

## Development of Mathematics Teachers: Experience from Tanzania

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**ABSTRACT** This paper highlights the pilot study on Mathematics Teacher Continuous Professional Development (MTCPD) programmes in Tanzania. The paper dwells on teacher professional development initiatives in the country for mathematics teachers by pointing out specific projects whose aims were to improve teacher classroom practices. The development of research instruments was done by the researcher and piloted in Tanzania. Though the findings from the pilot study showed the benefits of MTCPD, there were a number of challenges noted to have been inhibiting their full realisation. It was recommended that adequate funds be provided for running MTCPD programmes. It was also recommended that these programmes be conducted on regular basis and be able to reach all mathematics teachers in the country.

### INTRODUCTION

In Tanzania, mathematics is taught as a compulsory subject at primary and ordinary secondary (O-level) schools levels. The mathematics that is taught at these two levels is known as *basic mathematics*. At advanced level secondary school (A-level), the mathematics programme that is taught is known as *advanced mathematics*. This programme is taught as one of the subjects to the students who are taking mathematics as one of their core courses in their subject combinations. Basic applied mathematics (BAM) is taught to A-level students whose subject combinations do not include mathematics but they need it as support subject.

In 2005, a major revision was done in mathematics and other subjects' syllabi. This revision was geared towards paradigm shift from content-based to competence-based curriculum (MOEC 2005). The focus of the shift was on the activity-based teaching and learning of mathematics, which emphasises active participation by learners rather than passive compliance (Martin 1994; Triadafillidis 1996). According to MOEC (1997, 2005), the main objectives of teaching mathematics are as follows:

- i. To promote the development and application of mathematical skills in interpreting the world and solving problems in daily life;
- ii. To provide pupils with mathematical tools and logical thinking, which they can ap-

ply in understanding other subjects better;

- iii. To develop a foundation of mathematical knowledge, techniques and skills for studying mathematics and related subjects at higher levels of education.

The attainment of these goals and successful implementation of this paradigm shift depends on the qualification of teachers and their ability to synchronise different aspects of the mathematics curriculum (MOEC 1997, 2005). Despite these well-articulated objectives of teaching mathematics, students' poor performance has long been a subject of discussion among parents, teachers, educators, political leaders and students, themselves. For many years the failure rate has been dramatically high in this subject. This is evident, for example, in the low scores of students' Certificate of Secondary Education Examination (CSEE) in the Basic Mathematics subject, taken at the end of their fourth year at secondary school. In 2000 and 2001 the pass rates were 28.7 percent and 24.5 percent respectively whereas in 2011 and 2012 the pass rates was about 4 percent for both years. One of the factors that has been said to be contributing to this problem is the quality of teachers. As a result, the government, through the Ministry of Education, has been making efforts to improve the quality of teachers through different professional development initiatives. This is due the fact that teachers at different levels of education, especially at primary school,

secondary school and college tutors are employed with required qualifications, but they have significant problems due to poor preparations they received in college. The majority lack substantial subject matter knowledge, the knowledge of what to teach, and how to teach subject matter more effectively (pedagogy). Before focusing to these initiatives, the paper highlights the common teacher professional development programmes in the country.

### Teacher Professional Development

There are a number of definitions of professional development given by different scholars. According to Fullan (2001), professional development is the sum total of formal and informal learning experiences throughout one's career from pre-service teacher education to retirement. For Loucks-Horsley et al. (1998), professional development means the opportunities offered to educators to develop new knowledge, skills, approaches, and dispositions to improve their effectiveness in classrooms and organisations. For his part, Guskey (2000) considers professional development as those processes and activities designed to enhance professional knowledge, skills and attitudes of educators so that they might in turn improve students' learning. He adds that the process involves learning how to redesign educational structures and cultures.

From these definitions, it can be said that teacher professional development involves all processes and designed activities that enable teachers to acquire knowledge, skills, attitudes and behaviour enhancing their ability to function effectively in their classrooms. The next section highlights a number of professional development initiatives that have been done by the government in collaboration with non-governmental organisations.

To determine the effectiveness professional development programme, Guskey (2000, 2002) developed a five level evaluation model as highlighted here under.

