

Comparative Study on Structural Organisation of Mathematics Continuous Professional Development (MCPD) in Selected Developing and Developed Countries

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ABSTRACT This paper reports on a comparative study on Mathematics Continuous Professional Development (MCPD) programs piloted in selected developed and developing countries. The study sought to examine the status of existing professional development practice and the challenges practitioners experience in the implementation of such programs in these countries. The study was piloted in eleven countries namely, South Africa, Botswana, Namibia, Singapore, Zimbabwe, Swaziland, Poland, South Korea, Ireland, Morocco and Tanzania. The participants in each country were teachers, principals, subject advisors, district officials, provincial officials, service providers and facilitators. Data were collected by means of questionnaires for the teachers, interviews for other participants and observations for the facilitators. Data were then analyzed and compared using qualitative methods. The findings of the organizational structures operating in various countries that took part in this study indicated that, teachers were exposed to different professional development programs ranging from lesson reflections in South Korea and Singapore to at least cluster workshops in developing countries.

INTRODUCTION

Saed (2014) in their study on continuing professional development (CPD) for Science and Mathematics suggested that the design of the CPD program is not based on a single one shot design, rather it includes activities that are rich in content and creative in nature, fun, their implementation is simple and require short time, and the place of their implementation is convenient, organized, clean, and includes the needed materials and resources. This paper specifically presents the experiences during the pilot study of the project on analyses of mathematics continuous professional development (MCPD) programs in selected developed and developing countries carried out in June of 2013. The study sought to examine the status of existing professional development practices and the challenges practitioners experience in the implementation of such programs. The practitioners included teachers, principals, subject advisors, district officials, Ministries, service providers and the facilitators in the various countries. The study was piloted in eleven countries namely, South Africa, Botswana, Namibia, Singapore, Zimbabwe, Swaziland, Poland, South Korea, Ireland, Morocco, and Tanzania. The background of the existing MCPD's of the different coun-

tries will be outlined, citing similarities, differences, resource powers and the models implemented in the selected countries. The project is as a result of the Department of Mathematics Education (DME) at the University of South Africa (UNISA) embarking on engaging on voluntary basis research partners from developed and developing countries to address the challenges of improving the quality of teacher education in the country.

Pre-service teachers are trained and prepared to teach over a varying number of years ranging from a four year university degree in South Africa and many other countries to two years of compulsory training in-service training in countries like South Korea. For teacher professionals to continue functioning efficiently and productively and contribute meaningfully towards quality education, they must be given training opportunities to keep them up-to-date and, hence, be able to face new professional, curriculum changes, and global society challenges. Research suggests that professional development that is closely linked to improved student learning deepens teachers' understanding of subject matter content and how to teach it (Cohen and Hill 2000; Kennedy 1999). Kennedy (1999: 25) further points out that "programs that focus on subject-matter knowledge and on student learn-

ing of particular subject matter are likely to have larger positive effects on student learning than are programs that focus mainly on teaching behaviours". In mathematics education, teacher professional development is an indispensable aspect in human resource management and development. Cohen and Hill (2000) paid attention to the conditions that help teachers to apply their professional development learning to their practice, including direct links to their curriculum, time to practice with their colleagues, and on-going support. Consequently, they suggested that of most importance professional development must (i) develop teachers' content and pedagogical content knowledge and skills (ii) fit into the context in which they operate and (iii) pay attention to building capacity and teacher leadership to sustain new practices (Ball and Cohen 1999). This view has been adopted in many countries and teachers have been exposed in various professional development programs aimed at equipping teachers with skills for deepening teachers' pedagogical knowledge and career progression.

METHODOLOGY

For the purposes of this paper the pilot study was cross-national and comparative, since the teams set out to examine the mathematics continuous professional development (MCPD) phenomena in their eleven different countries. The intention of comparing their MCPD's was done using the same research instruments to learn from exemplary practices of mathematics teacher development programmes in use (from countries in the sample) in efforts to improve mathematics teacher development programmes in some countries, share and learn from practices employed in advanced countries. The aim is to seek explanations for similarities and differences, to generalise from them or to gain a greater awareness and a deeper understanding of social reality in different national contexts.

