

Examination of Locally and Externally-Initiated Teacher Professional Development (TPD) Programmes for Science and Mathematics Teachers in Ugandan Secondary Schools

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Abstract

This article draws from a study that explored how Ugandan secondary school teachers' competences are continuously developed to cope with the ever changing trends in Science and Mathematics teaching. The study was premised on a framework of professional development that views teacher education as a continuum that includes training, recruiting, retaining, and retraining. The article argues that in Uganda more research has been focused on the first two levels of the continuum, with evidence on the last one remaining less documented. Data was largely collected from qualitative semi-structured interviews with selected policy makers, school administrators, and teachers. The interviews were complemented with an analysis of relevant documents and a workshop with the participating teachers. A thematic analysis of the data revealed three categories of existing Continuing Professional Development programmes in Uganda including those initiated by government agencies and donors; those initiated by schools; and those initiated by individual teachers. The article highlights the need for a critical examination of these existing programmes with a view to ensuring that they reinforce each other.

1. Introduction and Background

A number of policy changes in Uganda in recent years have impacted on lower secondary education provision. The success in terms of access to Universal Primary Education that was introduced in 1997 was followed by an enormous demand for secondary education. To address this demand, the government introduced the Universal Post-Primary Education and Training (UPPET) policy in 2007. Under this policy, government covers a wide range of expenses for students enrolling in government-aided schools, and bursaries to those eligible (those scoring 4-28 aggregates) in selected private secondary schools in sub-counties without government-aided secondary schools. This policy has far-reaching implications on secondary schools and teachers such as having to cope with large classes and having to deal with learners from multiple

abilities and socio-economic backgrounds, among others.

Preceding the UPPET policy was the science policy which was introduced in 2005. This made all science subjects (biology, chemistry, and physics in addition to mathematics) compulsory at Ordinary (lower secondary) Level (O-Level). This policy was introduced to an already struggling science education sector. Performance in the science subjects as reflected by results of national examinations administered by the Uganda National Examinations Board (UNEB) at O-Level has been unsatisfactory for the past 3-4 decades. The Ministry of Education and Sports (MoE&S) refers to a study conducted by UNEB in 2004 which shows a consistent high failure rate in science and mathematics. The study shows that for five consecutive years (2000-2004), more than 40% of secondary school students failed science and mathematics (MoE&S, 2007a, p.3-4). For example, while 45.1% of the candidates failed mathematics in 2003, only 1.5% achieved Distinction in mathematics. This trend of failure persists to-date. In the recent 2009 O-Level results, science subjects were noted to have continued to register high failure rates with over 50% of the candidates unable to pass with the minimum grade 8 (Daily Monitor Reporter, 2010).

This state of affairs raises the need to explore the quality enhancement measures that are in place to train and equip secondary school teachers, more so the science teachers, with effective pedagogy and school administrators with the skills to create enabling environments for effective learning.

2. Training and Development of Secondary School Teachers in Uganda: An Overview

According to the official statistics accessible from the MoE&S, there were 50,767 secondary school teachers in total in 2007 (MoE&S, 2007b). Of these 39,520 were male and 11,247 female teachers. The data is not segregated according to the particular level of secondary education i.e. either lower secondary (Ordinary Level) or upper secondary (Advanced level). The minimum qualification for teaching at O-Level is Advanced Level (A-Level) with a diploma in education obtained from a National Teachers' College (NTC). Teaching at A-Level requires A-Level and bachelor's degree or B.A/BSc with a postgraduate diploma in education (PGDE) qualifications, although in situations of scarcity of graduate teachers, diploma holders tend to teach a specific subject across O- and A-Level.

Table 1 below, highlights the level of qualification of secondary school teachers in Uganda. All teachers in category 1-5 (34246 teachers in total) (67%) possess the required qualifications for teaching at secondary school level. The table shows that the majority of teachers (17,520) possess a diploma in education qualification, followed by those in possession of a degree in education (13,735). The qualification of 13,610 teachers (27%) cannot be accounted for (see category 9 below). The rest of the teachers (category 6-8) (6%) are teaching in secondary schools without the minimum qualifications.