**Level 1: Participant Reaction:** The purpose of this level is to gauge the participants' reactions about information (about the workshop, facilitators, etc.) and basic human needs. More specifically, this level focused on finding out participants' satisfaction about MCPD programmes and their components.

**Level 2: Participant Learning:** The purpose of evaluation at this level is to examine participants' level of attained learning (through simulation, personal reflection, and demonstration).

**Level 3: Organizational Support and Learning:** The purpose of evaluation at this level is to analyse organisational support for skills gained in staff development.

**Level 4: Participant Use of New Knowledge and Skills:** The purpose of evaluation at this level is to determine whether participants are using what they learned and using it well.

**Level 5: Student Learning Outcomes:** The purpose of evaluation at this level is to analyse the correlating student learning and objectives.

The emphasis on teacher education as a critical determinant of the quality of education is very much in keeping with the government's policy on prioritising basic education in its Education Sector Development Programme (ESDP) (URT 2001). In its appraisal document, ESDP recognises that teaching, like other professions, is in a constant state of renewal and that initial, induction and in-service are different phases of the same generic process, namely teacher education. In teacher education, professional development is divided into two main categories: pre-service teacher training and in-service teacher training.

### Pre-service Programmes

Pre-service teacher training refers to the professional development and preparation that teachers receive prior to entering the classroom and may include undergraduate or graduate coursework in education, coursework in the subject area they intend to teach, experience in the classroom as a student-teacher and certification. The pre-service teacher education programmes are meant to supply well-trained teachers for the entire education system. Access to teacher education is currently open to all secondary school leavers depending on the level they want to train, and provided that they qualify for the programme they want to join (see Table 1).

### In-service Education Programmes

In-service teacher training might include a graduate degree in education or the subject area taught, seminars and workshops, participation in professional organisations and conferences

**Table 1: The current structure of pre-service teacher education programmes in Tanzania**

<i>No</i>	<i>Level of education</i>	<i>Details</i>
1.	<i>Grade A Teachers</i>	These are the teachers who are prepared to teach pre-primary (nursery) and primary school students. Normally, teachers who are eligible to join the training to become Grade A teachers are supposed to be Form Four graduates with at least 28 points, that is, Division IV. The training offered to these teachers lasts for two years with an emphasis on teaching methodologies.
2.	<i>Diploma Teachers</i>	These are the teachers who are prepared to teach in secondary schools, although others teach in primary schools as well. Minimum entry qualification is advanced level secondary school education (Form Six) with at least Division III. The programme lasts for two years, which concentrates on both content and pedagogy.
3.	<i>Degree Teachers</i>	This is the highest level of teacher education programme in the country. Teacher trainees at this level are prepared to teach in secondary schools and teacher education colleges. The minimum entry qualification is at least two principal passes at advanced secondary school level.

and work with a mentor teacher. Teacher participation in the in-service education programmes is a way of supporting teachers to grow professionally. Professional inputs for teachers also have a substantial impact on students (United Republic of Tanzania [URT] 2001). The need to support them is very imperative in order to enhance the quality of their teaching that will ultimately improve pupils' performance in mathematics. This support can be realised through professional development programmes.

**Professional Development Initiatives**

The government recognises the need for teacher support for mathematics teachers in various ways. Through the then Ministry of Education and Culture (MOEC), local institutions such as the universities, the Tanzania Institute of Education (TIE), and the Mathematics Association of Tanzania (MAT) organised teacher support programmes enabling teachers to receive high quality mathematics education. The purpose was to enhance mathematics teachers' subject matter knowledge and pedagogical knowledge, of which when blended together, we get what is referred to as pedagogical content knowledge (Shulman 1986). Pedagogical content knowledge (PCK) is the knowledge of how to transform subject matter knowledge into something appropriate for a particular group.

Other efforts have established collaborative donor funded projects to receive support in these improvement efforts. Among the projects established in Tanzania were the Science Edu-

cation in Secondary Schools (SESS) project, Science Teacher Improvement Project (STIP) and Teacher Education Assistance in Mathematics and Science (TEAMS) project.

