in quantity and quality (teacher’s poor content and pedagogical knowledge), lack of motivation and interest by the majority of students who view the subjects as too difficult, poor mastery of the language of instruction and the quasi inexistence of teaching and learning materials (Makgato, 2007; Georgewill, 2006; Sing, Granville & Dika, 2010).

The most prominent factors among the ones listed in explaining this situation are the fact that most of the mathematics and science teachers still use the traditional ‘talk and chalk’ method when teaching; and coupled with this there is an abysmal dearth of textbooks to support teaching and learning. Moreover, these two factors have combined to determine the pedagogy used in the classroom as the lack of resources and facilities such as textbooks, laboratories, chemicals, tools and equipment, teaching aids tends to favor a teacher-centered approach. It is a known fact that when these facilities and resources are available, better teaching and learning occurs; students are more engaged in practical activities through experimentation, problem-solving, and interacting with one another in practical hands-on-activities. The motivation to
Many initiatives have sprung at the regional level to address this situation and have by and large consisted of remediying the poor content and pedagogical knowledge of secondary education mathematics and science teachers. Among the most recognizable ones are the Japanese-supported Strengthening of Math and Science Education in Africa (SMASE) which has introduced the Activities, Students, Experiments and Improvisation (ASEI) pedagogy and the Female Education in Mathematics and Science Education in Africa (FEMSA) launched by FAWE to develop girl-friendly learning environments for these subjects. However, both initiatives are donor-driven and regional in orientation. Therefore, the issue of sustainability should be of concern. For all intents and purposes, FEMSA, for instance, is now defunct as donor funding has dried out.

Very little has been done to address the poor teaching through indigenous policies at the national level using the many facilities afforded by ICTs to improve math and science teachers’ content and pedagogical knowledge.

**Policy Recommendation: Upgrading the Pedagogical and Content Knowledge of Secondary Education Mathematics and Science Teachers through Multimedia Enhanced Content**

In a bid to address the serious shortage and lack of qualification of math and science teachers in Tanzania, the government, through the Ministry of Education and Vocational Training (MoEVT), launched in 2014 a project called the ICT Retooling project to enhance and upgrade the pedagogical knowledge and subject content knowledge of teachers in selected difficult topics in science and mathematics at secondary education. According to a World Bank study (2014), Tanzania lacked 26,998 secondary school science teachers and this shortage was compounded by the fact that tertiary education institutions in the country can only produce 2,300 graduates annually. In terms of qualification, only 28% of the in-service teachers were qualified to teach math and science.

The ICT Retooling project was designed indigenously by the University of Dar es Salaam College of ICT (CoICT) and consisted of developing and integrating the multimedia elements to create the multimedia enhanced content in the selected difficult topics in mathematics, physics, biology and chemistry. It aimed at training 2,000 teachers who could not do well in a pre-test examination of their competencies to teach math and science.

In a paper submitted and presented at the 2015 International Conference of the AVU, Mtebe (2015) indicated that the choice of the development and integrating multimedia elements in the teaching of the subjects was premised on the following assumptions: “the multimedia content can enable to enhance learners’ understanding of concepts that cannot easily be
explained using text alone (Thomas & Israel, 2013). They can also simulate real processes such as motion, diffusion, or bonding atoms and allows learners to execute “virtual experiments” that would be dangerous, and costly to be conducted in school laboratories.

He describes in great detail the process of development and integration of the multimedia enhanced content. The development begins with the selection of difficult topics, design of the template and ends with digitization of the content blueprints. The integration process, on the other hand, consists of identifying the kind of multimedia elements (video, audio, or animation) that would enable the content to be easily understood by learners, recording and editing of videos, developing animations and integrating the developed multimedia. The process ends with the uploading of the material into a Moodle Learning Management (LMS) and burned into DVDs. The multimedia thus produced goes through a rigorous validation process. It is noteworthy that all the processes described above involve experienced Tanzanian secondary education math and science teachers to ensure relevance of the content.

In order to ascertain the relevance of the intervention, Mtebe and his associates designed a user satisfaction study (evaluation) to assess end-users’ satisfaction with the multimedia enhanced content. This is also a way of ensuring that the investment in money and time to develop the products was worth the while. He focused on five (5) aspects: content, accuracy, format, interface, and satisfaction.

The findings revealed the following:

1. In terms of the interface, the majority of respondents (89%) indicated that the interface was easy to use, 91% indicated that the interface was user-friendly, and more than two-thirds of the respondents (78%) indicated that the interface was easy to learn.

2. With regard to the format, 77% of respondents indicated that the content was effectively organized to allow learners to follow without much difficulty.

3. Concerning the content, 86% of respondents indicated that the content had sufficient content to enable learners to complete learning process, and 82% of respondents indicated that the content has educationally significant concepts, models, and skills for the subject. 77% of respondents indicated that multimedia items such as videos, animations and simulations included in the content allowed learners to control content. In addition, 78% of respondents indicated that the content was presented in ways appropriate to the learners’ knowledge, skills and abilities.

4. With respect to accuracy, nearly two-thirds (68%) of respondents indicated that the content was accurate.

5. Concerning overall satisfaction, 89% were satisfied by the multimedia enhanced content.
Recommendations

This Tanzanian case study on the use of ICTs to upgrade the qualification of math and science teachers in secondary education is a significant milestone as the intervention is homegrown both in its design and in its funding. Therefore, African governments should:

- Undertake a major reform in teacher education in math and science education by introducing both pre-service and in-service teacher professional development using ICT-based multimedia content.

African universities, and more specifically the schools of education and technology departments, should:

- Carry out studies to investigate the educational challenges faced by Africa in order to develop policy interventions and further interrogate the role of ICTs in addressing the problems.
- Engage governments in developing research and policy agendas in the teaching of mathematics and science through ICTs.

References


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