

Professional Development for Science and Mathematics Teachers in Tanzanian Secondary Schools

Gadi Moses Koda

Department of Educational Psychology and Curriculum Studies
University of Dar es Salaam, Tanzania
E-mail: kodagadi@gmail.com

Abstract

This paper describes and provides a framework for the professional development of science and mathematics teachers that could be employed as these teachers seek ways to improve performance in the classroom, consistent with the need to meet the national goal of providing all science and mathematics teachers with access to professional development opportunities. Implementation strategies for this programme include the commitment of science and mathematics teachers to the programme; ownership of the professional development programme; a focus on teaching and learning strategies that promote meaningful connections; extended planning time for the programme; support based on an assessment of their needs; recognition that change is a long-term process that requires long-term support; networking across schools within districts or regions in order to promote collegiality; and an evaluation process to guide future professional development opportunities.

Key words: Professional Development, Science and Mathematics Teachers, Tanzania

Introduction

Professional development refers to the on-going provision of learning opportunities to enhance teachers' knowledge and skills through various ways within or outside their schools and districts for the purpose of making classroom teaching effective. According to Maggioli (2003), professional development in general may be referred to as the skills and knowledge obtained for both personal development and career advancement. He also portrays professional development in education as an on-going learning process in which teachers engage voluntarily, or per institutional demands, in learning how best to adjust their teaching to the learning needs of their students. Professional development is not a one-shot, one-size-fits-all event, but rather an evolving process of professional self-disclosure, reflection and growth that yields the best results when sustained over time in communities of practice and when focused on job-embedded responsibilities. Speck and Knipe (2005) argue that professional development encompasses all types of facilitated learning opportunities, ranging from college degrees to formal coursework, conferences and informal learning opportunities situated in practice. It has been described as intensive and collaborative, ideally incorporating an evaluative stage. It has become a matter of great concern today in the education industry following global socio-economic, political and cultural trends. Increasing unification of the world's economic, political and cultural order dictates the need for more competent and knowledgeable human resources to face the challenges brought into the classroom by our students. As teaching becomes more complex today and a more demanding task than in the past, teachers are facing complex challenges from the outside world that are brought into the classroom by students through various ways, such as interacting with modern technology and the increasingly diverse population of students in the classroom (Timoth, 2000). Therefore, there is need to integrate new technology in the classroom to meet the rigorous academic standards of our children at the end of their studies. Stakeholders continue to stress the need for teachers to be able to enhance and build on their instructional knowledge to meet national goals (Koda 2006).

Although professional development has been criticised for its cost, for using time that should be spent helping students, for its lack of guidelines, vaguely determined goals and lack of data on its results in terms of an improvement in teaching and the school, effective professional development is often seen as vital for schools' success and teachers' satisfaction.

Looking at the strengths and weaknesses of the teachers' preparation programme that purports to invest in teachers' knowledge and skills, it continues to be a challenge. Teacher preparation has been criticised for not doing enough to equip teachers with the knowledge and skills that may help our children to learn effectively for their future life. Teachers are even less equipped to teach science and mathematics in secondary schools. The consequence of this state of affairs is that many pupils may develop a negative attitude to the subject of science and therefore not learn much (Hoban, 2007). This will put the nation in a dangerous position, affecting this generation and future generations of children and society in general. Therefore, teachers need more training through the professional development approach to improve their pedagogical skills so as to teach science and mathematics effectively. This is now possible as professional development approaches take many forms, which include; formal induction of teachers, teacher resource centres, clinical supervision, training of trainers, the teacher as a researcher, implementing innovative practice, peer coaching, advising teachers, mentoring new teachers, teachers' institute, informal networks, partnerships and individual guided professional development (Goodlad, 1984; Campoy, 2000; Blandford, 2000; Koda 2006 ; Sawchuk, 2010;).