Table 1: Secondary School teachers by education level

Category	Education Level	Male	Female	Total
1	Doctorate	37	5	42
2	Masters Degree	858	344	1202
3	Graduate	10315	3420	13735
4	Post Graduate Diploma	1384	363	1747
5	A Level + Cert./ Dipl	13741	3779	17520
6	A Level	2123	313	2436
7	O Level + Cert. / Dipl	256	85	341
8	O Level	109	25	134
9	Not Stated	9560	4050	13610
	Total	38,383	12,384	50,767

Source: MoE&S (2007b)

Although the available accessible data on teacher qualification presented above is not specific to lower or upper secondary teachers, it helps to illuminate the dire need for Continuing Professional Development (CPD) of teachers who are practicing with different levels of qualification. Certainly the need for and execution of CPD would vary across different categories of teachers. It can be observed that some of the teachers have actually upgraded to Masters and Doctoral levels implying that individual initiatives have been considered worthwhile. It can be expected that CPD will be highly demanded by those in category 3-5 that constitute over 60 percent of the total number of secondary school teachers although they possess the required minimum qualifications. Another challenge is to ascertain the best approaches for CPD in stratified staffing situations. A case in point is the 6 per cent without minimum qualifications whose needs would have to be addressed differently – first by ensuring that they acquire the necessary Initial Teacher Education (ITE) and thereafter establish the different sets of skills and knowledge that they may gain through CPD. At the same time, the 27 per cent whose qualification was unknown can create ambivalent conditions concerning the appropriate CPD capacities. Even more challenging in the development of CPD in the case of Uganda are the gender discrepancies in the qualifications of the female and male teachers. In each category the numerical difference between the male and the female teachers would possibly necessitate reflection on whether the Teacher Professional Development (TPD) or CPD can be structured with some gender-mindedness.

3. Conceptualising Teacher Professional Development and Continuing Professional Development

Teacher Professional Development (TPD) is increasingly becoming an integral component of education reforms and educational policy shifts. Indeed, in the developed countries, professional development for teachers has dominated educational policy changes and research since mid-1980s (Hurd, et al., 2007; Ling & Mackenzie, 2001). This has been premised on the fact that success of any reforms for school improvement hinges on the professional development

of teachers (Villegas-Reimers, 2003, p.29). In fact, “teachers are constantly called upon to add more and more tasks and content areas to their curriculum and to their professional role...” (Ling & Mackenzie, 2001, p.89). Yet, at the same time, the trajectories of teacher professional development are as diverse as they are context dependent (Komba & Nkumbi, 2008, p.69). A review of the literature illuminates the national, school and individual teacher initiatives for professional development. (cf. Hurd, et al., 2007; Ling & Mackenzie, 2001).

In African countries like Tanzania, TPD has focused on the improvement of the professional, academic and technical capacities to cope with the developments in science and technology. Although the national government ministry has a department in charge of TPD, the findings reported were based on interviews with the education managers at the local government levels among other informants. Clearly, the role of the local governments, which in this case are part of the national government, shows that there has been some organized engagement and support for professional development (Komba & Nkumbi, 2008, pp.74-76). However, the teachers reported that their schools had not invested much in the process of professional upgrading of their teachers despite the overwhelming increase in the number of teachers who had individually upgraded. The ongoing initiatives illuminate tremendous and systematic efforts to capacitate teachers in the different jurisdictions.

This article seeks to complement the existing literature by applying the conceptions of Mulkeen et al. (2007) who view the professional development of secondary school teachers to include four levels i.e. training, recruiting, retaining and retraining (Figure 1). Their view is that the four levels overlap for the holistic quality enhancement of the teaching force, and none of the four should be prioritised or neglected at the expense of the other. This is the same framework within which we also situate our understanding of the continuum of TPD in the context of secondary school teachers in Uganda, arguing that in most cases more focus is placed on the first two levels, with the last one on retraining remaining on policy papers and at most left to the good will of any interested stakeholder.