Porter et al. (2003) proposed that the characteristics of high quality professional development is informed by structural features of the organisation namely: (i) the form or organisation of the activity, (ii) the duration of the activity and (iii) the degree to which the organisation emphasizes the collective participation of groups of teachers from the same school, department or grade, as opposed to the participation of teach-

ers from many schools. They further assert that the form of the activity type depends on the reform type such as a study group, teacher network, mentoring relationship, committee or task force, internship, individual research project, teacher research centre in contrast to traditional workshops and conferences. The duration usually involves the total number of contact hours that participants spend in the activity including the span of time during which the activity takes place. To give a full structure of the organisation it will be also important to look at (i) the content focus of the activity, (ii) the extent to which the activity offers opportunities for teachers to be actively engaged to meaningful analysis of teaching and learning and (iii) the degree to which the activity provides coherence between teachers' MCPD and other experiences. In an endeavour to overcome the major problem in comparative research where the data sets in the different countries do not use the same categories, structural features in this theory will be used. The three structural features and the latter mentioned core features are viewed in this paper as the main features that would influence effective professional development in changing teacher practice and enhancing teacher knowledge and skills of teaching mathematics in the Sub-Saharan countries. This paper presents a comparative report on the structural organisation of MCPD's based on similarities, differences power sources and MCPD models implemented in the selected countries.

OBSERVATIONS AND DISCUSSION

Historical Perspective

Most African selected countries have suffered political and social controversies due to the previous incorporation of language and race issues in their education systems. The late Julius Nyerere (an education icon of the philosophy and policy of *Education-Education for Self-Reliance*—in Tanzania) once said that any educational policy needs well-trained professional cadres who are continually updated for it to succeed (Nyerere 1988). In Tanzania, the abolition of the East African Slave Trade in the 1860s marked a new beginning in the teacher education sector in the Western Education sense and the missionaries were the first architects to play a facilitator role in the history of the develop-

ment of teacher professional education (Anangisye 2009). During this period, freed or ex-slaves were the first potential teacher trainees on East African soil to undertake a teacher education and training course. Gradually teacher training in Tanzania was not only the sole responsibility of the state, but a responsibility of the University of East Africa (UEA), an Inter-Territorial University. Eventually all universities in Tanzania, private and public have introduced and strengthened teacher education programmes through government directive.

Certainly, this is the case with several different African countries on the continent especially in the sub-Saharan region. In South Africa many colleges for training black teachers were built with little national planning, quality assurance or accountability (Department of Basic Education and Higher Education and Training (DBEHET 2011). Subsequently, while colleges for black teacher education continued to mushroom all over South Africa, the training of white teachers in the colleges was being phased out in favour of a more structured and progressive university teaching qualification (Parker 2003).

Zimbabwe experienced teaching learners under trees and in farm sheds, importation of teachers, fast-tracking local training of teachers, higher level learners teaching lower level learners, when education was declared as a human right, compulsory and free after implementation of curricular changes resulting in education for all individuals after the post-colonial era of the 1980's (UNESCO Report). These similar teaching environments and conditions are currently experienced in some remote areas of South Africa. In the beginning of the 21st century, Zimbabwe acknowledged the effects of ICT tools and media which were incorporated and applied in education in general and in mathematics instruction and learning. This was undone by the drop down of socio-economic factors which affected not only the country but education as well. Recuperation from this situation entails rebuilding the education system and re-affirming the use of ICT and media resources in the teaching and learning of mathematics in the post 2010 era.

Just like South Africa, Namibia verged from the Bantu Education background that was characterized by segregation, racism, colonialism and apartheid. Reforms in teacher education in-

troducted include learner centred teaching, goal embodying accessibility, quality, equity and democracy. The Namibian education system embarked on multi-grade teaching to address the challenge of the teacher/learner ratio which was lower per grade than expected in the sparsely populated and remote areas in the 1990's (Ngololo 2012). Multi-grade teaching is a term used to describe the teaching in primary education of children from a number of grades usually in one class. Teachers and learners in this faced problems in learning and teaching mathematics in spite of financial and human inputs that the nation had engaged in improving the Mathematics performance in Namibia (Nambira et al. 2009). Poor performance in mathematics was associated with teachers' competencies in mastering the curriculum content, miss allocation of subjects to teachers in the phases as a result of shortage of Mathematics teachers, availability of teaching materials, methods of presentation, learning environment, lesson preparation, gender, and motivation to learn (Ngololo 2012). The CPD programmes developed after 2009 were therefore geared to train teachers on multi-grade teaching with regard to teaching approaches, for example, subject grouping, subject staggering and integrated day which teachers did not use during classroom visits and how to assess learners in multi-grade settings. This necessitated that teachers enrol for higher degrees in mathematics education so as to be adequately equipped with relevant content knowledge and skills required to close the knowledge gap between rural and urban school mathematics teaching.

