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THE QUALITY OF SCIENCE EDUCATION IN UGANDA

SCIENCE AND TECHNOLOGY POLICY COORDINATION DIVISION

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ABBREVIATIONS AND ACRONYMS

BTVET	Business, Technical, Vocational Education and Training
CURRASSE	Curriculums Assessment and Examination
ESIP	Education Strategic Investment Plan
ESPR	Education Sector Performance Reform
ESSAPR	Education and Sports Sector Annual Performance Review
ESSP	Education Sector Strategic Plan
GER	Gross Enrolment Ratio
ICTs	Information and Communication Technologies
MoES	Ministry of Education and Sports
MSI	Millennium Science Initiative
NCDC	National Curriculum Development Centre
NCHE	National Council for Higher Education
NGOs	Non-Governmental Organisations
NORAD	Norwegian Agency for Development Cooperation
NTCs	National Teachers' Colleges
PEAP	Poverty Eradication Action Plan
PLE	Primary Leaving Examination
S&T	Science and Technology
SESEMAT	Secondary Science and Mathematics Teachers
SS&H	Social Sciences and Humanities
STEM	Science, Technology, Engineering and Mathematics
UACE	Uganda Advanced Certificate of Education
GOU	Government of Uganda
UBOS	Uganda Bureau of Statistics
UCE	Uganda Certificate of Education
UGAPRIVI	Uganda Association of Private Vocational Institutions
UNCST	Uganda National Council for Science and Technology
UNEB	Uganda National Examinations Board
UNESCO	United Nations Education, Scientific and Cultural Organization
UPE	Universal Primary Education
UPPET	Uganda Post Primary Education and Training
USE	Universal Secondary Education
UVQF	Uganda Vocational Qualifications Framework

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EXECUTIVE SUMMARY

Significant investment in human capital is needed for Uganda to transform into a knowledge economy in the near future. The quality of education determines the extent to which the country has invested in its human resources. Enhancing science education is considered to be a strategic investment for a country that is aiming to create a critical mass of scientists and engineers to spur growth and development. The quality of science education is determined by institutional mechanisms, the quality and number of science teachers; the status of the science research and teaching infrastructure; and the relevance of the curriculum to the needs of the country. The level of enrolment and performance of science students at different levels are also a reflection of the quality of science education. This study considered these determinants and their relative influence on the quality of science education in Uganda between 2005 and 2010.

Though Government policy interventions have increased enrolments at all levels of education, major leakages were found to occur along the education pipeline. Science education is also challenged by infrastructure inadequacies, few and poorly motivated teachers and an examination focused curriculum that is devoid of innovation. As a result, consistently poor performance was recorded in science subjects, especially physics, chemistry and biology, which are highly practical.

The study recommends making Universal Primary Education (UPE) and Uganda Post Primary Education and Training/Universal Secondary Education (UPPET/USE) compulsory, reviewing and decongesting the education curriculum, as well as amendment of the assessment methods and improvement of science education infrastructure.

THE QUALITY OF SCIENCE EDUCATION IN UGANDA

Science and Technology Policy Coordination Division

1. INTRODUCTION

Education is critical to improved livelihoods and socio-economic development as it increases peoples' creativity and productivity. According to Bloom et al (2005)[1], education is widely accepted as an instrument for promoting economic growth. Education was highlighted in Uganda's Poverty Eradication Action Plan (PEAP, 1989) as one of the mechanisms for enabling poverty eradication in the country. As such, the formal education sector in Uganda has undergone a number of reforms to enable it to step up to this enormous task. These reforms include Universal Primary Education (UPE) as recommended by the Education Policy Review Commission (1989).

The Government White Paper (1992) upheld the recommendations of the Commission and also proposed a number of policies and programmes to improve access and quality of education in Uganda. Subsequently, UPE was introduced in 1997, and to increase transition rates from primary to secondary, Uganda Post Primary Education and Training/Universal Secondary Education (UPPET/USE) started in 2007.

2. QUALITY OF EDUCATION

Quality education cannot easily be exclusively defined. Irwin (1967) defined quality education as the maximisation of the schools' systems performance and ability to: (i) Prepare students for the adult role as citizens; (ii) Train them to fill an appropriate adult role; (iii) Develop personality, especially inter-personal skills; (iv) Remove the recipient from an unemployed status.

1 Bloom .C, Canning . D and Chan. K, (2005), "Higher Education and Economic Development in Africa", Harvard University, 2005.

The quality of education is highly dependent on how well students are taught and how much they learn. This can subsequently have an impact on how long they stay in school and how regularly they attend. The instrumental roles of schooling, such as helping individuals achieve their own economic, social and cultural objectives, can only be strengthened if education is of high quality (UNESCO, 2005). The Dakar Framework for Action (2000) declared that access to quality education was the right of every child. The framework affirmed that enrolment, retention and achievement were fundamental determinants of the quality of education. This expanded definition also outlines the desirable characteristics of the learners (healthy, motivated students), processes (competent teachers using effective pedagogies), content (relevant curricula) and systems (good governance and equitable resource allocation).

2. 1 Quality of Science Education in Uganda

Quality science education embraces all the main functions and activities of a credible education system. Determinants of quality science education include: institutional mechanisms; the quality and number of science teachers at all education levels; infrastructural requirements for science programme delivery; and the curriculum, among others. Enrolments and performance of science students at different levels to a large extent reflect the quality of science education.

Therefore, this study considered: the available systems to motivate students to study sciences; student enrolments; the quality of the personnel that deliver science curricula at all levels of education; the practical relevance of science curricula; the available science infrastructure; and student performance in sciences at different levels of education. As Uganda endeavours to transform into a knowledge economy, it is imperative that a synthesis of the quality of science education be undertaken to establish what has been achieved and what more needs to be accomplished.