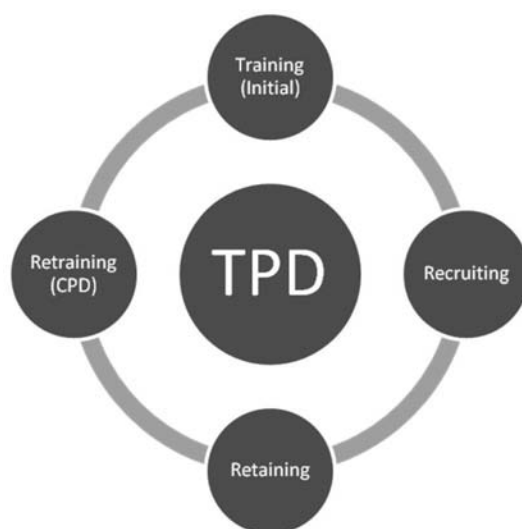


Figure 1: Levels of Teacher Professional Development

Retraining or CPD, the main focus of this article, has been defined as the means of updating, developing and broadening the knowledge teachers acquired during the initial teacher education and/or providing them with new skills and professional understanding (OECD, 2005). It manifests itself in various ways. For example, Conway et al. (2009, p.51) have argued that CPD can be developed to help and support teachers extend and deepen subject matter knowledge for teaching; extend and refine repertoire in curriculum, instruction and assessment; strengthen skills and dispositions to study and improve teaching; expand responsibilities and develop leadership skills; and develop a professional identity. Such a framework does not only help guide the spectrum of CPD but can also be used as a criterion for evaluating any CPD initiatives as a means of ascertaining their impact on the teaching, learning and leadership of secondary school teachers.

4. The State of Continuing Professional Development of Secondary School Science Teachers in Uganda and Research Gaps

The Education Sector Strategic Plan (ESSP) 2004-2015 highlights the importance of establishing continuous in-service training to enhance the quality of education (Sub-objective 2.2 and Strategies b) (MoE&S, 2005). Tackling CPD of secondary school teachers is even urgent. As noted earlier, the government has targeted the improvement of access to secondary education through the UPPET policy. However, the UPPET policy ought to be combined with quality enhancement measures if it is to lead to desired learning outcomes. Lessons learnt from the previous implementation of the UPE policy point to the need to build in quality assurance measures within an attempt to widen education access. Failure to do so leads to an emphasis on quantity at the expense of quality. It was also noted above that science and mathematics teaching and learning at the secondary level in Uganda faces serious challenges evidenced by the high failure rates. It is therefore indispensable to provide quality enhancement for the science subjects.

CPD for secondary teachers in Uganda and science teachers in particular, is not new. For example, the Secondary Science Education and Mathematics Teachers (SESMAT) Project funded by the Japanese Government has been going on since 2004 (MoE&S, 2007a). From Table 1 above it is also clear that some teachers undertake further training, which can be classified as in-service training undertaken on the teachers' own initiative.

There have been and are still ad hoc programmes in place intended to continuously up-skill secondary school teachers in various ways in Uganda, but CPD is yet to be appreciated as a crucial component of teacher development. Some teachers interviewed by Mulkeen et al. (2007, pp.52-53), for example, revealed that they had participated in an in-service teacher education program, but felt that the in-service professional development (INSET) they received prepared them to a lesser degree than their initial training.

Apparently, ITE has been arguably the most effective mechanism for TPD as it provides foundational knowledge and skills on which the teacher can build as they operate in their school

environments. As Musset (2010, p.3) has rightly asserted, “to teach is a complex and demanding intellectual work, one that cannot be accomplished without the adequate preparation”. It is thus worthwhile for education systems to strengthen initial teacher training for all teachers or even make similar arrangements for practicing teachers who may not have minimum qualifications. But equally important is ensuring that teachers continually improve on their practice.

What is unclear is how to harmonise the existing approaches so that mechanisms that permit continuous processes of TPD are coherently harnessed and maintained by keeping in mind the changing needs of the teachers and contexts in which they work. It is necessary to undertake an audit of all existing forms of CPD initiatives with a view to coming up with a holistic framework for continuously developing (science) teachers in Uganda. Accordingly, the research on which this article is based explored issues of teacher professional development at the following levels:

- Self-initiated by teachers
- Locally initiated by schools
- Externally (to the school) but locally initiated by other organizations such as the National Curriculum Development Centre (NCDC) and UNEB
- Externally initiated by donors (such as the SESMAT)

The overarching aim of the research was to explore how Ugandan secondary school teachers’ competences are continuously developed to cope with the ever changing trends in science and mathematics teaching. The study is even timely given the fact that the science subjects are now compulsory at the lower secondary level. This is in addition to an expanded secondary education sector following the implementation of the UPPET policy. The specific objectives of the research included the following:

- To find out how practising science and mathematics teachers continually enhance their professional practices.
- To establish the various strategies that secondary schools employ to continually develop their science and mathematics teachers.
- To examine the arrangements that are in place at the national level to continuously develop science and mathematics teachers.
- To find out what externally donor-initiated programmes are available for continuously developing science teachers’ proficiency.
- To analyse the perceptions of individual teachers towards the contribution of the various forms of teacher professional development to their professional practice.
- To assess the ways in which the donor-initiated professional development programmes complement local initiatives (at personal, school and national levels).

