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A Critical Analysis of the Compulsory Science Education Policy at the Secondary Level of Education in Uganda

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ABSTRACT

Uganda is one of the African countries that have been focusing on the science-led strategy to promote growth and development. One of the strategies is the science promotion policy, which started in 2005 and among other things made learning and enrolling on science subjects (mathematics, chemistry, physics and biology) compulsory at the ordinary level of secondary school education. This paper has, therefore, used a secondary review methodology to critically analyse the science policy at the secondary school levels (ordinary and advanced). The paper begins with an introduction that discusses the history of curriculum reform at the secondary school level globally and in Africa with emphasis on Uganda. It also discusses Uganda's science policy implementation strategies, which included the government's effort in providing resources such as laboratory equipment and science textbooks to government-aided schools. There is, then, a section that discusses the challenges that have hindered the successful implementation of science policy. This section shows that much as the government of Uganda has tried to facilitate science policy, the latest being the enhancement of salary for scientists, including science teachers by 300%, factors such as unresponsive curriculum content, shortage of qualified science teachers and inadequate laboratory equipment remain challenges to the, otherwise, good policy. The paper concludes by stating that improvement in science performance requires a multi-dimensional approach and, therefore, the recent salary enhancement that only catered for science teachers may not, necessarily, achieve much as far as improvement in the performance of students in science subjects is concerned.

Keywords: Science teaching, secondary schools, policy, critical analysis, Uganda.

INTRODUCTION

According to Verspoor and Bergman, science and technology are crucial for development and if harnessed properly, they can reduce poverty and boost economic growth and development of countries [1]. The goal of teaching science is the creation of national wealth through the application of scientific knowledge and skills. Worldwide, there have been two major waves of secondary education reform. The first one started when the Russians launched the first artificial satellite into space in 1957 [1]. The aim of this reform was to improve mathematics and science.

This inspired major changes in the curriculum in the western world and beginning a decade or so later, in other areas, particularly, in Africa [1]. As a result of this wave, major changes took place and these include; (a) a change from subject-centred curricula and teaching to learner-centred curricula and teaching (b), a change from purely academic work to learning by doing and (c), examination questions were reformed from recalling to knowledge application in new situations [1]. It is shown that this wave was, however, almost exclusively directed at academic minorities and the system of examination, largely, remained for the elite.

However, around the 1970s, the economic objectives that people desired could not be met without paying attention to the education of the less academic majority in secondary schools [2]. There was a realisation that effort should be put into developing their skills, attitude and competencies that would enable them to be successful in economies with labour markets that, increasingly, emphasise the capacity to acquire knowledge and skills, readiness to take initiative and contribute to innovation on production and process [1]. This resulted in the second wave that emphasised education for all as reflected in the extensive review of the secondary curriculum. This secondary curriculum reform wave resulted in clear national curricula in key subject areas such as science, mathematics, language and humanities and latterly technology. These curricula were directed at all learners regardless of ability [1].

In Africa, there was a delay in fully appreciating and infusing science education into the education systems. As a result, many African countries have been characterised by manpower problems in science disciplines, unexploited resources and over-dependence on expatriates [2]. The differences in science subjects and technology still, largely, account for the variances in development between developed and developing countries [2]. In August 2006, African ministers of education sitting in Addis Ababa, Ethiopia agreed that science and technology teaching must undergo reform at all levels of the African educational system [3]. The ministers drew a ten-year plan from 2006 to 2015 that highlighted science and technology as the most important tool available for addressing challenges of development and poverty reduction, and for participating in the global economy and the achievement of the United Nations Millennium Development Goals [3]. This is because science greatly deals with the day-to-day human activities and challenges of life such as agriculture, environmental management, health and nutrition. The plan aimed at improving learning outcomes, promoting the use of indigenous knowledge and encouraging more girls to pursue scientific careers [3]. Uganda is one of the African countries that have been promoting and implementing science policy in different sectors that include education. This paper, therefore, analyses the implementation of compulsory science-teaching policy in secondary schools in Uganda.

SUMMARY OF THE PAPER

The paper begins with the discussion of two major global secondary school curriculum reforms and the introduction of science and technology into the secondary school curriculum. Following this is a part that discusses Uganda's compulsory science-teaching policy of 2005 that made science subjects compulsory at the lower secondary school level (from form one to form four). Then, there is the discussion on the history of poor performance of science subjects at both ordinary and advanced (forms five and six) levels of education in Uganda. Following this is a section that discusses factors that have contributed to the poor performance of students in science subjects and then, the conclusion.