2.2 Science Education at Primary School Level

2.2.1 Science Enrolment

The Universal Primary Education (UPE) programme was initiated in 1997 with the objective of ensuring that all children of school-going age—both boys and girls—are able to attend primary school by 2015. UPE has had enormous impact in terms of pupil enrolment, which increased from 2.5 million in 1996 to 7.96 million in 2008 (UNCST, 2010; MoES, 2008). Science enrolment at primary level is embedded within the curriculum as every pupil preparing for the primary leaving exam has to study 'science' and 'mathematics' as two of the four subjects at this level. Therefore an increase in enrolment inevitably means that more pupils are introduced to science. The UPE programme has however faced several challenges, one of them being the high dropout rates. Ministry of Education and Sports (MoES) statistics show that out of 1,712,420 pupils who started P.1 in 2002, only 516,890 pupils sat PLE in 2009, representing only 30.1% of the pupils. This however was an improvement in comparison to 27% and 26% in 2007 and 2008 respectively. Several reasons have been given for the high dropout rates. The National Service Delivery Survey 2008 (UBOS, 2009) established that the most common causes of high dropout rates were the prohibitive costs of education and lack of interest. Whereas Government of Uganda (GOU) is examining options of reducing the high cost of education, the lack of interest by parents and pupils needs to be addressed.

2.2.2 Teaching of Science

The UPE programme has generally increased the level of enrolment at primary level, but this has not been matched by a proportionate increase in the number of teaching staff. The pupil to teacher ratio[2] in 2009 was 49 for all schools, although it was much higher (57) for government-aided schools (MoES, 2010). This is approximately four times more than the average for developed countries (OECD). High pupil to teacher ratio reduces pupil interaction, which causes the teachers to focus on the fast learners. This situation is exacerbated by the high pupil to classroom ratio (78 in government aided schools). Overcrowding limits teacher-pupil interaction, thereby leading to lack of concentration, poor performance and high rates of school dropout. Pupils are taught mainly with the aim of passing the national Primary Leaving Examination (PLE). The education system forces pupils to cram without being given an opportunity to inquire further. This method of teaching complicates science and creates a bias right from an early age. Teachers need to make science classes more interactive, activity and inquiry based.

Opolot (2008) noted that the UPE programme does not effectively complement the prevailing thematic curriculum at early primary level. For instance, the time allocated to teaching mathematics is five periods of only 30 minutes in lower primary or 40 minutes in upper primary (a period per day) in a 40 period week. This time is not enough for the effective delivery of science and maths at this level. With limited time, teachers concentrate on completing the curriculum because it is against this that they are evaluated. As a result, interesting the pupils in understanding and applying science is not a priority.

2 Total number of pupils/students enrolled in a given school divided by the total number of teachers in the same school.

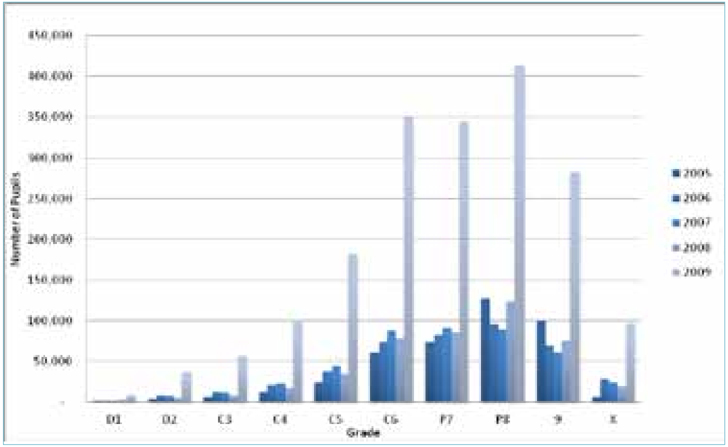
The quality of teachers who instruct the pupils also has a significant impact on the pupils' character, confidence and intellect. Although 68% of the primary school teachers have received training up to Grade III level (MoES, 2010), there are no consistent programmes for continuous professional development. Low teacher motivation and limited funding have further crippled efforts to sustainably increase capacity to handle the increasing numbers of primary enrolments.

2.2.3 Performance of Pupils in Sciences

On completion of the primary cycle of education, pupils' understanding and knowledge in science is examined in a two-hour Primary Leaving Examination in science and mathematics, among other subjects. The Uganda National Examinations Board (UNEB) grades performance ranging from the best (distinction one) to the worst (grade X). If a pupil scores pass 8 or worse in Mathematics or English, then they will drop a grade lower in the overall ranking.

Performance in sciences at this level has consistently been very poor as has been reflected in PLE results. Statistics from UNEB show that far fewer pupils score distinctions and credits in mathematics than those who fail (figure 1). The data further reveal that most pupils are clustered around the 'pass' grade. In 2009, there was a huge increase in the number of candidates that sat for PLE but more failures in mathematics were registered in the same year. Of the pupils that registered to sit for the mathematics exam, 42% scored pass 8 and lower while only 2.5% passed with distinction.

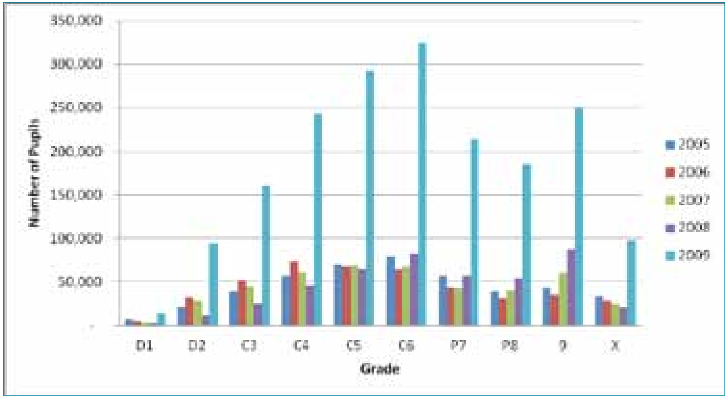
Figure 1: Performance of Pupils in Mathematics at PLE: 2005-2009



Source: UNCST, 2012

Performance in science has been equally poor although an improvement was registered in 2009 (figure 2). Of the pupils that were registered to sit for the science examination, 0.7% scored D1 while 14.8% obtained F9. The majority of pupils (17%) scored C6. Compared to mathematics performance in the period 2005-2009, pupils performed better in science.