5. Methods

Data was largely collected from qualitative semi-structured interviews with selected policy makers, school administrators, and teachers. The interviews complemented the analysis of relevant documents such as the Government White Paper on Education, the Education Sector Strategic Plan (ESSP), educational policies, reports, documented programmes and activities concerning Teacher Education and Secondary Education, and the Policy instrument on the compulsory teaching of Science. The data gleaned from a number of initiatives i.e. self-initiated by teachers, locally initiated by schools, externally (to the school) but locally initiated by other organizations such as MoE&S, National Curriculum Development Center (NCDC), Uganda National Examinations Board (UNEB), externally initiated by donors (such as SESMAT) was analysed by identifying similar meanings that arose out of the recorded and transcribed responses to the interview questions (Kvale, 1996, pp.187-190; Rubin & Rubin, 2005, pp.206-209). This was supplemented by the themes that emerged from the review of the documents.

6. Findings

This section presents how the different initiatives (local and external) can be harnessed to coherently and effectively develop the knowledge and skills of Science and Mathematics teachers in a continuous and un-fragmented manner.

Factors that create the need for CPD

There was a general agreement among those interviewed at the different levels i.e. policy, school and teacher level, that CPD was a ‘necessary evil’. Factors arguing for the fact that it should constitute any education system in the modern world, most specifically in the context of Uganda are summarized in Table 2 below according to the order of their prominence from the point of view of the respondents:

Table 2: Factors creating the need for CPD

	Factors
1	The dynamic nature of Mathematics and Science
2	Need for new ways of adapting to the changes
3	General low performance in Mathematics and Science
4	General negative attitude towards Mathematics and Science
5	Policy and curriculum change
6	Changing nature of students and their needs
7	Personal development and need to refresh self
8	To develop teacher confidence and interest as they grow in the profession
9	Need to interact with others in the same profession

It was noted by all respondents that as was the case with the dynamic nature of the world which was changing all the time, so was education, including Mathematics and Science. Within the Ugandan context researched, various changes were noted to have taken place in the recent past necessitating changes in which Mathematics and Science are taught. Some of the changes were policy-oriented and others had to do with the changed nature of students taking science subjects.

The ever changing nature of the world and education automatically requires that strategies are put in place by those in charge [in this context, the ministries of education, teacher education institutions, schools and teachers] to continuously provide opportunities of up-scaling the skills and competencies of teachers to adapt to the changes.

All the above, in addition to the general low performances in Science and Mathematics as demonstrated in the earlier sections, make continuing professional development of Science teachers a critical issue. On a positive note, our research (as the following section demonstrates) found that there were many opportunities provided by different stakeholders targeting the professional development of science teachers in different pedagogical and disciplinary areas. What appears to be urgently required is the critical examinations of the overlaps of such provisions to ensure coherence and harmonisation in the CPD business.

Existing CPD Programmes for Secondary Science and Mathematics Teachers in Uganda

As Table 3 below summarises, there are several actors and programmes at the national, school and teacher level, as well as short term-workshops and seminars organised by Higher Education institutions such as Makerere University and other local and international NGOs in the continuing professional development of science teachers in Uganda. One would argue that such initiatives offer a strong foundation to capacitate science and mathematics teachers to do their job effectively. On the other hand, while there are instances where the Ministry of Education has tried to harmonise the INSET time-table to avoid clashes, there still appears to be need for a critical examination of the programmes in place with a view to streamlining and reducing duplication as well as overloading schools and teachers.

Table 3: Existing CPD Programmes and Providers for Secondary Science and Mathematics Teachers in Uganda

Initiated by Government agencies and donors	Initiated by Schools	Initiated by teachers	Initiated by other agencies
SESMAT workshops	Workshops	Teacher associations	Makerere University subject workshops and other projects
Cyber (ICT) programme	Seminars	Further /additional studies	Africa Development Bank workshops
Uganda Communications Commission (UCC) ICT programme	Departmental meetings	Research and publishing	World Vision workshops
NCDC workshops and partnering with teachers	Team teaching	Peer-teaching & assessment	Lottery International lab training
Ministry of Education Technology shows	Science clubs	Consult peers & other schools (locally/abroad)	Kampala Pharmaceutical Industries (technical)
Uganda National Council for Science & Technology workshops	Support teachers upgrading	Science exhibitions	Other NGOs e.g. Revolution Walk Pure
UNEB workshops & sharing exam findings	Expert teachers from other schools	Outreach activities e.g. UNEB marking	
	Science exhibitions	Joining student discussion groups	
	Collaboration with overseas schools		

At the national level, there are three major initiatives for continuously developing the capacities of science teachers that the Ministry of Education is coordinating with the majority of the funding coming from donor agencies. These include the Secondary School Science and Mathematics Teachers (SESMAT) programme, the Cyber Schools ICT project and the ICT project supported by the Uganda Communications Commission.