In the research literature, the professional development of teachers in Swaziland is typically divided into three stages: (i) pre-service or initial teacher training, (ii) induction, and finally (iii) in-service teacher training (OECD 2005). CPD of teaching spending is channelled into pre-service teacher training with very little left for the induction of newly qualified teachers or for in-service training. The in-service of secondary mathematics teachers is provided by the in-service department of the University of Swaziland (UNISWA) also responsible for teacher upgrades in qualifications. Working with other professionals in providing MCPD is one of the department's objectives.

Botswana, a small developing state in Southern Africa, recalled lack of a grounded education in the early 1970s. Partly contributing to the

low quality of teacher development was Botswana's almost total dependence on another country (Britain) for its national revenue. By 2004, Botswana recorded a surplus of trained teachers to the extent that the hiring of graduates into the teaching service was no longer automatic (The Botswana Guardian, Staff Reporter 2004). In Botswana, more than the political and economic circumstances (Harber and Davies 2001) talked about, work ethics is, arguably, the biggest impediment to innovation implementation. Botswana has since early 2000 changed its reliance on the Cambridge Overseas School Certificate examination system to a locally based Botswana General Certificate of Secondary Education examination (Moswela 2006). Teacher professional development and school effectiveness had to be connected. That is, as teachers improve their teaching skills and methodologies, students' standards of achievement are also raised, and this has an impact on school improvement.

New education laws were passed in Poland which called for the "autonomy of schools as societies of students, teachers, and parents" granting schools final responsibility for instructional content and methods in 1991 (Glenn and Curtis 1992). The implementation of these new laws after 2000 required that all Polish teachers should (i) have a higher education qualification in order to teach in any Polish school, (ii) undergo continuous professional development, (iii) be competent to teach two subjects, (iv) be computer literate and (v) have a good command of a foreign language. Currently, professional development is reported to be taken by over 90% of teachers and has also informed salary increase based on qualifications and professional development for teachers.

In Singapore, the National Institute of Education (NIE) has been providing training to teachers for the past 50 years. A good education system depends on high-quality teachers who constantly seek to improve their practice, supported by school leaders and administrators, and resources from departments and agencies within Minister of Education (MOE 2009) Singapore. The ministry of education in this country therefore identified a need to build capacity for teachers themselves to take the lead in professional upgrading. All schools in Singapore are Professional Learning Communities. School Staff Developer (SSD) is a position created in every

school to facilitate professional development in all schools.

A new secondary mathematics curriculum called Project Maths was rolled out in Ireland in 2010. Significant changes in mathematics content as well as a focus on new active learning methodologies and the use of ICT were included in the new curriculum. A long tradition for teachers to be highly regarded exists within the Korean society with emphasis on loyalty to a nation, education by teacher, and devotion to each one's family. Teacher quality is therefore a very strong variable in the Korean educational society (Park 2004). This can be assumed as the main reasons why Korean students fare so well in international comparative studies as TIMMS, TIMMS-R or PISA (Park 2004). Contradictory, MOE introduced a policy on advanced mathematics education (MEST 2012) despite high grade ranks observed at international mathematics tests. This is because Korean students displayed a low interest, value and confidence in mathematics (Mullis et al. 2012). This was put in place to do away with traditional teaching ways, such as memorizing and solving problems without understanding of mathematical concepts. Various programs and policies were put in place to improve the quality and capability of teachers and provided various incentives such as a sabbatical year and a master teacher (Cho and Choe 2012).

Morocco recorded national prioritization of CPD programs to improve Education quality, with the mission to strengthen teachers' professional skills dating from 2001. It therefore boasts of several initiatives taken by the ministry of education in putting in place innovative and ambitious programs like Project TVI introduced in 2001, engaging on Distance Education by interactive technologies, for in-service training of primary school teachers (El Fellahi 2008). Others include GENIE for the generalization of ICTs in Education (Kabbaj et al. 2009), and the emergency program introduced later in 2012 to help develop the Secondary school teachers. This CPD program is supported by the European Union, UNESCO, USAID, and IOF (International Organization of Francophonie) as defined by the Emergency Program.

Professional Development Service for Teachers (PDST) in Ireland was established in 1990's and has grown to include support services established to address a variety of needs such as

school leadership and development planning, curriculum change, education programmes and other areas of teaching and learning. These developed in 2008 to include Project Maths Development Team (PMDT), a ground-breaking curriculum development initiative in post-primary Mathematics scheduled to run from 2008 to at least 2013. Other programs include Special Education Support Service (SESS), the project mathematics team (PMT), teacher professional network scheme and others. Continuing Professional Development for Primary and Post-Primary Teachers provided by Third Level Institutions all around the country. These programs addressed the advancement of teachers' pedagogic and management skills in the context of the work of the primary and/or post-primary school. This project sees the incremental development of revised syllabuses in Junior and Leaving Certificate Mathematics alongside a significant programme of teacher professional development. Syllabus revision is informed by classroom experience and changes in assessment are aligned with and underpin changes in syllabuses.