Background Information

The professional development programme for enhancing the knowledge, skills and abilities of science and mathematics teachers is increasingly viewed by the community, government and local educational administrators and policymakers and other stakeholders as the primary means of providing teachers and students with the opportunity to meet the global challenges that enter the classroom in various ways. The International Goals 2015, stipulated in 2003, set a framework for the Ministry of Education and Culture in all nations to establish education programmes that emphasised the importance of professional development programmes through the addition of a national goal to provide teachers with access to professional development programmes. This goal states that by the year 2015, "the nation's teaching force will have access to programmes for the continued improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to instruct and prepare all school students for the next century" (UN Goals 2003).

It is argued that among the aspects that lead to the deterioration of education is the paucity of training and under-utilisation of teachers due to the lack of a comprehensive in-service training programme (Koda, 2006). Malekela (2004) said that teachers have to know the subject matter well and how to teach it in appropriate way. The lack of confidence to teach science and mathematics was due to teachers' poor knowledge and lack of teaching skills. When teachers lack confidence to teach, they tend to use teaching methods that enable them to maintain control of the classroom. To have the confidence to carry out a certain task one must have the knowledge and skills to do so. Therefore, teachers should be trained well in both academic and professional aspects. It should be noted that teachers are key to the provision of quality education at any level. Secondary education level is no exception.

Qualified teachers are vital for instructing pupils and implementing the curriculum and hence their effectiveness depends on their academic and pedagogical competence (Galabawa, 2001; Tilya &

Mafumiko, 2010). Providing science and mathematics teachers with on-going professional development opportunities that support educational reforms remains a challenge for the Ministry of Education and Vocational Training in Tanzania. Increased enrolment and the consequent shortage of funds allocated to education has meant that there is also a lack of funds for professional development programmes and instructional materials for science and mathematics. To further complicate matters for science and mathematics teachers, the introduction of community schools and educational reforms in the 2000s has led to an increased number of students in schools with an emphasis on quantity education neglecting the other important side of the coin - quality. These and other reforms added a new dimension to the struggles of the education industry in seeking to address the issue of quality rather than quantity. In 2006, the enrolment in secondary schools was 675,672 pupils with 23,905 teachers, while in 2010 enrolment reached 1,638,699 pupils (increase of 41%) with 40,517 teachers (increase of 8%) with a pupil-teacher ratio of 1:40 (BEST2011). Due to the increase in enrolment, many schools lack the funds to provide new resources and staff development opportunities (Koda 2006). Teachers sometimes forget that teaching needs more commitment to exploring the students' environment using whatever methods and materials that will stimulate them to learn. In this situation one cannot expect schools to have a stimulating learning environment. Students may pass examinations in physics, chemistry, mathematics and biology but have little understanding of the concepts they have learned other than committing the definition, laws and principles to memory (Osaki, 2004).

Apart from the insufficiency of financial resources, the most frequently cited issue facing secondary schools in Tanzania is the recruitment and retention of teachers (Koda, 2008). Despite the awareness of the different training needs of teachers in Tanzania, few colleges and universities have courses specifically designed to prepare teachers. However, educators frequently cite personal and professional isolation as the greatest disadvantage of working in community secondary schools. The argument is that it is a cumbersome task to teach in secondary schools due to the high number of students per classroom. Therefore, networks of professional development programmes need to be developed to support teachers academically in these secondary schools for future quality education. The distinct differences between arts teachers and science teachers have been recognised by many (Kajinga, 2010). Some of these differences (e.g., close school-community linkages and the lack of access to resources) are likely to have an impact on how science and mathematics teachers respond to school reforms. Despite these needs, most school reform efforts have emanated from private schools, particularly those with a few students in the classroom, such as Kandoto Girls secondary school in Same district, a model for school improvement (NECTA, 2011 & 2012).

Rationale for professional development

The rationale for the professional development approach in Tanzania is that "teaching is a more difficult, complex and demanding task today than ever before in the history of education" (Timoth, 2000). Today's students are highly aware of the world beyond the classroom. They bring into the classroom a lot of experiences gained through interacting with the environment around their homes and engaging with modern technology, such as the radio, television and the Internet (Pringle, 2000). Because of the conditions teachers face in the classroom in Tanzania as well as changes in the curriculum, they need more knowledge and thinking capacity than those in the past. Therefore, teachers need to be well informed and trained from time to time in order to effectively teach our students how to live in the twenty-first century world and to equip them with up-to-date knowledge and skills.