The SESMAT (Secondary School Science and Mathematics Teachers) Programme

This is a programme open to all schools (government aided and private) and it focuses on science (Physics, Chemistry, Biology, and Mathematics) Secondary school teachers and trying to make them aware of innovations in teaching and learning science. The programme is sponsored by the government of Uganda in conjunction with the Government of Japan through its Japan International Cooperation Agency (JICA). The Ugandan government provides personnel (national trainers); training materials and the Japanese government provides technical support, personnel, equipment and apparatus.

SESMAT is premised on the assumption that teaching of Science should be made practical and teachers should be transformed. It provides in service training to science teachers to equip, retrain and develop competencies in them. SESMAT is also based on the paradigm shift from the conventional/ traditional talk and chalk to a more practical and learner centered approach

to teaching science and mathematics. The aim is to provide training opportunities to teachers of science, to improve teacher's ability in preparing lessons which results into improved performance in science and mathematics.

SESMAT training programs are conducted during every holiday, and many science teachers from different schools regionally attend training sessions for 2-3 weeks. According to the Ministry of Education officials interviewed, most of the regions of Uganda have been reached by the SESMAT project and many science teachers have benefited.

In order to sustain the programme and to ensure that schools and teachers own it, member schools contribute a small fee of one thousand shillings (1,000/=) per teacher towards the training. For Universal Secondary Education (USE) schools, this money is included within the capitation grant. In support of this view, the Permanent Secretary authorised the collection of 1000/= per child per term (3000/= per year). This money is then remitted to the Regional/District Management Committee and it is used to cater for district training. Teachers don't pay for the training themselves, and the head teachers are obliged to budget for teachers' transport allowances.

The officials interviewed at the national level together with school administrators and teachers all were positive about the contributions that SESMAT had made to continuously improving teachers' professional capacities. However, the teachers and school administrators were also critical of the programme in the following ways:

Some individuals felt that the programme had been imposed on schools, and in turn schools were imposing it on their teachers. One school administrator noted:

... It is as if the Japanese Government has [Sic] set a condition... and the Government pushes it to Ministry of Education. Commissioners are tough on schools ...“Your teachers must participate”. Teachers are going to attend not because of interest but because of compliance – it is an instruction from above. [AO-19-05-11-A]

Some teachers felt the programme was not of benefit to them and that the benefits were hidden, with the thinking that perhaps those enforcing its implementation were benefiting personally – leaving unanswered questions such as: “Why are teachers forced to do it?” – (OC-19-05-11-T).

Some felt that based on the fact that teachers can barely survive on their meager salaries and that they use holiday time to engage in other activities besides teaching so as to supplement their salaries, that the timing of SESMAT training was not favourable to them. Alternatively, they were of the view that at least some of the subscriptions that schools made to the programme, could be used as an allowance for the teachers: “Out of the money they charge, something needs to be tossed back to the teachers to give them motivation to participate” [KG-19-05-11-A].

Cyber School Technology Solutions Project (Digital Science in Secondary schools) and Uganda Communication Commission (UCC) under the Ministry of ICT

The Cyber project is a private firm that was contracted by the MOE&S to train science teachers and supply computers and software to the selected schools. It is sponsored by MOE&S and has its national offices at Uganda Manufacturers' Association (UMA) grounds Lugogo. The project was piloted in 2007 in one hundred (100) schools, and today it covers 200 schools, with plans to expand to another 100 schools. The project organizes training workshops with the aim of training teachers in using digital means to teach science. It uses animations, with the rationale that “*What you can't demonstrate practically in class can be done on computer*” [M-11-NCDC].

Unlike SESMAT, Cyber School is a project that deals with only government aided and specifically selected schools with no deliberate effort to reach out to private schools. It is limited to a specific selection within Government aided schools and is not as open as SESMAT. E.g. every district has 3-4 schools that get access to the equipment from Cyber. So far, 4000 teachers and over 6000 students have been trained. Selection of schools is based on a number of factors; including if the school is connected to any form of power (electricity, generator, solar) and if the school has room where to keep the computers. Such conditions disadvantage rural schools, although Cyber at times gives out computers with solar systems.