The background of CPD's in some of the underdeveloped countries is not well defined. It ranges from training teacher training workshops provided for redressing gaps in teachers' knowledge and skills. This is not the case in developed countries since teacher professional development dates back to five decades ago. Below the researcher discusses the structures of these CPD's in detail.

The Structural Features of the Organisation

In most of the selected countries, the form of the professional development is presented as in-service education or training is to increase or improve capabilities of already qualified teaching personnel. The following are illustrations of these forms as administered in each of the countries participating in the study. For each country the form will be outlined together with the activities involved and the duration of the CPD's. South Africa, Botswana, Swaziland, Tanzania and Zimbabwe share the same CPD structures in terms of the form of the activities, and the degree to which the organisation emphasizes the collective participation of groups of teachers from the same school. Below these similarities and differences in CPD formats are present-

ed. A common feature exists in all these countries where CPD's are conducted in the form of teacher workshops in clusters organised by the ministry in each country. Some CPD activities have also been identified to be the same with little emphasis on introducing teachers to ICT. CPD's in Morocco, South Korea, Singapore, Ireland and Poland advocated exposure of their pre-service and in-service teachers to ICT applications in their classroom practice. Online courses in these countries are available and are used for continuous professional development of teachers. On the contrary, Namibia registers no formal CPD programs that exist so far except sporadic CPD trainings have been carried out in the country to enhance the teaching and learning of Mathematics.

In Zimbabwe, teacher professional development undertook the form of (i) Progression to a higher qualification (for example, diploma '! bachelors '! masters); (ii) Short (relevant) courses (acknowledged by some kind of certification); (iii) Workshops (with recognition of some sort for participation); (iv) Mentorships (acknowledging transfer of expertise is considered desirable); and (v) Conferences/seminars (more for personal enrichment but with rub-off effects into practice (Mtethwa et al. 2013). CPD providers are brought in by the Ministry of Education and in general it is the Ministry that monitors and evaluates them. The duration of these CPD range from a 3 days to three years and more depending on the kind of development anticipated.

Provision of teacher education programmes in Tanzania is the responsibility the Ministry of Education and Vocational Training (MOEVT). Teachers are brought from their regions to one centre to be trained by university lecturers from Tanzania Institute of Education (TIE), in collaboration with non-governmental organisations such as the Mathematics Association of Tanzania (MAT) and many others together with the Ministry of Education officials. The pattern is such that lecturers and officials are sent to train teachers in their respective zones or regions. These CPD's take the form of teacher support programmes enabling teachers to receive high quality mathematics education. The goals include equipping deprived schools with textbooks, science and mathematics apparatus, as well as in-service education programmes for teachers. Their in-service education model used both the training of the trainers (TOT) and the cluster work-

shops, from which an internal evaluation after the first phase revealed many achievements but also a number of problems (Osaki 2002). In Tanzania, teachers and the teaching profession have low status today than during the colonial days and up to a few years after independence. Secondly, the generality of teaching view, second choosers view, and undesirable working and living conditions accounted for the low status of teachers and the teaching profession. In conclusion, the status of teachers and the teaching profession is measured in terms of economic gains which have implications for social gains. Hence, the revival of the lost glory lies in the hands of the Government of Tanzania and, partners or stakeholders in the teaching sector (Anangisye 2009).

The in-service of secondary mathematics teachers is provided by the in-service department of the University of Swaziland (UNISWA). The in-service department often works with the inspectors in organising workshops for teachers. Working with other professionals in providing MCPD is one of the department's objectives to provide teachers with regional and national workshops, material's development, and school visits. Teachers organise their own workshops in clusters where in-service officials attend these cluster workshops as consultants in the subject. The workshops address curriculum innovations and pedagogy and are held approximately once in three months and usually short taking about half a working day.

Policies have been adapted from Singapore and Malaysia by the Ministry of Education, Skills and Development (MOeSD) in Botswana. The country enjoys an oversupply of qualified teachers. The ministry through the Department of Teacher Training and Development is committed to providing world class quality and accessible education and training. The resulting values would be Botho, Thuto, consultation, transparency, quality services, team work, creativity and innovativeness. MCPD is supported by the Department of Teacher Training and Development which is responsible for the development and implementation of MCPD programmes at primary and secondary education. The department implements its programmes through the Department of Mathematics and Science Education at the University of Botswana for secondary schools and through education officers in the country-wide education cen-

tres. CPD programmes have organisational deficiencies and still need to urge the teachers to take ownership of professional development. Teachers have good content knowledge and do not understand that they have to improve their pedagogical knowledge so there is a need to change the mind set for teachers. The main problem lies with the monitoring and implementation of CPD programs. Teachers need to be attracted to attend the workshops.