The aim of the Paper

This paper aims at giving a critical analysis of science education policy at secondary school level of education in Uganda. The authors have achieved this by analysing the performance of learners in science subjects at the Uganda Certificate of Education (UCE) and Uganda Advanced Certificate of Education (UACE) levels since the implementation of the science policy in 2005. The challenges that have hindered the effective implementation of the policy have also been discussed to achieve the aim of the paper.

METHODOLOGY

The authors have utilised a secondary review methodology to come up with this paper. Data from textbooks, journal articles, media reports and government documents has been used to come up with this paper.

COMPULSORY SCIENCE TEACHING POLICY IN UGANDA

Uganda is one of the countries in Africa that have, already, begun the process of revising its secondary education system to make it appropriate for the whole age cohort, rather than, a selected few. The Government of Uganda has advocated and promoted science and technology for the last three decades. For example, the Government White Paper on Education (1992) describes the role that science and technology play in promoting development [4]. One of the ways of promoting science and technology was the implementation of a compulsory science-teaching policy in lower secondary schools (form one to form four). It should be noted that Uganda's secondary education structure has got six (6) years of education i.e., four (4) years of lower/ordinary level and two (2) years of higher/advanced level. The Ugandan education structure is such that at the end of the ordinary level, students sit for the Uganda Certificate of Education (UCE) examinations while at the end of the advanced level, students sit for the Uganda Advanced Certificate of Education (UACE) examinations. Therefore, the science policy that started in 2005, made chemistry, biology, physics and mathematics compulsory for all lower secondary school students [5]. In addition, as a way of encouraging students to offer science subject combinations at the advanced level (form five and six), the government of Uganda also announced that science students would receive majority slots at the university and tertiary institutions intake with 75 per cent of government scholarships reserved for science-oriented courses [6]. The idea behind the science policy was that since obtaining her independence in 1962, Uganda has, always, promoted the teaching of humanities hence, largely, producing white-collar- job seekers, a situation that resulted in a shortage of scientists like doctors and engineers [7]. The science policy was on the premise that the advancement of science and technology would contribute to the development of modern civilisation in Uganda [8].

In order to facilitate the implementation of the policy, especially, in less privileged schools, the government of Uganda through the Ministry of Education and Sports, put up some measures that included the provision of laboratory kits, provision of chemistry, biology, physics and mathematics textbooks to public schools and construction of science laboratories in some public schools [9]. More to this was the establishment of the Secondary Science and Mathematics (SESEMAT) program in order to enhance the teaching skills of teachers [10]. The government of Uganda has continued to enforce science policy. A much more recent development is the salary enhancement of all scientists. In May 2022, the Cabinet approved Uganda shillings 735 billion to enhance the salary of scientists, including, science teachers in

the financial year 2022/2023 which began on 1st July 2022 to 30th June 2023. This increment, for example, has seen the salary of a graduate science teacher increase from the Ugandan shilling 1.1 million to 4 million [11]. To protest unfair pay, all the arts subject teachers in public primary and secondary schools under their umbrella organisation, the Uganda National Teachers Union (UNATU) called for industrial action to demand uniform salary increment [12]. The strike that lasted for 20 days did not yield any positive results and, the teachers were forced to call off the strike after meeting the president of Uganda who retaliated that the salary increment for scientists was based on the government's science-led strategy and cannot be interfered with [13]. Addressing the media, the Minister for Information, Communication Technology and National Guidance also affirmed that much as the government appreciates and acknowledges all the professionals, the emphasis on scientists' salaries was based on the fact that they play a vital role in developing and transforming the economy [11].