***SESS Project(2000-2004)***

SESS project operated in public secondary schools in 3 out of 26 regions of the country. It operated in 28 O-level government secondary schools (14 old and 14 community in the Coast, Dodoma and Iringa regions. Its goal was to equip deprived schools with textbooks and science and mathematics apparatus, as well as ran in-service education programmes for teachers. Their in-service education model used both the training of the trainers (TOT) and the cluster workshops. The project also involved holding intensive science-training camps for girls and training science and mathematics teachers how to encourage girls to learn about science and mathematics. This came in response to concern that girls often fall behind in their performance in science and mathematics and tend not to opt for science and mathematics when given choice of subject of study.

***STIP Project (1998-2005)***

As for the STIP, though it operated in schools owned by the Christian Social Sciences Council (CSSC), it also served some public and private secondary schools. A total of 117 schools were served by the project. It also supplied books and ran workshops for teachers.

Their workshop approach used a philosophy called Starter Experiment Approach (SEA) which was designed to introduce every new science or mathematics topic or concept using a starter experiment to generate discussion and engage the students. However, no rigorous evaluation had been done to determine its impact in schools.

#### ***TEAMS Project (1996 – 2004)***

The TEAMS project, which was situated at the University of Dar es Salaam (UDSM), had joined hands with other projects such as SES-Sand STIP to support the Ministry of Education's efforts to provide in-service education. The aim was to support mathematics and science teachers enhance their pedagogical content knowledge and skills (PCK and S). The SESS and STIP projects were limited in terms of their coverage. The TEAMS project had done a number of activities in relation to this issue. One of them was to prepare, among others, mathematics teaching materials on different topics contained in both O-level and A-level syllabi to complement, as well as to supplement, the scarce teaching materials available in schools. The project had also been involved in exploring more effective ways to support science and mathematics teachers through in-service education programmes. This had been done through the Collaboration to Support Mathematics Teachers (COSMAT) study. This study explored the potential of school-based peer collaboration in supporting mathematics teachers to enhance their PCK and S. This approach had been chosen due to its potential of ensuring continuous and on the spot support. An evaluation study done by Anderson and Sumra (1995) at one of the secondary schools in Tanzania has shown positive impacts of the approach. Teachers could share ideas on how to handle difficult topics and how to improve classroom practices. These efforts resulted into improvement of learners' achievement. The COSMAT study was committed to explore peer collaboration as part of a professional development programme for mathematics teachers in various schools.

#### ***EQUIP Project (2003 – 2011)***

The projects elaborated earlier on, focused on secondary schools. Moreover, there was one project that was specifically targeting primary

school teachers. The project was known as Education Quality Improvement through Pedagogy (EQUIP) in attaining the expected outcomes. The pedagogy that was advocated by the programme was learner-centred approaches. The project cut across the entire subjects in primary schools, mathematics being one of them. EQUIP was part of Oxfam's Education Programme in Tanzania which focused on the professional development of primary school teachers so as to enhance the quality of their work in the classroom. This project operated in one of the regions in the country called Shinyanga. This region was selected because of its persistent low performance in the Primary School Leaving Examinations (PSLE) and also low participation of girls in education. The project supported 174 primary schools, 2033 teachers and over 117,000 pupils, the majority of whom were girls. Training in LCA was the major area where EQUIP project had made a remarkable impact. District Education Officers (DEOs), school committee members, parents head teachers argued that training in LCA had enhanced teachers' confidence and improved their classroom.

#### **New Professional Development Initiatives**

Department of Mathematics Education (DME) at the University of South Africa (UNISA) has established partnership with some countries, including Tanzania with established professional development programmes. Other countries in Sub Sahara Africa in this endeavor are Swaziland, Botswana, Zimbabwe (Southern Africa); Ghana and Nigeria (In West Africa) and Uganda (East Africa). DME also shares expertise from the best performers in the Organisation for Economic Cooperation and Development (OECD) in the Programme for International Student Assessment (PISA) studies. These countries include the Republic of Korea (South Korea), Singapore, and Poland.

In order to make this collaborative initiative operational, UNISA in collaboration with participating countries prepared project activities that guide project execution. One of the activities is the development research instruments. The instruments were aimed at collecting information about professional development initiatives within the participating countries. The development of instruments was followed by their pilot testing and validation.