Teacher professional development in Botswana is conducted in the form of teacher school based workshops and cluster-based workshops by whoever has the knowledge and skill in a particular content area (Moswele 2006). This has led to the development of the 2010 National Policy Framework on In-service Teacher Training whose mandate was to coordinate in-service provision as an effort to provide a common approach for all CPD providers. The activities of the programmes include among others, facilitation in the development of teaching and learning materials, and supporting teachers to implement the new curricular. These CPD are provided by colleagues in the same school and by the outside funders, the TTandD principal education officers for primary and junior secondary schools and the DMSE-INSET for senior secondary schools in the form where the teachers enjoy free exchange of ideas amongst themselves using available resources was opted for in this country. Professional development in this country sometimes affords teachers promotion based on a performance system. The major challenges that face the MCPD are the availability of human resources in monitoring and evaluation of the programmes.

Some forms of CPD's in South Africa included the Dinaledi schools, National Curriculum Statement (NCS) and CAPS training, district or sub-district or school-based workshops and in-service or ETDP seta (skills development) training. The activities include provision of learning support materials and the unpacking of challenging topics, acquisition of content knowledge, pedagogical content knowledge and skills to present (interpret and/or implement) the curriculum. The participation in MCPD programmes influenced teachers' practice in terms of motivation as well as the quality of skills and knowledge and uplifting their confidence in the teaching and learning of mathematics. MCPD programmes were identified as their ability to em-

power teachers with new approaches in teaching and learning and provide them with the confidence to teach the content. The shortage or lack of resources was cited as the weakness of the implementation of MCPD programmes. Improvement of teaching skills and learners' performance were highlighted by teachers as successes in their classroom practice after attendance of or involvement in CPD's. The Department of Education, the school, non-governmental organisations and individuals served as the source of financial support for their MCPD. Although some of the workshops were conducted by higher institution of learning they also reported challenges with regard to the shortage of facilitators, hence they often opted for the services of expert teachers. Basically these MCPD'S are targeted at capacitating novice teachers and under-qualified teachers to proficiency. They also registered concern around the availability of time to train teachers and absence of the evaluative mechanisms to measure the effectiveness of the MCPD offered. This was observed as most of their responses revolved around the government initiated evaluative system called Integrated Quality Management System (IQMS). This is a tool used by the government to measure teacher performance and progression although teachers in the study have doubts about the effectiveness of the instrument, due to its monetary incentive.

In South Africa, the cascade model has also been criticized (Khulisa 1999; HSRC 2000; Graven 2004) because of its inadequacy to deliver effective training of teachers where the misinterpretation of the information in the process of transmitting to the next level was in previous studies done in the country (Fiske and Ladd 2004; Ono and Ferreira 2010). Teachers in this country described CPD's as a guiding, empowerment, enrichment, enhancement and development tools of content knowledge and teaching that helps to close existing gaps in the content knowledge and teaching practices. As a description in terms of what CPD would do to/for them, teachers identified collaboration with other professionals as reflective of CPD.

Since 2010 the University of Namibia has been the sole provider of teacher preparation in the country by decision of Cabinet of the Republic of Namibia. The preparation of teachers includes integration of content and teaching strategies, with specific emphasis on learner-

centred teaching. Most of the teachers receive this support from the Ministry of Education through its advisory service and through this they upgrade their qualifications. Moreover there has not been a unit specifically set for Continuous Professional Development for teachers in the country. The Continuous Professional Development (CPD) of teachers is relatively a new concept in the Namibian context. The newly established CPD Unit at the University of Namibia (UNAM, CPD 2013) is an attempt to bridge this gap in the provision of CPD courses and skill upgrading of the Namibian teachers in all school subjects. Starting in 2013 the Ministry of Education has established the Continuous Professional Development Unit within its ministerial structure. The schools were also tasked to establish Continuous Professional Development committees at their schools to spearhead the provision of teaching skills and content to the serving teachers.

Professional development in Singapore, provide teachers with an update in knowledge and skills, where they pursue certification, and are financially supported by Ministry of Education. There is also The Professional Development Continuum Model (PDCM) where teachers study at their own pace using building block approach and this also leads to certification of Advanced Diploma, Advanced Postgraduate Diploma and Masters in education (Fig. 1).