The project offers to each selected school six (6) computers under the first pilot and eventually four (4) other computers are offered. On these computers, software is installed customised to the science syllabi for O'level Mathematics, Physics, Chemistry and Biology. Some other software (Virtual labs) where practicals from O'level science subjects are digitised is installed onto computers. In order to enhance the teachers' ICT skills, Cyber Schools Solutions provides a 3 day training, under which all participating teachers receive training and a selection based on performance is made of super teachers. The super teachers receive a further 3 days of training, after which they return to their respective schools and help train other teachers.

Like the Cyber Schools project, the project facilitated by UCC (Uganda Communication Commission) under the Ministry of ICT is an informal programme that has given computers to schools. When UCC gets computers, it writes to the MoE&S and the MOE&S selects schools.

Overall, there seems to be overlaps as well as divergences in the activities of the three CPD providers at national level in the way they are organized, how they conduct training and the knowledge/skill areas they target (see Table 4 below). While all of them organize short-term training ranging from 2 days to 3 weeks, SESMAT seems to be comprehensive targeting pedagogy and practical skills whereas Cyber and UCC are largely focused on providing computer skills.

Table 4: Organisation, Approach and Knowledge/Skill areas by SESMAT, Cyber and UCC

	SESMAT	Cyber School...	UCC
Organised	Short-term sessions during holidays (2-3 weeks)	Short-term sessions (3- day training) Training of Trainers (ToT) approach	Short-term sessions
Conducted	Activity-based Peer-teaching Micro-teaching	Practical skills Workshops	Training computer managers
Knowledge or skill areas	Communication skills Leadership skills Learner centred pedagogies Skills for improvisation	Computer skills Management skills	Computer skills e.g. booting

CPD by other Government and Non-Government Institutions

In addition to the 3 government/donor-initiated CPD programmes described above, there are also initiatives introduced and facilitated by other government-associated institutions and departments such as the Uganda National Examinations Board (UNEB), Uganda National Curriculum Development Centre (NCDC), Uganda Council for Science and Technology (UNCST), Makerere University and other non-government organizations.

For instance, UNEB organizes training for teachers in setting and marking national examinations, which participating teachers testified was very useful in up-scaling not only their assessment skills but also subject content. UNEB also shares findings from national examinations annually, which helps teachers and schools to know the weak areas and possible improvements that need to be made in the teaching of various science subjects. On its part, the NCDC recruits some teachers to serve as subject panelists and curriculum reviewers. Teachers benefit individually from such opportunities and also return to their schools and share the expertise gained from serving as subject panelists and curriculum reviewers. The National Council for Science and Technology organizes subject-specific workshops for teachers and national or regional technology exhibitions, sometimes in collaboration with Makerere University and Ministry of Education and Sports.

Another major actor in the provision of CPD for science teachers is Makerere University, which occasionally organizes subject-specific and sometimes general science courses and exhibitions for secondary school science teachers and students. Normally Departments in the College of sciences organize subject-specific short courses for teachers during school holidays. The School of Education has also been active in providing CPD for practising teachers. For example, between 2007 and 2010, using funds for a British-Council funded partnership project

with the Open University (UK), a number of science and arts subject teachers were trained in how to develop open sources resources. The project was code-named E-Learning and Teacher Education (ELATE).

Other providers of CPD have included the World Vision international NGO which organises workshops particularly on “appreciation of the girl child in the study of sciences”. Kampala Pharmaceutical Industries (KPI), a manufacturer of science chemicals and equipment runs workshops and lectures on how to use them. KPI also helps SESMAT survive because they emphasise science with the assumption that “if kids leave school having learnt sciences, they go into manufacturing” (Teacher interviewee). Lottery International occasionally offers professional development on laboratory equipment and computer laboratory, while Revolution Walk Pure, an NGO, sensitises students on issues of HIV AIDS and sexuality in some schools.

School-Level and Individual Teacher CPD Initiatives

In addition to CPD programmes for teachers that are externally initiated at the national level and facilitated by donors, there are a number of other initiatives that respondents mentioned to be initiated internally at school and individual teacher levels. The school-level-initiated programmes take the following forms:

- Subject-specific seminars and workshops where distinguished people are invited to come and talk to teachers and equip them with relevant skills such as pedagogy and how to develop teaching/learning aids, professional conduct and innovation in teaching.
- Departmental meetings where teachers of a given subject meet termly or annually to do a SWOT analysis of their subjects with a view to improving how it is taught and learnt.
- Encouragement of learning from peers through team teaching, joint scheme of work making and lesson planning.
- School initiated-science clubs (physics, chemistry, biology, mathematics) - these help to explain abstract concept to students.
- Schools encouraging and supporting professional development “for those wishing to go for further studies to consolidate on the subject matter they are handling”. The support is mostly in terms of giving lesser workloads to teachers who enroll for further studies.
- Supporting Science exhibitions every term where different stakeholders such as parents, local community leaders and MoE&S officials are invited to see and give feedback on how sciences are being taught.
- Linking the school and teachers to other schools internationally. For example, one school in Kampala had developed an exchange program with secondary schools in Norway. The collaboration was focused on water conservation and treatment.