Figure 2: Performance of Pupils in Science at PLE: 2005-2009



Source: UNCST, 2012

Poor performance in sciences right from primary level has a negative impact on attitudes towards sciences, leading to preference by a greater majority of students for courses in Social Sciences and Humanities (SS&H) to score better grades

> The Government in 2006 established a policy that made the core science subjects (physics, chemistry, biology and mathematics) compulsory for all lower secondary level students.

and remain competitive. However, the current method of assessment doesn't adequately measure and reward student understanding of scientific principles and innovation. The education sector should consider alternative assessment methods if pupils' interest and innovation are to be harnessed.

2.3. Education at Secondary Level

2.3.1 Science Enrolment

Government introduced Universal Secondary Education (USE) in 2007. In February of the same year, the Universal Post-Primary Education and Training (UPPET) programme was launched. The main objective of these programmes was to receive the increasing number of primary school graduates and to consolidate the gains from UPE. According to the Education and Sports Sector Annual Performance Review (ESSAPR) 2009/2010, the introduction of USE/UPPET in 2007 increased the Gross Enrolment Ratio for secondary school enrolment from 25% in 2006/07 to 27.6% in 2007/08. The transition rate to S.1 improved from 63.9% in 2008/09 to 64.8% in 2009/10 while the transition rate to S.5 improved from 48% to 50.7% in the same period. However, secondary education access indicators are still dismally low. In 2009, the Gross Enrolment Ratio[3] (GER)

3 The total enrolment in a specific level of education (Pre-primary, Primary, Secondary and Tertiary), regardless of age, expressed as a percentage of the eligible official school-age population corresponding to the same level of education in a given school year:

at secondary school level was 28.2% while the Net Enrolment Ratio4 (NER) for students aged 13-19 years was even lower at 23.8% (MoES, 2010). Whereas it may be argued that the bulk of students enrol in other post primary institutions, MoES statistics show that in 2009 there were only 38,928 students, the majority (58.5%) of whom were above the age range (13-19 years) for this level of education. This shows that many children who are supposed to be in school are actually not in the formal education system, which undermines the objectives of UPE, USE and Government's policy on science education.

Uganda's education system is such that in Senior 1 and 2 students are expected to study 18-20 subjects on average after which they select a minimum of 16 subjects. The Government in 2006 established a policy that made the core science subjects (physics, chemistry, biology and mathematics) compulsory for all lower secondary level students. This policy was meant to improve science literacy because, previously, the majority of the students after Senior Two were opting for subjects in SS&H, which were considered easier to pass. However, this intervention has been negatively offset by high dropout rates. For instance, of the 260,080 candidates who sat for Uganda Certificate Examinations (UCE) in 2010, only about 39% were pioneers of USE in 2007.

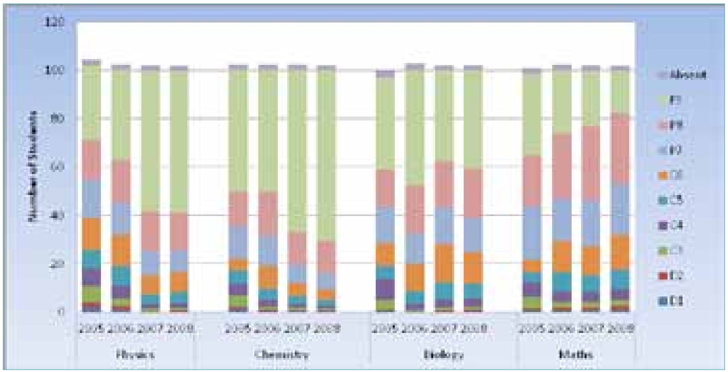
4 The enrolment of the official age group for a given level of education (Pre-primary, Primary, Secondary and Tertiary) expressed as a percentage of the corresponding population.

2.4 Performance in Sciences

2.4.1 Performance in Sciences at Ordinary Level

Performance in the core sciences at O' Level was very poor as illustrated in figure 3. For instance, the majority of students who sat for the UNEB examinations between 2005-2008 scored failures in the core sciences with chemistry and physics being the worst performed subjects. During the same period, the performance in SS&H subjects was better than mathematics, which was the best-performed core science subject. In general, students are mainly failing the lab-based courses of chemistry, physics and biology, and this is attributable to—among other things—the poor science infrastructure in schools and the teaching and learning methods that are largely theoretical.

Figure 3: Performance in the Core Sciences at O' Level: 2005-2008



Source: UNCST, 2012

Students in O' level study a wide range of subjects (up to 20 in some schools) within a limited period of time, which subsequently leads to a more theoretical coverage of the subjects. Given the nature of sciences, it is necessary that students are taught practically in order for them to appreciate and understand the concepts as well as get hands-on experience. Due to the design of the curriculum, time constraints, inadequate facilities and inappropriate pedagogy, practical teaching is not usually done, resulting in students developing apathy towards science subjects. The quality of science education is to a large extent affected by the curriculum design. The curriculum is exam-based, devoid of activity-based learning, and does not stimulate interest and innovation. Students perceive school science as lacking relevance. It is often described as abstract and theoretical. The science curriculum is overcrowded with unfamiliar concepts and laws, leaving little room for enjoyment, curiosity and a search for personal meaning and significance. It often lacks a cultural, social or historical dimension, and it rarely treats the contemporary issues related to science and technology. This problem is reinforced by the method of assessment, which rewards those with a high propensity to regurgitate what they have crammed as opposed to being innovative. Teachers are restricted by the curriculum because emphasis is placed on its completion and not how well students can apply and explain what they have learnt.

Teachers on the other hand are also to blame for the students' poor performance. They are not innovative and creative and therefore make science learning boring. They don't make use of the environment and locally available materials to teach; some of them are not able to relate science to everyday life, thus making it detached and irrelevant. It is not uncommon for a teacher to go to class without a lesson plan, and some teachers are not able to competently set up experiments. Coupled with lack of sufficient science infrastructure in both the private and public secondary schools, it is no wonder that the performance in science subjects is very poor (box 1).