Because change is synonymous with life, when the pace of change accelerates, our survival will depend on education, which will prepare individuals to deal with it. Rogers (1969 P.104) contends that, “We are faced with an entirely new situation in education where the goal of education, if we are to survive, is the facilitation of change and learning”. Only the man who is educated is the man who has learned how to learn; the man who has learned to adapt and change; the man who has realised that no knowledge is secure, that only the process of seeking knowledge gives a basis for security. Change is reliance on a process rather than on static knowledge. Change that can be brought about through professional development strategies is the only thing that makes sense as the goal of educational change in Tanzania as we focus on the modern world. (It should be noted that education should bring change and that change is education).

The teaching profession as whole is in a constant state of change. To cope with the 21st century, it is critical that all students have sufficient knowledge and skills, especially as regards science and mathematics. Mosha (2006) maintains that the only constant variable in society today is change. The past has changed, the present is changing and the future will change. Hence the need to constantly update one’s knowledge as nobody has full command of it in any field. Teachers are key to enhancing learning in schools. In order for them to teach in the required manner to meet educational challenges they need extensive learning opportunities. Studies suggest that high-quality teaching can make a significant difference to student learning in any area of specialisation. The National Science Teachers Association, NSTA (2006), argues that a high-quality science and mathematics teaching workforce requires meaningful, on-going professional development. It further argues that to achieve this goal, schools and school systems must devote time and resources to effective professional development for all science and mathematics teachers and science and mathematics educators must support learning throughout their careers.

There is broad agreement in the field, and increasingly empirical evidence as well, about what constitutes quality professional development for science and mathematics educators (NSTA, 2006). Key principles, synthesised by the National Institute for Science Education (NISE), include reflecting on the research on effective classroom learning and teaching; building pedagogical content, knowledge and skills as well as examining practice; using research-based methods that mirror those needed in the classroom; facilitating the development of professional learning communities; supporting teacher leadership; integrating professional development with local government priorities and continuously evaluating its effectiveness.

NSTA (2006) contends that schools and school systems must move forward with professional development programmes based on the best information currently available. The science and mathematics education community should continue to encourage this and conduct systematic research into effective professional development to add to our knowledge base for particular purposes in various contexts.

Purposes of professional development

The Oregon Department of Education (2012) argues that the purpose of teachers’ professional development strategies is to help teachers develop and apply the knowledge and skills that are needed to help students learn. It further argues that the intended outcomes of teachers’ professional development are defined in terms of improved professional practice, but the long-term goals should always focus on improved student outcomes. According to Tiptop job (2012), there are seven benefits of professional development strategies:

Retaining and sharpening old skills: Skills a teacher had developed in the past that may have become slightly out of date will be sharpened. It is always good to brush up these skills because over time, especially if they are not used constantly, they can start to fade. For example, experimental skills in physics or chemistry that one might have learnt at University through practical activities may not be used in his/her current role, but revisiting these skills through the same or advanced practical activities in the new course will allow him/her to retain the skills and improve on them.

Development of new skills: Professional development will allow a great deal of new skills and knowledge to be learnt. The whole point in getting involved in further development is to advance teachers' abilities and growth so that they can perform more highly skilled and demanding tasks. It allows them to build specific knowledge and competencies that are related to their current role and which can prove to be useful when they return to work.

Keeping up-to-date institutional trends -: It is important to ensure that teachers and educators are kept up-to-date with institutional trends and developments. Thus, personal learning can ensure that they are doing so. Not only can this help teachers and educators to perform their own role but it also helps the school and the school system understand their position in the marketplace, which can assist strategic decision-making.

Fresh Perspectives: Professional development allows teachers and educators to draw upon fresh perspectives from the outside world to incorporate in their school system and role. This gives them the chance to think about new ideas and opportunities. By reflecting on these things, teachers can bring creative solutions to the institution. It can help them to acquire relevant tools and best practices that can be used in the school to improve its strategy and performance. This is because new knowledge creates real-time solutions and innovative initiatives for the school and the school system.