**Purpose and Objectives of the Study**

The purpose of the pilot testing of instrument was two-fold. The first was to determine the instruments that need revision. The second was to get some insights about the mathematics teachers’ continued professional development programmes in the participating countries. More specifically, the objectives of this study were as follows:

1. To find out which research instruments need improvement to suit the Tanzanian context.
2. To investigate the types of MTCPD programmes that exist in Tanzania.
3. To find out whether there is a policy that guides MTCPD in Tanzania.
4. To investigate where the support of these programmes (in terms of financial, facilitation, expertise, etc.) come from.
5. To find out who monitors the quality of the programmes offered and what methods are used to monitor.

**METHODOLOGY**

The pilot - testing of instruments involved a number of stakeholders that were involved in mathematics teachers’ professional development programmes. The exercise was guided by the following research questions:

1. Which research instruments need improvement to suit the Tanzania context?
2. What are the types of MTCPD programmes that exist in Tanzania?
3. Is there a policy that guides MTCPD in Tanzania?
4. Where does the support of MTCPD (in terms of financial, facilitation, expertise, etc.) come from?
5. Who monitors the quality of the programmes offered and the methods used to monitor.

The participants of the study were drawn from four regions namely Arusha, Dar es Salaam, Iringa and Mbeya. Purpose sampling was used to select the regions and participants who were involved in the study. Purposive sampling refers to the intentional seeking or selecting of individuals or situations likely to yield a greater understanding of the phenomenon of interest (Krathwohl 1998; Creswell 2002). The intention for choosing the individuals or situations is whether they are “information rich” (Patton 1998). As regards to the selection of the regions, Dar es Salaam was involved because it was the

headquarters of the Ministry of Education where the Ministry officials who could give information about MTCPD could be found. Mbeya region was selected because it was the headquarters of the Southern Highlands Zonal Inspectorate, whereby the Chief Inspector was also a mathematics educator. Therefore, it was thought that his experience could be of paramount importance for this pilot study. Iringa region was involved because it was the researcher’s working station and also is one of the prominent inset centres. The selection of Arusha region was on the reason that besides being one of the prominent INSET centres, one of the national mathematics facilitators, who was a female teacher, was residing there. The participants involved in this pilot study were those who were willing to participate in the study so to improve the instrument as well as giving preliminary insights about the MTCPD programmes in Tanzania. These were mathematics teachers (10 from primary schools and 10 from secondary schools); 8 teachers’ college tutors; 2 Ministry of Education officials, 3 school inspectors, 2 facilitators, and 3 heads of schools. The pilot-testing involved the instruments for district Officials, principals/heads of school; school inspectors, mathematics Teachers, Ministry officials, and facilitators. The instruments not pilot-tested were observation schedule for facilitators and MTCPD provider interview. The reason for not pilot-testing the Observation Schedule was that during the pilot testing of the instruments, there was no proper training, seminar or workshop that involved mathematics teachers. On the part of MTCPD providers’ instrument, the major CPD provider was the Ministry of Education at the same time there was an official Ministry instrument that had been pilot tested. Table 2 shows the list of participants by gender.

**Table 2: List of participants by gender**

<i>Level</i>	<i>Female</i>	<i>Male</i>	<i>Total</i>
Ministry officials	1	1	2
REOs	0	1	1
DEOs	1	0	1
School Inspectors	1	2	3
Heads of School	1	2	3
College Tutors	3	5	8
Secondary School Teachers	4	6	10
Primary School Teachers	7	3	10
Facilitators	1	1	2
<b>Total</b>	<b>19</b>	<b>21</b>	<b>40</b>

## RESULTS AND DISCUSSION

This section presents the results and discussions of the pilot-testing of the instruments. The presentation is done according to the research questions and is divided into two parts. The first part highlights about the results of pilot testing of instruments and the second part dwells on insights about the MTCPD programmes that were carried out in the participating countries, in this case, Tanzania.

### Part 1: Pilot Testing of Instruments

The instruments were pilot-tested to the appropriate respondents and the identified anomalies rectified to fit Tanzania context.