Box 1:
Science Education at Secondary Level

At the secondary level, the implementation of a mandatory science policy was undertaken to strengthen students' knowledge and skills in science and technology. A similar policy was adopted at the tertiary level, which now requires that 57% of the students receiving Government scholarships study science and technology. This renewed focus on science education is designed to redress historical trends and attitudes, which promoted and valued education in the arts and social sciences. Science received little attention at both levels. At the secondary level, there have been inadequate numbers of trained science and math teachers, especially in rural areas. Many teachers who are teaching those subjects are poorly prepared. Additionally, the provision of equipment and laboratories was very expensive and, until recently, was not a priority.

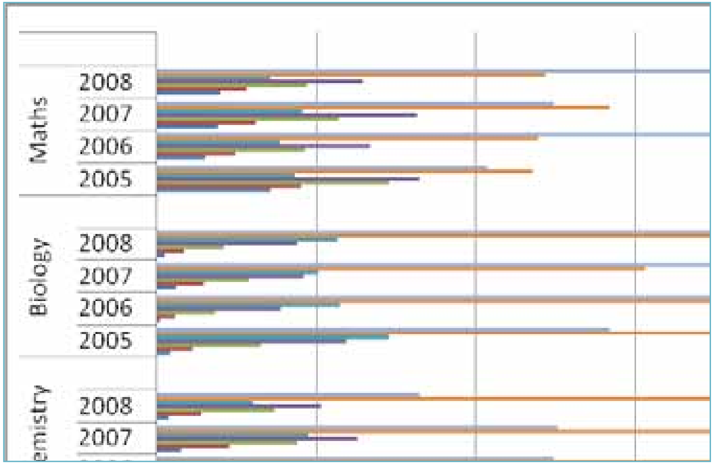
Source: Wood, 2008.

2.4.2 Performance in Sciences at Advanced Level

Enrolments in sciences at the upper secondary school level are only about 20% of the total enrolments and this is due to high failure rates in sciences at O' Level. Furthermore, some of those students that perform well in sciences are not interested in pursuing

Performance in these subjects in UACE was very poor as illustrated in figure 4 below. Students who scored grade A, B or C in the core sciences were less than 10% of the total number of students sitting exams in these subjects for the period 2005-2008. The majority of students scored grade O (earning them only one point) or failed completely.

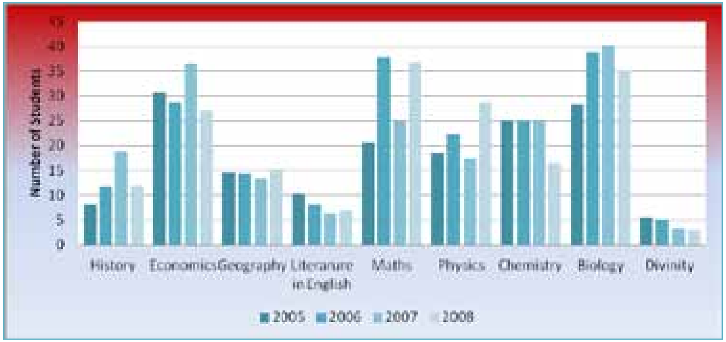
Figure 4: Performance in Core Sciences at A' Level: 2005-2008



Source: UNCST, 2012

Ordinarily, most of the students who choose to study the core science subjects at A' Level have performed well at O' level. Nonetheless, high failure rates have been observed at A' level. A comparison of performance of Science and Art subjects in 2008 revealed that History, Economics, Christian Religious Education (CRE), Geography, Literature in English, Kiswahili, French, Mathematics, Physics, Chemistry and Biology were the best performed subjects in that order. An illustration of failure rates for the period 2005-2008 for selected subjects is provided in figure 5. Data for the same period shows that science subjects occupied the last four positions out of the best eleven subjects done by students at this level. Poor performance in sciences at A' Level can be attributed to a lack of career guidance, poor practical preparation at O' Level and inadequate infrastructure, among other factors.

Figure 5: Failure Rates at A' Level for Selected Science and Non-science Disciplines: 2005-2008



Source: UNCST, 2012

Science performance by students in rural areas is worse than that of their counterparts in urban schools (box 2). According to Womakuyu (2009), 50% of the students in urban schools passed sciences while 80% of their rural counterparts had low grades or failed sciences altogether. Urban schools balanced their performance in both arts and science subjects, but these represented only about 20% of the schools that sat UACE in 2007. Overall, schools outside the central region posted better grades in the arts subjects, with about 80% failing sciences. Schools in rural areas have inadequate science teachers (quality and number), equipment, exposure, and some of them get to handle laboratory glassware for the first time during their final national examinations.

Box 2:

Poor Performance by Upcountry Schools

In Eastern Uganda, Amolatar district did not have any student doing sciences. In Amuria, the best student scored a credit 5 in General Paper, a B in Physics and a subsidiary in Economics. He had a score of '5BO'. The rest of the four passed with subsidiaries, meaning no student was admitted to university from Amuria to do a science course. The district's five best arts candidates scored at least two principle passes. In Northern Uganda, Pader had no single science candidate. However, all its best five arts students scored at least two principle passes. In Karamoja, Kaabong district hardly had a student for sciences or arts. Kotido district had no student in sciences and five of its arts students had four principle passes with an average of Grade D or three points. Moroto had three students passing sciences with at least a principle pass, and had all its top five qualifying for university, with three principle passes. The rest of the districts like Abim and Nakapiripirit had no science students.

Source: Wamokuyu, 2009

2.4.2 Secondary School Science Teachers

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 teacher training 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, teach without adequate preparation and in some cases teach 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.

The UPE and USE programmes have led to increased enrolments. However, these have been met by a less than proportionate number of teachers recruited. According to a report by MoES (2010), the student to teacher ratio in secondary school is 18. This high ratio negatively affects the level of teacher-student contact and supervision, which consequently affects student performance.