Networking opportunities: By going on courses, visiting educational events and other professional development avenues, teachers will meet new people and network with educational experts, leaders and like-minded individuals. Building relationships like this can be extremely useful for finding out about career opportunities, work-related guidance, lifelong learning opportunities and insider information. This network can come in handy in the teachers' current workplace and in their future career.

Expanding horizons and exploring career opportunities: Professional development allows teachers and educators to think about things and realise the opportunities available to them. With the skills and advanced knowledge they will gain, teachers will begin to appreciate what their career prospects are and which path they can potentially take.

Energising and renewing: Sometimes it is a good idea to take a break and refresh one's mind. It can be renewing and make one feel like new. By taking time out to personally develop, teachers will be taking a step back from their role to do something different. The energy and sense of fulfilment can be carried positively into their job and personal life. Professional development is about moving oneself on to the next stage along the learning curve, and not only can this development be of use to everybody as individuals but it can also benefit the institution they work for. Because of this, all educational institutions should consider sending their staff on professional development courses in order to reap the spin-off benefits.

Furthermore, a review of education literature on science and mathematics teachers reveals that they make a great contribution to the vision of educational reform. The tendency for one researcher's "problems" to be another researcher's "opportunities" is best demonstrated by typical practices in our education today (Kajinga, 2010).

The so-called "quality education" being championed by many people today was born out of necessity long ago in the history of education. Cooperative learning, multi-grade classrooms, intimate links between the school and community, interdisciplinary studies, peer tutoring, block scheduling, the community as the focus of study, older teachers teaching younger ones, site-based management, and close relationships between teachers and students all characterise school improvement practices that lead to quality education (Stem,1994, p. 1). While science and mathematics teachers have the potential to be a wonderful laboratory for educational innovation and improvement (Sher, 1991, cited in Stem, 1994, p. 1), they experience challenges in getting on-going professional development opportunities due to the location of their schools, the limited availability of instructional resources and the unavailability of substitute teachers to release them. This paper describes the implementation of a professional development and school improvement model that addressed the challenges experienced by those who are geographically isolated. Figure 1 provides an overview of the interrelated elements and strategies for professional development

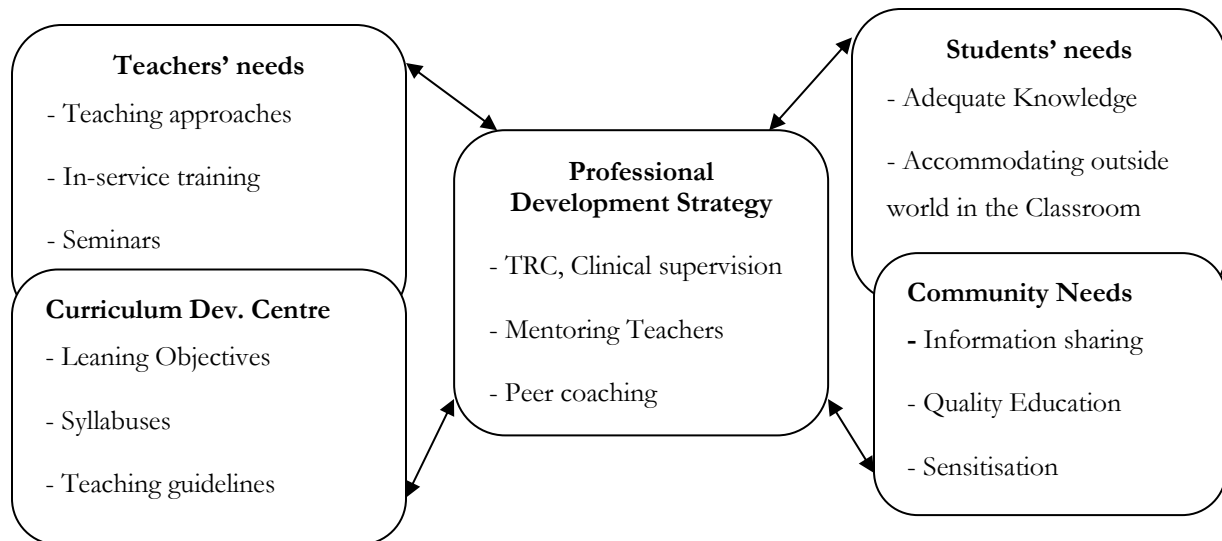


Figure 1. A conceptual model for professional development of science and mathematics teachers in Tanzania: Source: Author's model