- Through national and regional headteachers' associations, teachers are encouraged and supported to join subject networks that potentially develop their capacities as science teachers, for example the Joint Mock Associations to which teachers are members. It also organises subject-specific workshops within the district inclined to sciences.

In addition to the school-initiated CPD programmes, individual teachers reported to also have taken their own initiatives to keep themselves abreast of the changing trends in knowledge and pedagogy of the Sciences. Some individual initiatives included the following, among others:

- Joining teacher subject associations, which provides opportunities for learning with and from peers.
- Peer teaching where more than one teacher is involved in teaching students for a particular lesson and joint setting and marking of exams.
- National Examiners within schools discussing with junior and non-examiner colleagues.
- Those who go for in service training sharing their new knowledge and skills with colleagues.
- Joining science student clubs and discussions, which encourages further interactions with students and learning from one another.
- Enrolling for further studies including Postgraduate Diploma programmes, Masters and PhD.
- Researching and writing books and pamphlets which encourages reading and keeping updated on the new knowledge in the subject.
- Taking initiatives to attend science exhibitions that are organized nationally or by other schools
- Applying to become examiners - marking and setting regional and national examinations

Methodology used and Knowledge areas targeted by the different CPD providers

There are some overlaps in the way CPD is organized at the different levels (See Table 6 below). For example both the external CPD organized by government institutions or donor-funded projects and those which are initiated at school level use short seminars/workshops as a method of delivery. However, at school level seminars/workshops seem to be supplementary, while government, donors and other agencies use them as the primary and almost only methodology or approach to CPD.

In terms of knowledge areas and skills targeted at the different levels of CPD delivery, the list is quite expansive (also refer to Table 5). Issues of pedagogy, assessment, ICT and instructional materials development seem to be cross-cutting. The fact that the same knowledge areas are emphasised at the different levels would mean that each level re-enforces the other.

On the other hand, it could imply duplication of initiatives. Given resource scarcity it could be useful that different providers specialise in delivering professional development in their niche areas. This would point to the need for round-table dialogue among the different providers to establish areas that could possibly be harmonised to minimise duplication, where possible.

Table 5: How CPD is organised at the different levels and the targeted knowledge areas at each level

	School-initiated	Teacher-initiated	Govt & donors	Other agencies
How Organised	Departmental meetings SWOT analysis 1 day seminar/ workshop focussed on an identified need Local expertise and guest speakers Team planning and teaching	One-on-one consultation Peer teaching Individual research Evening or holiday study	1-2 weeks workshops (mainly during holidays or weekend) by selection & invitation Area of focus chosen by agency Sharing evaluation reports	Short-term workshops & training
Knowledge / Skills targeted	Pedagogy/ methodology Assessment/ examination skills Instructional materials design (creativity) Professional conduct Practical & science application Technical e.g. equipment handling	Assessment/ examination skills ICT Science concepts & content General e.g. leadership, communication, innovative, etc. skills	Pedagogy/ methodology Assessment / examination skills Instructional materials design (creativity) Practical & science application Technical ICT Science concepts & content Curriculum issues	Practical & science application Technical ICT Science concepts & content General e.g. leadership, communication, innovative, etc. skills

Overall, from Table 5 above, it appears that at school and individual teacher levels, CPD is more long-term and could be more sustainable e.g. through continuous departmental meetings, peer-teaching, individual research, etc. compared to that which is externally delivered through once off and short-term workshops by other agencies. It can be argued that sustained CPD takes place at the school and individual teacher level and that knowledge and skills obtained from participating in the external CPD programmes is useful if it is effectively reflected upon and contextualised at the school and individual level. The following section offers insights into what teachers perceived to be the knowledge and skills gained from the different CPD programmes and how it impacted teaching and learning.

Perceived Knowledge and Skills Gained from CPD Programmes

In Table 6, a summary of the knowledge and skills that teachers who had participated in

CPD programmes were presumed to have obtained and found valuable in their professional work is presented dichotomized into internally-initiated and externally-initiated CPD. The knowledge that was most significant for the teachers was basically related to the use of learner-centred approaches in teaching science and mathematics. Such knowledge was attributed to the externally-initiated CPD owing to an examination-oriented education system of Uganda.