The minimum qualification required for a secondary school teacher as prescribed by the MoES is Grade V. In 2009, the majority (86.3%) of teachers in service had the minimum required qualifications and of those, the highest number (over 39%) had at least a Bachelors Degree in Secondary Education (MoES, 2010). However, according to ESSAPR 2009/10, the subjects of Science, Mathematics and English are mainly taught by A' level dropouts. Therefore, in spite of the fact that most teachers meet the minimum qualification requirements, few of these are science teachers. Particularly in rural schools, there is a scarcity of well-qualified teachers.

Teachers need continuous professional development to update them with contemporary best practices for science teaching (box 3). To improve science teaching and learning in Uganda's secondary schools, MoES introduced the Secondary Science and Mathematics Teachers' (SESEMAT) Programme which is designed to re-tool science teachers so that there is a change of attitude among students towards the learning of science and mathematics; a change of perception among teachers in the teaching of science and mathematics and the use of available instructional materials. Through the SESEMAT program, several hands-on and minds-on activities have been designed to enhance the teaching and learning of science and mathematics in secondary schools. As a result, 2508 secondary school science and mathematics teachers had been trained and supplied with curriculum materials; 2 super science competitions had been conducted attracting 252 participants; and 479 head teachers had been sensitised by 2008. Increased learners' participation during science lessons has been reported as a result of the programme as well as improved teacher attitudes, although better science performances are yet to be registered.

Box 3:
Continuous Professional Development for Teachers

The country is currently oversupplied with teachers in some areas of the curriculum and under-supplied in others, particularly the sciences and mathematics. Redressing this balance early will be essential if the curriculum reform is to succeed, not least to avoid significant retrenchment of teachers in contracting subject areas. Current teacher education programmes are 'front-end-loaded' with a relatively small (by international standards) school practice and the post-training probationary period, although it exists, does not seem to have much meaning. This, together with the minimal support for continuous professional development, implies that teacher training is seen as a once-off process; a teacher once trained is trained for life. Countries that have developed modern responsive curricula have realised that teacher education is a lifelong process in which the initial teacher training programmes are but the beginning.

Source: CURRASSE, 2007.

2.5 Infrastructure for Science Teaching

2.5.1 Textbooks and Infrastructure

Laboratories, textbooks and other related infrastructure are important for adequate functional delivery of the science curriculum, but many secondary schools in Uganda lack these essential facilities. The Parliamentary Committee on social services (2009) noted that despite making science subjects compulsory at O' level, most schools in the country did not have adequate laboratories. They further reported that out of all the 911 government schools, only 455 (50%) had functional science laboratories. This implies that students in 50% of government schools do sciences without access to laboratory facilities. According to the ESSAPR 2009/10, most of the schools were not teaching or conducting science practicals. The inspection was based on a minimum of 8 periods in a week for all the science-based subjects in S.3 and S.4. The findings indicated that 79% of the schools do not conduct practical lessons in sciences; in Moroto for example 80% of the schools do not conduct practicals, in Manafwa it was 63%-90% and 42% in Butaleja. For some schools that have laboratories, there are no reagents and even where they exist, the teachers don't have sufficient time to prepare the practicals. Most private schools can't afford the cost of science infrastructure and therefore opt to conduct practicals infrequently, especially towards national examinations. According to the Uganda Secondary Education and Training: Curriculums Assessment & Examination (CURASSE), Roadmap for Reform (2007), it costs roughly seven times as much to teach a learner for a year in secondary school than in primary school because of the high cost of science infrastructure and equipment. However, some schools are now using cyber school technology solutions (CSTS), which enable teachers and students to observe science experiments being conducted by use of computers. Since its inception, 1,800 teachers and 2,900 students had been trained and 600 computers installed with CSTS programmes delivered to participating schools (UNAS, 2008). This technology complements the laboratory-based practicals and is not supposed to substitute the real experience. Nonetheless teachers should be innovative and make use of locally available materials for demonstration in order to ease students understanding and link science to their everyday lives and experiences.

Textbooks that are also vital for science teaching have been criticised for not being engendered and adaptable to local situations besides, they are not readily available. For instance an example given in a textbook that refers to a rocket being fired at a certain speed; students cannot easily relate to this because most of them have never seen or even imagined a rocket and many girls would be intimidated by this 'masculine' example. On the other hand students do not exhibit inquisitiveness and thus no longer invest time in reading. This has had a negative impact on their innovativeness, scientific literacy and knowledge. Ugandan science authoring and fabrication of science equipment for teaching purposes should be encouraged to demystify the notion that science is a foreign concept.

2.5.2 Pedagogy and Curriculum

Pedagogy5 and the teaching methodologies have presented unique challenges for the delivery of the science curriculum. According to CURASSE (2007), the curriculum is largely a collection of examination syllabuses where their teaching is directed at achieving the highest grade in the examination, as are the textbooks written for them. The level of skills-assessment is low while remaining overloaded. In addition, content and pedagogy have not adequately adjusted to address contemporary issues in emerging fields of science. For instance, areas of the science curriculum have not been effectively updated to permit the accommodation of recent knowledge (box 4).

5 Pedagogy is the study and theory of the methods and principles of teaching

Box 4:
Assessing a Broad Ability Range

The existing examination system addresses a narrow ability range and is characterised by high failure rates, particularly in the sciences and mathematics. The questions, in the science and mathematics papers are somewhat ritualistic in nature, following a set pattern in the way they covered a topic. The textbooks used (science textbooks date from as far back as the 1940s) are also attuned to the ritual, which means that it is possible to obtain high marks by mastering the ritual rather than understanding the subject. All this means that it is not clear what the concept of pass and fail means in terms of real mastery of the subject. The examinations serve not to reward achievement but to operate as a crude filtering device to remove all but those who can master the art of passing examinations from the ladder to the next level of education. This is generally regarded as a very crude method of selection resulting not uncommonly in high failure and dropout rates at the higher level.

Source: CURRASSE, 2007.