In the professional development approach of using teams for school improvement, not only should a team exist, but it ought to be formed through an intense team-building process. Team building is seen as a way to sidestep the institutional resistance to change to bring about educational reform (Maeroff, 1993 p.514). The change process should reflect the initiation of ideas, participation and support, promote a change in behaviour and beliefs and address the overriding problem of ownership (Fullan & Stiegelbauer, 1991). The appropriateness of this approach for science and mathematics teachers was demonstrated by Nachtigal (1989). His findings indicated that individuals at the local level must play a significant role in designing the solutions. However, outside assistance

and resources may ensure that local improvement efforts are successful. When several schools collaborate, improvements are more likely to be achieved because working together provides the moral support to move forward. The anticipated shift from past practices to new notions of professional development suggests that school-based approaches include opportunities for teaming up, developing a community of learners, and improving the effectiveness of the curriculum and instruction for both teachers and learners. Effective school-based teachers' professional development must be driven by a coherent strategic plan, including multiple forms of job-embedded learning (e.g., study groups, peer coaching, clinical supervision, mentoring teachers, lesson study, to mention a few). These promote both individual and organisational development (Sparks, 1994).

The growing consensus on having challenging standards for science and mathematics teachers broadens the focus on teaching and learning to include holistic curricula and instruction that promotes meaningful connections across the curriculum, supports connections with parents and the community, and coordinates regular and special-education programmes. Numerous recommendations from research findings highlight flaws in conventional wisdom and point to promising alternative ways of teaching science and mathematics. Knapp et al. (1993) suggest emphasising meaning and understanding, embedding skills in the science and mathematics context, and encouraging connections between subject areas and between school and future life outside school. These interrelated elements provide the theoretical background and support the planning and implementation of the programme.

The introduction of Teacher Resource Centres (TRCs) as one of the professional development strategies in Tanzania was intended to promote quality education for primary school teachers. However, the current TRCs are used to promote the teaching of educationally disadvantaged students in secondary schools (Mwamalili, 2010). Currently, districts are required to develop and implement professional development programmes to improve the quality of education in schools where students do not show substantial progress in meeting education goals. This lack of progress is defined by the low number of students achieving good results in the final national examination. However, to examine how TRCs might contribute to secondary school performance through having professional development programmes in them will greatly depend on the TRC coordinators being proactive. The implementation of professional development programmes in TRCs could provide a framework for planning a meaningful and on-going professional development programme, which can be summarised as follows.

Implementation stages

1. Invite schools to participate and be committed to the programme.
2. Promote ownership of the professional development programme.
3. Discuss technical assistance based on an assessment of the programme's needs.
4. Look for support for the programme as change is a long-term process and requires long-term support.
5. Focus on teaching and learning strategies that promote meaningful connections.
6. Set an extended planning time for the professional development programme.
7. Make changes resulting from the improvement process in all the schools in the district
8. Create a network of schools to support the exchange of ideas and promote collegial support.
9. Conduct an evaluation to guide future professional development opportunities.

To invite cluster schools to participate in professional development programmes for school improvement and commit to using a school team that includes classroom teachers, special programme teachers, school administrators and parents

To implement professional development, a coordinator should visit each identified school to invite it to participate in the professional development programme. The programme should be designed with the collaborative effort of cluster schools and district education institutions. Funding for this programme should come from schools and participants to top up what is contributed by the district office.

To train a cadre of teachers to conduct professional development programmes at the school level to promote ownership of professional development.