### Part 2: Insights about the MTCPD Programmes Carried out in Tanzania

#### *Continuous Professional Development Programmes in Tanzania*

Findings under this section highlight about the policy guiding CPD programmes, stakeholders' perceptions of MTCPD and the types of programmes in Tanzania.

#### *Policy Guiding CPD Programmes*

Through interviews, officials from the Ministry of Education were asked whether there was a general policy in Continuous Professional Development (CPD) for teachers in general in the country. The two officials from the Ministry who were involved in the study said that there was such a policy, and it is stipulated clearly in the general Educational and Training Policy (ETP) of 1995 and was formulated by the Ministry of Education.

*Teacher professional development constitutes an important element of quality and efficiency in education. Teachers need to be exposed regularly to new methodologies and approaches of teaching consonant with the ever changing environment. The teaching effectiveness of every serving teacher will thus need to be developed through planned and known schedules of in-service training programmes.*

In connection with the vision and mission of CPD in the country, they argued that this was contained in the MOEC (1995: 50), which states that:

*In-service training and retraining shall be compulsory in order to ensure teacher quality and professionalism.*

Also, through interviews with heads of school, school inspectors and questionnaires administered to mathematics teachers, it was revealed that there was no clear policy guiding the provision of MTCPD at school level. One school inspector had this to say about the issue:

*Indeed there are no mathematics teachers continuous professional development programme activities included in the school policy.*

However, the heads of schools claimed that there were aware of the importance of MTCPD.

*We are aware of the importance mathematics teachers' continuous professional development but we do not have school policy that stipulates it.*

Thus if it happens that teachers from their schools are invited to attend any programme, they would normally support them by giving permission or subsistence allowance and pay for other training costs if need be.

#### *Types of MTCPD Programme*

Regarding the types of existing MTCPD programmes in the country that involved mathematics teachers, the Ministry officials argued that the most common ones were refresher training and once off intervention type. They also mentioned the lesson study, adopted from Japan, which is still very new in the country.

Moreover, they gave detailed explanation about the current SESS programme, which they said was the continuation of the former SESS project. Through interviews, the Ministry officials the SESS programme had been streamlined as one of the important units in Secondary School Department in the Ministry of Education. This programme had been working since 2009 towards improve knowledge, skills and attitudes towards science and mathematics. The programme had been involved in the preparation of training materials that were used to train teachers. The training was conducted at national level for preparing national facilitators. These national facilitators were then obliged to train zonal facilitators. Thereafter, the zonal facilitators are responsible for training regional facilitators. Then regional facilitators trained teachers at their respective regions. The implementation framework of INSET for secondary school sci-

ence and mathematics teachers in Tanzania is shown in Figure 1.

The training was conducted in cycles. Cycle I training was done in 2010, whereas Cycle II training was conducted in 2011 and Cycle III was conducted in 2012. Support to teachers through these cycles focused on how to handle challenging or rather difficult topics; how to teach mathematics using learner-centred or competence-based approaches; how to construct quality evaluation instruments such as different test items; and how to guide students to prepare quality project work. Other areas included facilitation skills and improvisation of mathematics teaching materials.

Apart from training teachers, the programme is geared towards training other stakeholders such as heads of school, school inspectors, municipal and district council officials on their responsibilities and obligations in handling and supporting MTCPD programmes.

**Criteria Used to Select the Providers of the MTCPD**

Information was also sought about the criteria that were used for selecting the providers of the MTCPD. According to Ministry of Education Officials, not everybody was suitable for providing MTCPD programme. Thus they set