2.6 Business, Technical, and Vocational Training

2.6 Technical, Vocational Education and Training

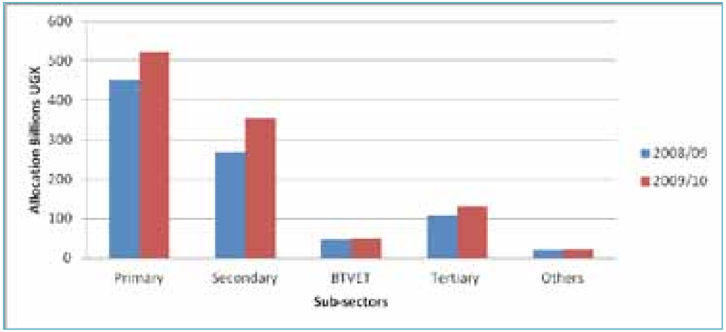
As Uganda transforms into a knowledge economy, vocational skills are a strategic component for the development process. Skilled technicians and craftsmen are essential for a vibrant innovation system; therefore business, technical and vocational training (BTVET) is pivotal for national development. According to

ESSARP 2009/10, BTVET institutions comprise of Community Polytechnics, Farm Schools, Technical Schools, Technical Institutes, Vocational Training Institutes, Technical Colleges, Uganda Colleges of Commerce, Health Training Institutions and other Specialised Training Institutions that include Agriculture, Forestry, Fisheries, Wildlife, Meteorology, Survey and Cooperatives. Uganda's vocational education system is three–tiered so one can join a BTVET institution on completion of primary school, after O' level and at tertiary level. Primary school leavers can enrol for three-year full-time courses, leading to the award of a Uganda Junior Technical Certificate. Students who have completed O' level can also obtain a craft certificate (Part I and II) from technical institutes on completion of three-year full-time courses.

The BTVET sector has witnessed tremendous positive developments and these have come about as a result of Governments policy shifts as pronounced in the White Paper on Education; the PEAP; policies on UPE (1997) and USE (2007) and the Education Sector Strategic Plan (2003 – 2018) among others. In 2003, the BTVET policy was adopted by MoES to provide a platform for technical skills development and prepare students for entry into the labour market. The sector has since been propelled forward as reflected by the increased appreciation among the population, creation of more BTVET institutions and the ever increasing enrolments and graduates. Enrolment into BTVET institutions in FY 2009/10 was 30,709 (MoES, 2010) with only about 22% of these being female.

However, BTVET in Uganda is associated with manual work and there is a cultural bias against manual work that is yet to be overcome. Thus, many students who should be enrolled in these institutions are not. Nonetheless MoES channelled efforts into registering and licensing private BTVET institutions; developing infrastructure in these institutions, and establishing new BTVET institutions in districts where they didn't exist. It is anticipated that these efforts will go a long way in increasing student enrolments and quality of education at this level. However, these and more efforts that are geared towards improving the sector have been hampered by financial constraints; BTVET is the least funded education subsector at 4.5% in 2009/10 (ESSAPR, 2009/10). Although funding for BTVET increased by 2.5% between 2008/09 and 2009/10, this fades in comparison to 16%, 31% and 22% for the primary, secondary and tertiary sub-sectors over the same period (see figure 6).

Figure 6: Breakdown of Allocations to Education Sector



Source: ESSAPR (2009/10)

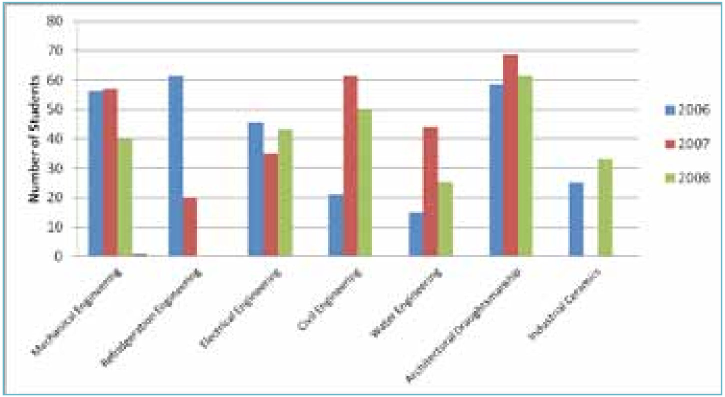
The subsector is further constrained by regional and gender disparities in enrolment, prohibitively high unit costs of operation and shortage of qualified instructors among other things.

2.6.1 Teaching of Science in Business, Technical and Vocational Institutes

The business, technical, vocational education and training was viewed as one of the ways of equipping a portion of the Ugandan population with practical skills to enable them to fight poverty. As such the MoES undertook a reform of this important subsector and one of the outcomes of this reform was the establishment of the Uganda Vocational Qualifications Framework (UVQF) Secretariat in 2004, through which qualification standards, curricular and assessment measures were developed. These reforms have gone a long way in enhancing the quality of BTVET as a whole and science teaching and assessment in this subsector. However, TVET in Uganda has been riddled by the shortage of qualified instructors, especially in the Government-aided institutions. MoES in 2009/10 trained 120 instructors through Uganda Association of Private Vocational Institutions (UGAPRIVI) and all science and mathematics tutors were taught pedagogy under the SESEMAT programme (MoES, 2010). These are positive steps in the right direction, however more needs to be done.

Student performance, particularly in sciences, is noticeably poor at this level of education. The Uganda National Examinations Board (2008) noted that performance at ordinary and higher diploma levels in the BTVET subsector is poor. Perpetual failures have been recorded, particularly in technical and science-related disciplines. On average, 40% of the students at this level fail (figure 7). Technical and vocational education is extremely practical implying that the unit costs are high and prohibitive. Moreover, many TVET institutions lack proper infrastructure for conducting practical training. As such, many institutions have to compromise on the quality of teaching, leading to high failure and dropout rates. Industrial training is an integral part of vocational education, and the practical field experience helps students to appreciate the world of work and link what they have been studying to practice. However, the existing linkages between institutions and industry are weak and not streamlined (Lugujjo, 1998). Students have to struggle and go through informal channels to get industrial placement. Many of those that get the placement are underutilised, not adequately supervised by school and workplace supervisors. Some students are not even placed in areas in which they have been trained. There is a need to build and strengthen linkages between the training institutions and industry to validate the contribution of this critical education sector.