There is further professional development for Learning Support for mathematics LSM teachers which exposes teachers to various courses like activity based lessons for low ability pupils in the primary mathematics schools, developing quality lesson studies, enhancing deeper understanding of some mathematics topics like calculus, improving classroom practices and systems through action research, leveraging technology to make thinking visible, enhancing social and emotional competences of teachers and others. Teachers are entitled to 100 hours of professional development per year. The model used understands teachers as learners, observers of learning and as reflective practitioners. This involves teachers studying learning in action and doing mathematics. Mathematics Teacher Preparation and Professional Development in Singapore is a process where mind sets are changed, knowledge is constructed, and the capacity to learn is enhanced. There are three main roles for teacher professional development

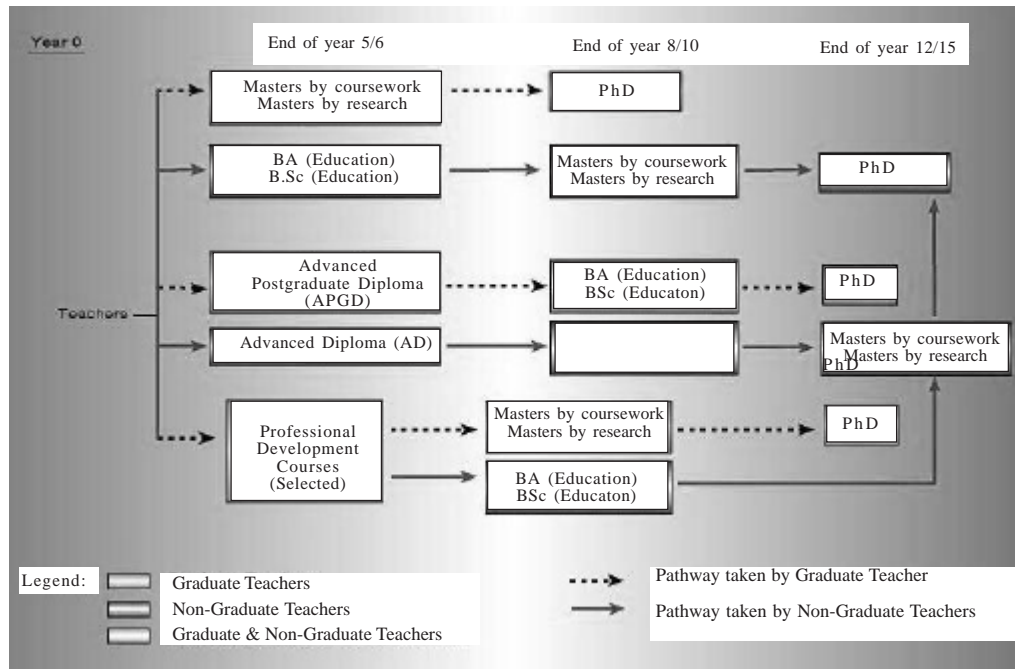


Fig. 1. The Professional Development Continuum Model (PDCM)

in Singapore: (i) changing teachers' Mindset for implementing new initiatives, (ii) helping teachers to construct knowledge instead of receiving it and (iii) enhancing learning capacity for teachers to be life-long learners. The main goal of professional development in this country, therefore, is to enhance teachers' capacity to learn. There are many differences in the Singapore system that other countries cannot emulate. These include the fact that (i) Singapore is a small country with only 300 schools, (ii) All Singaporean pre-service teachers attend Singapore's only teacher training institution, the National Institute of Education (NIE), (iii) Almost all teachers in Singapore are trained in NIE with all budget funding provided directly from the Ministry of Education, (iv) Teachers are provided with pre-service training, professional development, school leadership preparation and educational research in the institute, (v) Teacher trainees are employed by the ministry of education and are fully sponsored in a model that involves work and training together at the same time (Ban Har 2013).

Like Singapore, Ireland ran CPD programmes for teachers by mentoring in 24 pilot schools

and will include its first conference: Maths Counts in November of 2013 to promote collaboration and lesson Study across the country. (www.projectmaths.ie, www.ncca.ie). Practising teachers were equipped with content and pedagogical knowledge and the technological skills required in workshops to teach new curriculum through the National Council for Curriculum and Assessment (NCCA). All Project Maths related CPD programmes are funded by the Department of Education and Skills (DES), and run by the NCCA. Independent of the NCCA, the National Centre for Excellence in Mathematics and Science Teaching and Learning (NCE-MSTL), HEIs throughout Ireland, and other privately funded education organisations have offered their own programmes to support teachers with the new curriculum. These consist of evening sessions for teachers, online workshops and materials for teachers and summer courses. (www.nce-mstl.ie). While there is some level of collaboration with the Higher Education Institutions (HEIs) throughout Ireland, these workshops are typically run independent of any HEI, in Education Centres across the country. They are facilitated by a team of Regional and Local Facilitators who

are required to be practising mathematics teachers with a school affiliation. University staff or members of other education organisations are not permitted to be facilitators (www.ateci.ie).