Basing on the history of poor performance in science subjects, there is the question of whether increasing pay for science teachers will improve students' performance in science subjects. According to Mafabi, the government of Uganda has climbed the tree from the top by only increasing the salaries of scientists [14]. Accordingly, the government should, rather, equip the institutions of science learning and research, build and equip modern school libraries with science textbooks among other essential prerequisites for improved science and technology. Citing an example of one male science teacher in one secondary school who was full of excitement and had started planning for how to spend the enhanced science money before receiving it, Mafabi argues that salary enhancement for scientists will not result in improved performance in science subjects but, has only served to cause an aggrieved lot of arts subject teachers. Salary enhancement for science teachers could, perhaps, cause some personal changes in the lifestyles of the science teachers in terms of improvement in their feeding and drinking routines [14]. This argument is based on the fact that since the implementation of the science policy in 2005, performance in science subjects has been declining and this has been attributed to different factors as will be discussed later.

POOR PERFORMANCE OF STUDENTS IN SCIENCE SUBJECTS SINCE THE COMPULSORY SCIENCE POLICY IN 2005

Reports from the Uganda National Examinations Board (UNEB) show a trend in poor performance of science subjects for more than a decade at ordinary level and a decline in the number of students who offer science combinations at the advanced level since the implementation of secondary science policy in 2005. For example, since 2010, reports have shown a consistent failure of more than 40% of students in physics, biology, chemistry and mathematics [5]. In 2011 and 2012 the failure rates in chemistry at ordinary level were 71.1 % and 75.6% respectively and the majority of those who passed had no credits and passed only marginally [5]. It is documented that nearly three-quarters of 2012 ordinary-level candidates did not pass chemistry and biology [15]. In 2013, nearly 45 % of students who sat ordinary level examinations did not reach the minimum competency level in mathematics [16]. Of 306,507 candidates who sat in 2015, 60% failed to obtain, at least, pass 8 to qualify for a grade in physics and chemistry [5]. The situation remained the same for the entire decade. For example, half of the students who sat 2019 UCE failed to achieve the minimum of pass 8. This was, especially, in physics and chemistry with nearly 60 per cent of females unable to score a pass 8 [17]. The situation was not different in the 2020 UCE results where nearly half of the 330,592 candidates who sat UCE did not achieve the minimum pass 8 level in science subjects [18].

The above situation at the ordinary level is shown to have impacted not only the quality of grades at the advanced level but also the number of students who offer science subject combinations. It has been documented that though science subjects are compulsory at the ordinary level, the enrolment and performance of students at the advanced level and at institutions of higher learning have not improved. For example, in 2016 only 14.5% of students who sat UCE took science combinations at the next intake of Advanced level. The 2019 UACE results showed that Uganda National Examination Board (UNEB) was worried about the few numbers of students who opt for science combinations at the advanced level. It is shown that only 10% of students registered for science combinations in 2018 [17]. This implied that about 10,447 students were science students out of over 104, 476 students who sat for UACE [17]. It is also documented that the few students who opt for science combinations hardly pass them to continue with science-related programmes in institutions of higher learning [17]. For example, it is reported that performance in biology had been declining over the years. In 2016, 40.8% of students who sat for biology scored only 2 points, making it the worst done subject. In 2017, half of the 75,451 science students failed to obtain a principal pass according to statistics from UNEB while in 2018; biology was the worst performed subject in that no single student in the entire country scored a distinction [19].

Based on the above situation, the government has been asked to drop the compulsory science policy. The call was first made by UNEB chairperson while releasing 2015 UCE results. The chairperson tasked the government to rethink the science policy because it was not delivering the desired results since the sciences were made compulsory in 2005 [20]. In the same manner, the general secretary of the Uganda National Teachers' Union (UNATU) advised that the government should go back to the pre-2005 situation when sciences were only compulsory in form one and two. The general secretary advised that after form two, students should be guided by their teachers and parents to choose whether to continue with the sciences or drop them for the humanities at form three [20]. Different factors have been advanced as to why students continue to perform poorly in science subjects. These are discussed in the next section.

FACTORS RESPONSIBLE FOR THE POOR PERFORMANCE OF STUDENTS IN SCIENCE SUBJECTS

Much as the government of Uganda tried to promote the successful implementation of compulsory teaching policy, it has been limited by different factors discussed below:

Unresponsive curriculum content

Many studies show that students and pupils perceive school science as lacking relevance. The curriculum is seen to be abstract, theoretical and authoritarian. The curriculum is overcrowded with no room for enjoyment and with no contemporary issues related to science and technology. According to Jonathan, Uganda like any other African country inherited a colonial type of curriculum that is more rigid and theoretical in content [21]. For example, each course option offered has elaborate content and corresponding manpower. The existing curriculum is, largely, a collection of examination syllabuses; their teaching is directed at achieving the highest grade and examinations aim at assessing knowledge only with very few marks given for showing an understanding of how to apply knowledge [21, p:16]. Results from the study by BFA in the metropolitan districts of Kampala, Wakiso and Mukono showed that the curriculum is overloaded with content that contributes to poor teaching and performance of students in

Uganda. In this study, teachers complained of issues such as an overloaded syllabus, duplicated content and repeated concepts that do not allow them to have enough time for demonstration and building concepts [22]. Instead, teachers expressed the view that they aim at struggling to finish the overloaded syllabus, an approach that cannot help produce quality learners [22]. This situation has been attributed to the fact that the government of Uganda only updated the curriculum by making sciences compulsory without making room for its effective implementation, hence, contributing to curriculum overload in terms of content and the number of subjects. The same curriculum is examination-driven and knowledge-based, rather than, being skills-and competency-based. This presents serious threats to possibilities for learner-centred teaching to happen in the classroom. This means that schools teach to test only the theoretical part, which is a threat to science performance [22].

Inadequate laboratory and other science equipment

Laboratories, textbooks and other science-teaching-related infrastructure are important for adequate functional delivery of the science curriculum. Much as the government of Uganda has tried to facilitate science teaching by proving resources such as laboratory equipment and textbooks, inadequate laboratory equipment has been acknowledged and documented as one of the major structural problems hindering the successful implementation of science policy in secondary schools in Uganda [23]. The Uganda National Examinations Board acknowledges that some schools lack science laboratories [23]. The Parliamentary Committee on Social Services (2009) noted that despite making science subjects compulsory at the ordinary level, most schools in the country did not have adequate laboratories. They further reported that out of all the 911 government-aided schools, only 455 (50%) had functional science laboratories. This implies that students in 50% of government-aided schools do sciences without access to laboratory facilities. According to the ESSAPR 2009/10, most of the schools were not teaching or conducting science practical lessons. For some schools that had laboratories, there were no reagents and even where these existed, the teachers did not have sufficient time to prepare the practical. It is also noted that most private schools can't afford the cost of science infrastructure and, therefore, opt to conduct practical lessons quite infrequently but afford practical lessons a few times, especially, toward the sitting of national examinations [24].

Shortage of science teachers

The problem of shortage of science teachers has been documented as one of the factors that have affected the successful implementation of science policy in Uganda.

A report by Ismail had this to say:

> *"Quality science education hinges to a large extent on the quality and number of science teachers available. Though education is at the core of national development, the teaching profession has not been accorded the status it deserves in Uganda. Enrolments in national teacher training colleges and teacher training colleges/ institutions (NTCs and TTCs) and education programmes are on the decline. Most students who enrol in these institutions do so due to a lack of alternatives. Some teachers leave the profession after training while most of those who remain are not interested in teaching. Teachers are among the worst paid civil servants and many schools don't offer them housing and other essential facilities. Consequently, some teachers offer their services in several schools, taking on unbearable loads, teaching without adequate preparation and in some cases*

> *teaching subjects in which they are not trained. In cases where science experiments and demonstrations have to be set up, science teachers need to put in extra time and effort. However, science teachers are not adequately motivated, hence, affecting the quality of their teaching and delivery," [24, p. 15].*

While releasing the 2016 UCE examination results, the Minister of Education and Sports acknowledged the fact that a successful science policy required enough teachers, which the government did not have. The Minister reported that there was a need for more 4,000 science teachers yet, the government did not have money to pay them [25]. Reports from UNEB show that the lack of enough science teachers is also reflected in the administration of practical exams. According to the UNEB Executive Secretary, practical examinations begin late in most schools because some teachers move to more than two examination centres to help prepare for the practical papers on the same day [25]. It is reported that lack of enough teachers results in little teaching, especially, in rural schools as the few available teachers are shared between several schools. According to Urwick and Sarah much as the issue of moonlighting is widely practised at secondary and tertiary levels in Uganda, teachers of sciences at secondary school are in relatively high demand and, therefore, they practice moonlighting in broad daylight in a way that most of them allocate half-days to different schools [26]. The problem of shortage of science teachers is shown to affect science teaching in different ways that include reducing time on task for students and creating large class sizes among others [26].