Figure 7: Failure Rates in Ordinary Diploma Engineering Courses: 2006-2008



Source: UNCST, 2012

2.7 Tertiary Level Education

The tertiary sector in Uganda has been growing due to GOU education policies that include liberalisation of the education sector and introduction of UPE and USE. Between 2007/08 and 2008/09, tertiary enrolments increased from 137,190 to 156,397 (NCHE, 2007). Total enrolments have increased on average by 14% since 2005. In particular, these increases have been largely in the university component of tertiary education. Although non-university higher education made up 81.3% of the tertiary subsector, they registered only 32.5% of the student enrolment in the sector, i.e. universities contributed 67.5% of total tertiary enrolments. This phenomenon can largely be explained by the liberalisation of this subsector, which has resulted in an increase in the number of private universities. Female participation rates at tertiary level have also greatly improved. There are more female enrolments as a result of government initiatives to promote female tertiary education. In 2007 and 2008 females, enrolled in 27 universities, made up 44.3% and 42.6% of the total enrolments respectively, a much brighter scenario compared to the average female enrolment of 40.9% for the period 2001-2005 (UNCST 2010; UNCST 2008).

The Government of Uganda recognises the important role played by Science, Technology, Engineering and Mathematics (STEM) human resources in national development. As such Government sponsorship to students pursuing core science courses increased to 75% from 50%. But student enrolment in core science courses, in comparison to those who choose careers in social sciences and humanities, has remained consistently low.

2.7.1 Science Enrolment at Tertiary Level

Enrolment into tertiary institutions in Uganda has been on the rise over the past decade. According to NCHE, the average annual growth rate was estimated to be 14% over the last decade. The average annual science growth rate is estimated to be even higher, at 22%. This growth is largely attributed to Government's policies on science education that have seen more science students in the pipeline from O' to A' Level and finally to tertiary institutions. Increased government support to science students in tertiary institutions has also played a major role. However, the gross tertiary science enrolment ratio remains low and in 2008, it was 0.3 (UNCST, 2010). This is below the required minimum of 40% recommended for rapid economic growth and effective contribution in the global knowledge based economy. Figure 8 further illustrates science enrolments in tertiary institutions in comparison to those in the arts and the total enrolments. Low enrolments into science courses are due to teacher and student factors; science curriculum structure; method of assessment; and social factors.

Source: NCHE, 2008

2.7.2 Science Enrolment and Gender

As a strategy to promote entrepreneurship and job creation, the government has promoted the teaching and learning of science courses. This is another supplementary intervention on top of the policy that made science teaching compulsory at ordinary level. Despite these bold interventions however, the number of female students pursuing sciences at tertiary level has not significantly improved. For instance, female enrolments in the humanities rose by 109% during 2008-2010, but by only 18% in the medical sciences for the same period. This is because very few girls are registering for and passing sciences well enough to qualify for government scholarships.

2.7.3 Teaching of Science at Tertiary Level

There is now general consensus that in order for Uganda to advance economically, a critical mass of scientists, researchers and innovators is required to transform the economy. As a result, government increased sponsorship to students taking sciences at government universities. However, despite such bold interventions, institutional challenges still hamper the delivery of relevant science curricula at university level. Science delivery at universities in Uganda has been observed to be indifferent to the practical side and more focused on the theoretical aspects. According to the World Bank (2007), students tend to follow a closed recipe type of formation rather than open-ended investigations that would enhance students' independent thought processes and reasoning skills. Science at universities does not adequately build more generic human reasoning capacities for the students. Science university students, who are themselves a product of a fundamentally weak secondary school education system, are unable to grasp the 'cocktail' of courses whose curriculum conception or structure is generally problematic. Science delivery also faces the challenges of infrastructure. Universities are meant to be the ivory towers of new knowledge and research. In Uganda however, this has been difficult owing to the lack of adequate facilities like laboratories, equipment and reagents to carry out cutting edge research. This ultimately results in for instance 'engineers' who have never operated a machine or 'industrial chemists' who have never been in an industry environment. A number of interventions such as those under the Uganda Millennium Science Initiative of UNCST and the Ministry of Education's rehabilitation of some NTCs have been carried out to try and address the infrastructure gaps. However, these efforts have been limited and a far cry from what needs to be done. Some tertiary institutions have also formed strategic partnerships that have helped them to improve their infrastructure. For instance, Makerere University in collaboration with NORAD managed to refurbish facilities for the Faculty of Computing and the Faculty of Technology.

2.7.4 Science Staffing Requirements at Tertiary Level

To have a vibrant science based economy, a critical mass of scientists and engineers need to be trained by high quality faculty. In Uganda, teaching is currently not an attractive profession, therefore there are glaring capacity gaps in terms of numbers and quality. There is an aging professoriate in the science faculties and young scientists are not taking up teaching positions, largely due to low pay. In recent years, many potential researchers and scientists have been wooed by audit firms and the private sector, which pay considerably more than the academic institutions. There is also a trend of academic staff joining politics, which deprives the sector of this irreplaceable capacity. To address these gaps, many students who perform well are enticed to stay within the institutions' and lecture, but the disadvantage with this is that they don't have skills in pedagogy. It's not guaranteed that everyone who performs well is necessarily a good teacher. There is also a dearth of government funding for science research as individual researchers struggle to get sponsors for their projects. The student to lecturer ratio in science faculties is better than that in the social sciences and humanities faculties, but this is mainly because of the low enrolments in science courses.