Table 6: Knowledge and skills gained from CPD programmes

	Knowledge	Skills
Internally-initiated e.g. Cyber	Management skills for example, how do you keep computers working CYBER	Skills of how to handle equipment (MoE&S) Computer skills (MoE&S)
Externally-initiated e.g. SESMAT	Practical approach to teaching science and mathematics under SESMAT Learner centered approach to teaching under SESMAT	Innovative skills under SESMAT “ability to use whatever exists to conduct science lessons e.g. plastic bottles” (MoE&S) Leadership skills Communication skills

Innovative skills can be considered as crucial in enabling teachers to improvise under conditions of scarcity that have typified sub-Saharan African contexts. Moreover, the advantages that can accrue from learning in groups during CPD sessions enabled teachers to get acquainted with valuable skills in leadership that are transferable to school or classroom contexts as they teach.

The perceived gains from CPD have been articulated in a range of ways. First, the results from national examinations have been steadily improving through reduction in the percentage of those failing science and mathematics. Second, there was adoption and adaptation of alternative methods and approaches to teaching. More specifically, traditional ways were being supplemented with constructivist approaches that enabled the learners to construct meaning as teaching was taking place. On the whole, this facilitated learning within and outside class. Third, in the interim reports about the Cyber project, most comments were positive. For example, it is claimed to have increased students' interest in science subjects. Schools had given testimonies that for the first time they had been able to get first grades. However, such impressive perceptions cannot be taken wholesomely. It has been argued that whereas there had been attempts to monitor the impacts of externally-oriented initiatives e.g. SESMAT, there was hardly any empirical evidence that it had actually impacted on teaching although there were various claims of improvement in teaching as a result of CPD.

Even then, several measures had been put in place to ascertain the impacts of CPD. There was use of standard instruments such as questionnaires to ascertain teachers' capabilities before and after training. The questionnaires attempted to obtain information on the extent of motivation of the teachers and on how useful the lesson had been to their daily professional

practice. It has to be emphasized that information that was used to gauge the effectiveness of the training were also given to the learners to obtain their views on whether there had been any change in their learning.

7. Challenges in the Provision of CPD

There are a number of challenges at two levels: school and policy-making levels. At the school level, challenges were noted in the discrepancies between CPD ideals and the reality on the ground (e.g. resource constraints); heavy workloads/large classes which lead to lack of time for CPD; overcrowded/irrelevant syllabus/curriculum; the examination-driven education system; deep-rooted negative attitudes towards science subjects; teachers' assumption that participation in CPD does not have such personal gains as promotion and increased salary. Similarly, the challenges at policy level arise from the fact that CPD programmes (mainly donor-driven) have not been well-institutionalised which makes continuity doubtful. In addition, internal coherence among departments at the Ministry of Education and Sports needs strengthening – for instance, the lack of harmonisation between UNEB & NCDC syllabi. The other challenges include the concentration on government-aided schools only; and the fact that CPD activities take a top-down approach i.e. from the Ministry of Education to the schools.

8. Conclusions

Based on the finding of the research reported herein, we suggest that

- CPD should become part of the national school calendar to ensure that every teacher benefits.
- Curriculum review with a focus on meaningful and relevant content should be ongoing.
- There should be strong efforts to harmonise the teaching syllabus (NCDC), the examination syllabus (UNEB) and CPD activities.
- There should be strong efforts to coordinate CPD with a supportive/conducive environment at the school level in order to increase the gains from CPD.
- Schools and teachers need to be provided with resources for any effective change at the classroom level to take place.
- There are multiple providers of CPD which are positive efforts but which sometimes duplicate their programs and activities. Thus there is a need for a more coherent approach to CPD.

Overall, the recommendations stated above are consistent with the views of Ling & Mackenzie (2001), Hurd et al. (2007) and Villegas-Reimers (2003). These earlier scholars illuminate the importance of CPD and the increasing centralization of CPD initiatives by

national governments through focusing on specific curricula issues. This trend has in certain instances yielded positive results in contexts where processes have been harmonised especially at the policy level. Yet at the same time, CPD at the school and individual levels is a key feature in the Ugandan case that should be harnessed. In fact, it is at variance with other related contexts in sub-Saharan Africa (see for example, Komba & Nkumbi, 2008, p.74-76). These dimensions could sustain the complementary benefits of locally and externally-initiated Teacher Professional Development programmes for science and mathematics teachers in Ugandan secondary schools.

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