To create a sense of ownership, an invitation should be given to science and mathematics teachers to take part in a professional development programme on condition that the schools commit themselves to a school improvement programme. With the commitment and active participation of coordinators, classroom teachers and school heads will come a sense of ownership. Commitment is important because intensive technical assistance will have little impact unless it is linked to collaborative working relationships (Fullan, 1992). If the staff of a school have been identified as failing to demonstrate substantial progress and have been asked to improve their school's performance, it should be regarded as an embarrassment for the whole school. However, those who get this opportunity should make a commitment to the school and the programme to improve their school's performance. To increase the capacity of schools to conduct their own future professional development programme at their schools, the MoEVT should assist the coordinator in developing long-term professional development plans. Each school should select a cadre of teachers to conduct a series of professional development activities for their school during the vacation, assisted by in-service videos. To promote the transfer of responsibility for professional development to the school members, the professional development coordinator and teachers should co-present the first series of workshops for parents at the school. The success of these workshops will increase the confidence of teachers in the professional development programme and so they will subsequently conduct several more successful workshops for parents on their own. Funds for this programme should come from various sources. Schools' contribution should constitute over 50% of the budget, which will mean that participants will be committed to the programme because of their contribution to funding it and release teachers from school to attend the programme.

To discuss technical assistance based on the programme coordinators' assessment of their current and subsequent needs as they implement their school-based improvement plans. Allow time for extensive planning at the initial stage.

The professional development programme should focus on the importance of school planning and collaboration to improve the teaching of science and mathematics as well as the regular programme. To initiate this programme, a two-day team institute should be held early in the school calendar for teachers in district schools. This intensive planning session should be held at a location far away from the individual schools and communities so that the participants are not distracted or interfered with. The programme coordinator should guide the schools involved to conduct a comprehensive needs assessment, develop a draft for school improvement plans, and identify subsequent technical assistance needs. The planning session should be the turning point in terms of making the participants committed to the programme and avoiding the possibility of them getting away to have time to talk and plan for other things, forgetting that professional development is important for the success of the school. The needs assessment and comprehensive planning should reflect the needs and interests of all the participants, which should be communicated (a) to the coordinator of the

programme and other members of the programme, focusing on the meaning of professional development for teachers as a whole rather than on isolated skills relating to science and mathematics instruction; and (b) to parents to increase their involvement in their children's education.

To recognise that change is a long-term process that requires long-term support in the form of coaching, feedback and follow-up that is readily available and responsive to local concerns.

To establish high expectations of and enthusiasm for teachers' professional development MoEVT should meet with the coordinator and all school heads before the beginning of the school year to brainstorm ways in which to involve other stakeholders in building strong professional development activities and to coordinate technical assistance in other schools and districts as a whole. Discussion should focus on extending the positive results of the programme to other schools in other districts and implementing follow-up strategies. To support the programme, heads of schools should be given resources to enable their school to implement professional development programme models, such as support for disadvantaged groups and peer coaching. Coordinators should discuss these models with the teachers prior to developing a plan for staff development. The team should develop plans reflecting strategies that promote collegial interaction and ownership of the professional development programme (e.g., peer coaching, networking through subject teacher associations, lesson study groups, and training a cadre of teachers to conduct a professional development programme at school and district level).

To focus on teaching and learning strategies which encourage holistic instruction and promote meaningful connection across the curriculum and with parents.

To establish common needs and to promote a network support for the programme across districts and the nation as a whole, the programme should focus on strategies promoting positive self-esteem in all children, integrating children's needs in the curriculum, and incorporating problem-solving strategies in teaching science and mathematics through using a variety of approaches. To model the effective professional development approach for schools to improve science and mathematics knowledge, a one-day workshop should be held each month in response to teachers' request to address difficult topics in those subjects and to support the knowledge and skills that have been integrated in programme activities. To build a sustainable programme, coordination should be extended to include classroom teachers, school heads, professional development expertise from recognised universities and other stakeholders. Experience shows that when people share ideas it helps them move away from focusing on isolated skills and worksheets to focusing on knowledge (Routman, 1988.) To gain further insights into practical implementation of professional development, participants (teachers) are required to be attached to mentors who have experience of science and mathematics and if possible have already implemented an alternative professional development approach in other subjects. To ensure that the programme approach is effective, the practitioners or mentors should be experienced teachers from higher learning institutions. Their experience would contribute a lot in terms of knowledge and skills for the benefits of tomorrow's engineers and the nation as a whole.