In South Korea, many universities also offer extra programs to develop teaching competencies of pre-service teachers such as teaching workshops, competitive exhibition of teaching, mentoring for students, teaching behaviour analysis lab, teaching clinics, special lectures on leadership development, peer tutor system, debating contest on educational issues, competitive exhibition of lesson plans, lectures on teaching, etc. (Kim et al. 2010). Prof Hee Chan Lew reported that all the instruments were piloted even though some instruments were not relevant to the Korean context. Two programmes including the first level teacher program and teacher training program for getting second degree were used. He suggested the introduction of teachers' teaching ability test which will begin from this year as a matter of duty throughout Korea. In Korea, the principal and the subject advisor are in one school, so he would rather combine the principal's and subject advisor instruments. There is a mathematics subject advisor in each school. There are so many kinds of MCPD's in Korea and it was a challenge to choose the most proper programs. Teachers worry very much about evaluation of their teaching ability such that they equip themselves with attending many different MCPD's.

Two education systems exist in Korea, namely, in school and outside school education. The teacher quality used to be very important but now the focus is on how to change and develop teachers continuously. Various incentives such as research funding and sabbatical year have been initiated for promotion to a school supervisor, honour to be a master teacher, good scores on mandatory evaluation of teachers, inner confidence as an expert teacher have been re-enforced by the Korean government to motivate teacher performance to higher levels. A four year degree or diploma is not enough for a teacher to teach in public secondary school. The teacher still needs to enrol for two years in the Science, Teaching Education Art and Mathematics (STEAM) from which teachers will write the 'teacher ability to teach test' to enable them to be effective teachers in public schools.

There is then Special Training where teachers get support for two years on their tuition,

and salaries. Korea also has a history of Lesson Study which is called "Research Lesson" and then general training mainly on other skills like ICT training for teachers is one of the CPD's for teachers. Teachers invite the principal, colleagues, sometimes, even parents to give an advice on teaching. This is slightly different from the lesson study in Singapore since the latter focusses mainly in changing teachers' mind sets about teaching. Classroom friendly teacher education is needed to extend the teaching practice from six weeks to six months. Korea also wants to introduce teacher internship for one year after the four year diploma. Teaching and learning involves lesson preparation, lesson implementation and evaluation while school life deals with personal and social teachers' life in school. 'The quality of education cannot exceed the quality of the teacher,' forms the basis of education in Korea. Teachers in this country are also entitled to three months for vacation, per year. Therefore teachers are recommended that they should take training courses with 60~80 hours every year to supplement their weak points based on the teacher evaluation. Korean students' good achievement in PISA and TIMSS comes through a high quality of Korean teachers well trained on the tradition that teachers are highly regarded.

Although professional development is not compulsory for in-service teachers in Poland, it is taken by about 90% of the teachers since it is difficult for them to get promoted without it. All Polish teachers must have a higher education qualification completing professional training at all levels. Teachers are rewarded according to their professional development expertise. ICT and digital school has been developed to expose teachers into the use of new devices and is funded by the government. The teachers are exposed to conference attendance, prepare papers and learn and share teaching methods with each other, attend a lot of professional development courses. It is on this basis that they are rewarded. The Polish boast of a number of CPD providers including Oerodka Rozwoju Edukacji (ORE) - the Centre for Education Development, established in 2010 as the merger of the National In-Service Teacher Training Centre, local education authority networks, universities and teacher education colleges. the British Council, the Alliance Française and the Goethe Institute and many others. ORE facilitates quality assur-

ance in education through supporting schools and educational institutions, and also supports changes in the system of education in the field of teachers' professional development. After 2012 the digital school program was introduced in Poland. The program is divided into four: e-school (infrastructure and equipment for schools), e-teacher (teacher training to raise teachers' ICT competences), e-student (ICT equipment for students) and e-resources (creating open textbooks, redesign of Scholaris, the national platform for educational resources, and production of ICT tools for school management).