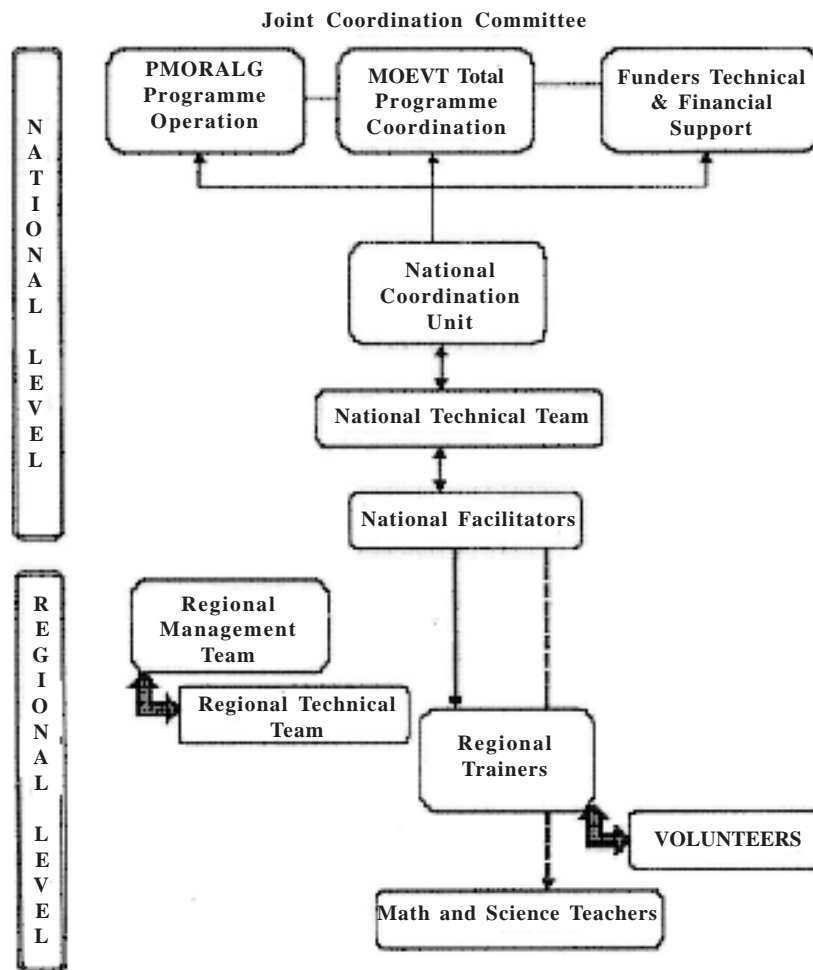


Fig. 1. Implementation framework of INSET for science and math teachers (URT 2014)

criteria that guided in the selections which included the mastery of subject matter; teaching experience; Communication ability skills; and positive interpersonal skills. The final criterion that was taken into consideration was enthusiasm supporting teachers. To be able to support teachers, MTCPD provider must be enthusiastic in the subject. Short of that, he/she might not give desired support to the mathematics teachers. According to the Ministry officials, most of the MTCPD programmes were conducted during holidays and weekends in order to avoid interrupting teaching schedules in schools and colleges.

### *Participation in MTCPD Programmes*

When asked about whether they participated in the MTCPD programmes or not, differences in terms of responses were given by secondary school teachers, college tutors and primary school teachers. For secondary school teachers, all who were involved in the study said that they got opportunity to participate in these programmes only once. For primary school teachers and college tutors, the situation is a bit different (see Table 3).

**Table 3: Participation in MCPD programmes by institutional level**

<i>Level</i>	<i>Participated</i>	<i>Not Participated</i>	<i>Total</i>
Primary schools	2	8	10
Secondary schools	9	1	10
Teachers colleges	2	6	8
Total	13	15	28

Table 3 shows that the number of those who participated in MTCPD was higher among secondary school teachers than among college tutors and primary school teachers. For instance, those who did not participate had been in the teaching profession for more than twenty years.

Most of the participants, especially from secondary schools mentioned Ministry of Education as the most prominent service provider in collaboration with the development partners (especially, JICA). Other organisations that had been mentioned to be conducting seminars for mathematics teachers were the Professional Teachers Association of Tanzania or 'Chama Cha

Kitaalaam cha Walimu Tanzania (CHAKIWATA)' and Tanzania Teachers' Association "Chama Cha Walimu Tanzania" (CWT). The Mathematical Association of Tanzania (MAT/ CHAHITA), in particular, had been supplementing efforts made by Ministry of Education in raising competence among mathematics teachers. It has been conducting annual seminars for its members as well as interested teachers. The lecturers from University Departments of mathematics have been offering support, mainly on topics which teachers found difficult to teach.