Teachers not properly trained to teach science

Science teaching is such a complex, dynamic profession that it is difficult for a teacher to stay up-to-date. For a teacher to grow professionally and become better as a teacher of science, a special, continuous effort is required [27, p.21]. To teach science effectively, science teachers need to have an adequate level of knowledge of science [28]. According to Shulman, teachers not only need to know their content but also need to know how to present it effectively [29]. A teacher with strong pedagogical knowledge employs effective teaching strategies, creates well-designed lesson plans, applies successful classroom management techniques, and develops an understanding of student learning [30]. Effective science teaching requires an understanding of learners' needs so that the teachers can support them [3]. In a study conducted in China, it was found that teachers tended to ignore students who put up their hands several times during lessons because they were anxious to finish the lesson on time [30]. A study in China on compulsory teaching of geography found out that there was a discrepancy between urban and rural schools and the former easily recruited qualified teachers [31].

According to reports, the problem of poorly-trained teachers in Uganda is reflected in different ways that include mechanical and theoretical teaching and lack of understanding of basic science concepts among others [32]. Reflecting on the 2016 UACE and UCE results, UNEB affirmed that there was evidence that teaching of science in Uganda is, largely, theoretical despite significant efforts by the Ministry of Education and sports to facilitate schools with laboratory materials and equipment [33]. In a related study, it was concluded that teachers used, mainly, teacher-centred methods in the delivery of content and that using science kits did not significantly impact the performance of teachers in the core sciences [33]. The BFA study found that some teachers did not understand basic concepts in mathematics. In some districts of Uganda such as Soroti, Kaberamaido, Katakwi and Amuria, it is reported that schools rely on form six dropouts to teach science due to a shortage of science teachers [22]. There are also

reports of laboratory equipment lying idle in some schools because teachers have no capacity to utilise them [23].

Learners' attitudes toward science subjects

Munguti defines attitude as a neural or mental state of readiness organized through experience exerting a directive or dynamic influence upon the individual's responses to all objects and situations with which it is related [34]. Research has identified a relationship between attitude and performance [24]. According to Aiken, the relationship between attitude and performance is reciprocal [35]. Students' attitudes in sciences could be explained partly on the basis of their attitudes and aspiration, which are distorted by thinking that science subjects are hard [36]. This has the adverse effect of making students track themselves out of science-based and perform poorly in examinations [36]. In Uganda, one study found out that the negative attitude of students contributes to their poor performance in science subjects. In this study, it is reported that some students said they did not just like science subjects while others believed science is too hard to pass [16]. In a study by Amir that investigated learners' attitudes and performance in science subjects at advanced level in secondary schools in Mbarara, Uganda, it was found that most female learners had a positive attitude toward science subjects and, therefore, ended up performing better than male counterparts [37]. The authors concluded that a positive attitude results in positive results [37].

CONCLUSION

This paper has provided a critical analysis of the science education policy in the secondary schools of Uganda. By utilising secondary review methodology, the paper has shown that in 2005, the government of Uganda started implementing the science-led strategy that had compulsory teaching of science subjects at the ordinary level of secondary education among its components. The paper has shown that to facilitate effective and successful implementation of compulsory science-teaching policy, the government of Uganda has tried to provide resources such as laboratory equipment, science textbooks and science teachers to government-aided secondary schools. However, the paper has discussed that irrespective of the government's efforts in facilitating the successful implementation of compulsory science-teaching policy, the performance of students in science subjects at the ordinary level of education has not only been poor but has also been declining since 2005. Also, the policy has not translated into many students opting for science subject combinations at the advanced level of secondary education. Moreover, the few students who opt for science combinations hardly pass them to enrol for science courses at higher institutions of learning. A critical analysis of the policy has shown that a range of factors has affected its successful implementation. Among others are unresponsive curriculum content, shortage and poor quality of science teachers, inadequate laboratory equipment and negative attitude of students toward science subjects. Based on this, any strategy that aims at improving the performance of students in science subjects needs to address all the above-mentioned factors by taking a multi-dimensional framework. In this view and as already observed by critics, the recent salary enhancement that only included science teachers with complete disregard for Arts teachers will not translate into an improvement in the performance of science subjects since performance is a function of various factors as indicated in this text above.

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