A regular CPD programs to renovate the teacher profession was and is till now missing in Morocco. So, the "Emergency Program" (2009/2012) aimed in setting up a clear and perennial policy for an efficient CPD with the following objectives: (i) to upgrade the current staff of teachers and administrative, to align their profile on the best standards in terms of teaching skills and professional qualifications and (ii) to optimize the teachers' redeployment, by providing them with requalification sessions offering them the possibility of retraining. Ministry provides CPD in Morocco. Various organisations in Morocco provide funding for the implementation of MCPD's. A confirmed policy exists. CPD provided initial training for candidates with Licence Diploma (4 year diploma after secondary school at university). Pedagogy directives and ICT's were integrated in the teaching of mathematics in the last decade. Political decisions hinder the efficient and effective implementation of MCPD in Morocco. A few themes namely 'MCPD's needed for career progression; the role of academics within teacher professional development. What other reasons have teachers noted with regard to teacher professional development other than career development? Inspectors are responsible for training teachers in professional development in Morocco. Genie as a professional development program to facilitate the implementation of ICT'S in mathematics and is one of the best in-service training teachers in mathematics from 2006? MCPD should be based on teachers' needs and the inspectors that facilitate these programs are trained in different sessions. All instruments were piloted except the observation schedules since there was no session of CPD was organised during the piloting period.

Comparative Analysis

The summary on comparative analysis of the existing MCPD's of the different countries is presented on similarities, differences, resource powers and the models implemented in the selected countries. The Continuous Professional Development (CPD) is a national priority in all the countries involved in this study and aims to improve the Education quality and strengthen teachers' professional skills. This is besides the fact that in Zimbabwe, the operational and managerial bodies have a reasonable level of provision for the CPD of mathematics teachers which is reported to be functionally ineffective largely due to financial constraints and weaknesses. Organised teacher support programmes enabling teachers to receive high quality mathematics education were facilitated through the 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) including projects like SESS, STIP, and TEAMS. The ministry of education in Swaziland and Botswana caters for professional development of primary and junior secondary school teachers only while the University of Swaziland and Botswana University, is responsible for the senior secondary school teachers respectively. Contradictory, MCPD has not as yet taken root in Namibian schools as a formally established mode of improving the professional conduct and skills of Mathematics at the different education phases.

Singapore boasts of: (i) Grade level courses where teachers are introduced to Lesson study, Effective instruction, and Examining the mathematics (ii) Customised courses where teachers are engaged in individualized full-day or half-day program implementation courses designed to meet the specific needs of schools/districts like using Visual Models, Assessment, Grade-Level Monitoring, Technology, and State Testing (iii) In-classroom support modes where teachers are exposed to an in-depth look at how technology resources can easily be integrated in instructional routines. Student online manipulatives, interactive whiteboard activities, online teacher resources and the Singapore Math, Bar Models app for iPad are just a few of the resources covered in such sessions with strategies for efficient classroom integration. This is similar to South Korean education which also

subjects mathematics teachers to further two years of professional development after they qualify as teachers.

Findings from the pilot studies conducted indicated that recruiting, preparing, and retaining teachers in eleven countries showed that the providers of teacher education differed from country to country. In some countries, universities provided all teacher education. In others, teacher training colleges offered non-university levels of preparation. Variation in mathematics teacher education is a product not only of readily visible differences in organization and structure but also of divergent views (of, for example, educational experts, policymakers, and reformers) on how best to conduct the preparation of teachers.

CONCLUSION

Teacher professional development is a lifelong and continuous process in which teachers are expected to upgrade their knowledge, master new skills and change their practices since advancement in their teaching career is finally for their students and education reform. Efficient management and leadership in ministry of education down to school managers are accountable and responsible for schools not to only apply appropriate teacher professional development and human resource development policies but to ensure that professional development for teachers is an investment. This should involve strategic investments of time, capital and human resource to enhance teachers' teaching career in practice.

Obviously, only skilful and knowledgeable teachers can form a foundation of good schools with high quality students. Therefore, enhancing is considered the most important and strategic investments of time, money and efforts that human resource managers make in education. These investments must be well prepared and conducted since teacher professional development acts as a key indicator in education human resource management and development. Most of all, investments on teacher advancement ultimately result in improving achievement of all students.

The current focus on accountability has increased attention to the effectiveness of Mathematics Continuous Professional Development in the countries like Singapore, South Korea,

Poland, Ireland, and many recent studies have examined MCPD initiatives to determine which ones were effective. In trying to address the differences in defining effectiveness used across studies the search for effectiveness has generated interest in finding a common set of features that are present in various MCPD programs deemed successful.

It appears that in almost all the selected countries the providers value the CPD's since they contribute into the improvement of in-service teacher performance in enhancing students' pass-rate whilst balancing the change in curricular over the years. The beneficiary objective is career progression.

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