All participants who indicated that they had participated in the MTCPD programmes said that the activities were very relevant to their classroom practices. On emphasising about this matter, one secondary school teacher argued that it would have been very difficult for him, for example, to handle learner-centred approach without having the opportunity to gain insight about the new syllabus.

*Before attending the training on the LCA, I used to believe that I was the only sole source of knowledge when it comes to teaching and learning of mathematics in the classroom. Pupils have to take what I teach them. Now I agree that pupils also know a lot about what we teach them. Let us give them opportunity to show us their potential. This is the essence of learner-centred approach.*

Another secondary school teacher had this to say about the influence of MCPD in his professional practice:

*The programme had made me able to carry out mathematics lessons under problem solving approach. Also through this programme I'm able to assess appropriate mathematics books and teaching materials which can make a lesson meaningful to the students.*

Yet another secondary school teacher had this to say about how the programme improved her skills and knowledge on teaching the subject (mathematics) and the change of attitude towards teaching profession.

*It has improved my knowledge and skills about the subject. It has also changed my attitude and behaviour about the professional.*

Most of the teachers, who participated in the MTCPD programmes, were aware of the objectives of the programme because these were clearly stipulated in their invitation letters.

The results from this section concur with the results by Fernandez (2005), Hill and Ball (2004),



Horn (2005), Lewis et al. (2009), and Remillard and Bryans (2004) which indicate that teachers can develop their mathematical content knowledge in a number of different ways, including solving and discussing mathematics problems, studying students' mathematical thinking, collaborating with other teachers to plan or discuss instruction, analyzing instances of classroom practice, and using new curricular materials).

### **Support of MTCDP Programmes for Mathematics Teachers**

Support for mathematics teachers to facilitate the implementation of MTCDP programmes came from different sources depending on the level at which the implementation was done. At national level, the support came from the Ministry of Education and development partners (donors). The development partners include Japan International Cooperation Agency (JICA) and the World Bank. At regional or district levels, the support came from municipal or district councils. At school level, the support came from school management. The support that participants received from these sources included finance, such as, living allowances and busfare; permission to attend the programmes and training materials.

However, teachers claimed that the support they were receiving was not adequate. They cited the example of living allowances provided that could not suffice to settle their accommodation charges. Thus, they had to top up the difference from their own pockets.

In connection with the support for MTCDP for mathematics teachers, schools inspectors who claimed that they contributed in improving teachers' pedagogical content knowledge, especially in the area of competence-based teaching. One of them had this to say about the matter:

*Currently, in my position as a school inspector specialized in science and mathematics subjects with a small team of inspectors we have visited over 134 secondary schools and facilitated over 867 teachers among other academic issues, the pedagogy on competence-based teaching and learning in various subjects including mathematics. We have been doing these facilitations upon request from the individual schools and we hope more schools will register their requests on these facilitations.*

*Specifically, on MCDP we haven't done yet.*

### **Strengths and Weaknesses of the MTCDP Programmes**

#### **Strengths**

Participants highlighted some strength of the MTCDP programmes. One secondary school teacher was specifically impressed with the way the programmes were organized:

*The programmes were excellently organized and the chosen components were well selected (skills for teaching mathematics under problem solving approach) was very important to be achieved by the teachers.*

Other teachers underlined a number of issues that they perceived as strengths of the programmes. Some said that the programmes addressed areas that teachers could not handle appropriately during teaching. They also added that their confidence in teaching was enhanced. Others argued that the programme they attended helped to inculcate a collaborative working relationship between teachers from different parts of the country, which ultimately established teacher networks where sharing of ideas was made easy.

Some issues that teachers raised in this area actually concurred with the results of studies elsewhere, especially in the aspect of teacher collaboration. One way that professional development can support teachers' ongoing learning is by catalysing changes in collegial relationships and structures for collegial work. Recent research has pointed to the value of collaboration for the learning of teachers (NCTM 2010). Collaboration with colleagues can spark the need for teachers to explain their practices and to articulate rationales for instructional decisions, helping teachers make tacit ideas visible and subject to shared scrutiny and develop deeper, more widely shared understandings of students' learning (Chazan et al. 1998; Horn 2005; Kazemi and Franke 2004).