3. OBSERVATIONS AND CONCLUSIONS

a. Government of Uganda policies on UPE and USE have led to increased enrolments at primary and secondary levels of education. However, these gains are being compromised by the fact that UPE and USE are not compulsory, so many children who are supposed to be in school are actually not in school. The success of these programmes is being compromised by high dropout rates. Enrolments at tertiary level also increased as a result of the USE programme and liberalisation of the tertiary education sector.

b. The science education policy has improved science literacy among students. Science enrolments at A' level and tertiary level have also increased, but in comparison to enrolments into SS&H courses, there is still a huge disparity.

c. Gender parity is a challenge at all levels within Uganda's education system. More males enrol into school at all levels, and yet higher dropout rates are reported among females.

d. The teacher factor also affects the quality of science education in Uganda. The student to teacher ratio is high at all levels of education, thus compromising contact between students and learners.

e. Teachers are not well facilitated and so some of them take on multiple jobs and are often too busy to prepare lesson plans, let alone set up experiments. Teachers at all levels lack continuous professional development to refresh their skills and knowledge from time to time. However, teachers are also victims of the system in which they were trained and are teaching in.

f. Quality of science education is impeded by the lack of proper and adequate science infrastructure for science teaching. Government through funding facilities from the African Development Bank and the World Bank embarked on projects to upgrade science teaching infrastructure. Although these are positive steps in the right direction, many of these projects are still at a pilot phase and a lot is still to be done.

g. Sciences are the worst performed subjects at all stages of the education cycle in Uganda. This is because they are taught theoretically and students don't see the connection between what they are learning and everyday life. Assessment methods don't measure innovation and they require students to reproduce what they have crammed. These and other social factors have led students to perennially fail science subjects.

h. Teaching and learning of sciences is completely detached from the world of work. Linkages between academia and private sector are extremely weak and students hardly get opportunities for apprenticeship or internships. Where these opportunities exist, students have to lobby for them and they are often deployed to positions that have no connection to what they are studying. Supervision by the company and teachers during internship is extremely inadequate.

4. RECOMMENDATIONS

I. Basic education should be provided for teachers that train children in pre-school because it is at this stage that science awareness begins. The government is primarily responsible for setting up such an institution. In addition, standards should be set for pre-schools and they should be included on the MoES inspection schedule.

II. The Government through the MoES should make UPE and UPPET/USE compulsory to improve literacy levels, more specifically scientific literacy and innovation. Students will acquire skills that can enable them to be gainfully employed and fight poverty.

III. To improve science teaching and learning, the teaching profession should be made attractive through raising the status and satisfaction of teachers. The profession must reclaim the prestige and allure that it had in the post-colonial era. This can be achieved by providing teachers a competitive package commiserate with their critical role in national development. Teacher training institutions should be attached to 'Teaching Schools' to promote continuous teaching practice during training. A similar model is being used by institutions (e.g. Universities, Nursing Schools) that train medical personnel. Teacher training institutions should be encouraged to offer remedial programmes where in-service teachers can go for professional development.

IV. A deliberate programme to popularise science in schools at all levels of education should be developed by the MoES in partnership with the UNCST. This programme can include use of drama groups and local musicians to act/sing about science; use of print and electronic media to promote science; and creation of science centres where students can visit and relate science to life. Science fairs in schools should be revived and made compulsory and they should be pupil based not teacher based. These will go a long way in demystifying and raising interest in science.

V. Uganda's education curriculum should be reviewed at all levels of learning to make it less congested, and more practical and connected to everyday life. The NCDC needs to ensure that curriculum development is aligned to teaching, assessment methods and private sector demands. When the curriculum is reviewed teachers should be trained, textbooks and instructional materials printed before the new programme is rolled out.

VI. UNEB together with NCDC should amend assessment methods particularly for science subjects. Assessment should be continuous and not only limited to examination periods. Students should be rewarded for understanding the underlying concepts as opposed to the memorisation and repetition of facts. In examinations, the proportion of questions testing scientific inquiry should also be increased.

VII. The government should intensify efforts aimed at improving science learning infrastructure. The construction of these facilities should take into account accessibility by students with disabilities. MoES should also work out an arrangement where students in schools that don't have adequate science infrastructure are given opportunity to share and utilise science laboratories and equipment of neighbouring schools.

VIII. Government should continue to support the introduction of ICT in schools and in all teacher education programmes. ICT can be used not only as a viable vehicle to offer distance support, especially to upcountry teachers, but also as a tool to enhance science learning. Increasing 'science awareness' and skills among science teachers through regular ICT training clinics (remedial programmes) will enhance their teaching capabilities. Frequent and regular re-training programmes in science-based programmes should be introduced at national level to propagate continuous professional development.

IX. Student enrolment into science education courses has been decreasing over the years despite government efforts to increase them. Consequently, the number and quality of teachers are inadequate as there is an unprecedented exodus of qualified teachers into emerging fields such as ICT. As a result, those who remain have to teach across levels, which compromises the quality of delivery. The profile of the teaching profession should be raised by providing better salaries, housing, study leave and better in-service training. Teachers operating in uniquely challenging environments should also be offered additional support like transport facilities to enable them to carry out their duties and roles more professionally. In addition, enrolment into science education can also be further enhanced by rewarding prospective students with bursaries and supplies and requiring them to teach for a specified period. This will ensure a continuous flow of a steady and fully motivated human resource.

X. Regarding BTVET education, there is need for creation of demand for new occupational profiles. Issues regarding training quality—access, flexibility, relevance and gender disparities—need to be addressed too. More inter-sector linkages and trainer-industry collaboration should be enhanced to validate the contribution of this critical education sector.

XI. Current funding inadequacies have been a major challenge for research in Ugandan tertiary institutions, particularly universities. In order to further enhance excellence in research, concerted efforts by government and the donor community must be geared towards promoting focused research in the strategic interventions essential for national development. Upgrade of laboratories and training facilities could be improved to adequately improve the quality of teaching and research. More programmes like the Millennium Science Initiative (MSI) fund or Innovation Fund should be established to promote and support cutting edge research.

XII. MOES should have a policy on the maximum number of periods that a science teacher can teach per week. Some teachers take up to 32 periods a week and therefore don't have time to attend to students and set up experiments. Heads of departments and Head teachers should be more involved in lessons supervision. MOES should also carry out more regular and thorough school inspection. In addition, where possible, schools should be encouraged to implement lesson study i.e. colleagues sit in and listen while a teacher is conducting a lesson and critique content and pedagogy.

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