#### **Weaknesses**

Besides the strengths, the participants revealed a number of weaknesses that were associated with the MTCDP programmes. One of the weaknesses that came out vividly was lack of

funds to support programmes at school level. Inadequate preparation of the programmes was also spotted by a number of participants, which they said affected their effectiveness. In addition, lack of follow up and on-the-spot support during implementation of the programme ideas in the classroom was noted by four secondary schools who were interviewed. Participants' reactions on how the programme is organised and conducted is of paramount importance to its success. Guskey (2000, 2002) argues that measuring participants' initial satisfaction with the experience provides information that can help improve the design and delivery of programmes or activities in valid ways. He adds that positive reactions from the participants are usually necessary prerequisites to higher level evaluation results. MTCPD organisers and providers need to take this caution seriously for their effectiveness and success.

### **Strategies to Sustain the Programme in Schools**

According to the Ministry of Education officials, one of the strategies that they use to ensure the sustainability of programmes in schools is to sensitise the heads of schools about the importance of the MTCPD for the quality of education offered at their schools. Another strategy that was mentioned by the officials was to sensitise district councils to see that this is one of their obligations as all the public primary and secondary schools are under their mandate.

### **Monitoring and Evaluation of the Quality of the Programmes**

#### ***Monitoring of MTCPD Providers***

In responding to the question regarding the monitoring of MTCPD providers, the Ministry officials argued that this was done at different levels. During the training of national facilitators, the Ministry officials would be there to see that the training was done appropriately, whereby they would write reports on how the training went. When the national facilitators are sent to the zones to train regional facilitators, then lecturers from various Universities were asked to follow them up so as to monitor how the training was conducted. Eventually, when the regional trainers go to train in their respective regions, zone facilitators would be following up how activities were going on and wrote reports.

### ***Evaluation of MTCPD providers***

Ministry of Education officials contended that Evaluation of MTCPD providers is done from national to classroom levels. Though they admitted that a more rigorous evaluation is done at national and zone levels. They argued that evaluation model that was followed was adopted from Guskey (2000, 2002).

In terms of evaluation of participants after attending the programmes, they were mixed responses. Five secondary school teachers said that they were evaluated at school level by JICA in collaboration with school inspectors. The aim of the evaluation was to find out if the support they (JICA) had been offering had impact in the classroom situation. The two primary school teachers and two college tutors said no such evaluation was done to them after attending the programmes.

### **Challenges Facing Implementation of MTCPD Programmes**

Challenges that face MTCPD programmes implementation are manifold, depending on the level at which the implementation is done. At national level, according to officials from the Ministry of Education, the critical challenges were inability to access all mathematics teachers and lack of funds to run regular MTCPD programme throughout the country.

At district and regional levels, the major challenge is lack of funds to run MTCPD on a regular basis. One Regional Education Officer argued that:

*We are depending entirely on the Ministry of Education to run the programmes.*

Regarding the same issues, one District Education Officer claimed that although the responsibility of running schools is under the District and Municipal councils, but very little or no money at all was set aside for running MTCPD, especially for primary school teachers.

At school level, the major challenge, like other levels is lack of funds. Many schools lack funds to support the programme. One head of school argued that parents were supposed to make contributions to support these initiatives but because of poverty, most of them could not afford to do so.

### CONCLUSION

Findings from the pilot study show that teachers appreciated the importance of MTCDP regarding the benefits they acquired. However, there were a number of challenges that were noted to have been inhibiting the full realisation of the benefits. The findings realised a need for all stakeholders to join hands to overcome these challenges so as enable teachers benefit fully from MTCPD for ultimate improvement of mathematics education.

### RECOMMENDATIONS

In this pilot study, it had been found out that teachers who were in the MTCPD programmes appreciated and benefited from them. The programmes had helped them to enhance both content and pedagogical knowledge. Full realization of these benefits could be achieved by seriously addressing the challenges that had been highlighted, such as inability to address all mathematics in the country due lack of funds. This study, therefore, recommends that the government should set aside adequate funds that can be used for running MTCPD programmes on regular basis, so as to reach all mathematics teachers at all level throughout the country for quality. It is also recommended that a rigorous study regarding the impact of MTCPD programmes should be carried out, especially, a comparative study between rural and urban areas.

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