Initially, to focus should be on improving the school. Team members to be committed to the improvement process and to gradually make changes resulting from the improvement process in the entire professional development programme.

The coordinator of the professional development programme should constantly focus on how the participants should implement changes resulting from the improvement process. Many schools have

difficulty finding substitute teachers, but should find a creative solution to involve other community members in one-day workshops. Teachers who have participated in previous workshops should volunteer to help cover classes so that other teachers can attend the next professional development programme.

Provide extended planning time for a professional development programme using strategies, such as vacation development activities to develop staff and substitute teachers.

Like other educators, teachers often have difficulty finding extended planning time for staff development during the school year. The professional development programme approaches, namely clinical supervision and mentoring novice teachers, should provide participants with an opportunity to learn how to find time for professional development. Participants should be given time to design and prepare professional teaching materials such as books and should have access to many teaching resources and models for children's use in the classroom during their absence. During the vacation individual teachers could participate in numerous programmes, such as peer coaching, subject associations and advising teachers. Schools should hire substitute teachers for half of their staff so that they can attend demonstrations of effective teaching strategies provided by a professional development expert. In school, demonstration teaching could model effective teaching strategies that promote higher-order thinking in science and mathematics. This could be one of the most effective strategies for involving the entire cluster of schools in a district or region. Participants could get the opportunity to discuss the demonstration lesson before they return to their normal classes to implement the procedure. The substitute teachers could then take the classes for the remaining half of the teachers so that they can also attend the professional development programme.

Create a network of teams across the schools to support the exchange of ideas and promote collegial support.

Team members should express the need to continue to meet together and form a support network for the exchange of ideas, as they feel isolated from teachers in other schools except those in the same school. Unlike other subjects, science and mathematics teachers have limited access to teachers from nearby schools. Networking across all schools in the district would be accomplished through collegial visits to other schools in the programme to observe the effective teaching of science and mathematics by their colleagues and to exchange ideas. The strengths and weaknesses observed should be shared at a meeting at the end of the visit and a strategy devised that would help to resolve them within the school environment. Participants should make a plan to regularly visit other schools in the following vacation.

To conduct an evaluation to guide future professional development opportunities and to identify the parts of the programme which are more effective for these teachers and for replication in the future.

As part of the professional development process, assessing the effectiveness of the professional development approach is essential. To do it, at the end of each programme, the members should complete both a team and individual assessment form concerning their participation in the programme. The participants should state how they have benefited from the programme and what they are going to do with the knowledge and skills gained from it. They should come up with a recommendation for more workshops in the next programme in their schools to enthruse others in the district.

Participants should report any significant changes in the knowledge and skills acquired during the previous programme. Through this, teachers will become more aware of new strategies for teaching

science and mathematics and more willing to explore new ways in which to use these strategies in their classroom instruction.

A mini-research, conducted by Master of Science Education students at the end of each year of study in 2009-2011 as one of the requirements for completing the CT603 course (Professional Development for Science and Mathematics teachers in Dares Salaam secondary schools, validated the professional development approach to school improvement and the need for change. Each participant administered a survey on the professional development programme in one of the secondary schools. The findings show that, although the *Education and Training Policy* (1995) stipulates clearly that teachers should be given professional development, this has not been fully implemented in the visited schools. When the teachers were asked if they had been given any opportunity to participate in a professional development programme in their school, some responded that they knew nothing about professional development and had never heard about it since they joined the teaching profession ten to fifteen years ago. However, others responded that they were aware of it but they had never attended a programme. When the heads of schools were asked how information about professional development is disseminated to teachers, their response was that they should read the Education and Training Policy.

Those who managed to attend a professional development programme before joining the schools visited responded that sharing information with teachers from other schools in the district gave them the opportunity to know about the professional development programme and they applied to join it through their subject association meetings. Sixty-three per cent (63%) of respondents reported that they shared information and showed enthusiasm by inviting education inspectors to conduct workshops as one way of receiving professional development in their subjects. Eighty-four (84%) indicated that the sharing of information took place through school activities such as workshops and demonstration lessons. Ninety-six per cent (96%) of the respondents indicated that the informal sharing of information by team members occurred only during the tea break. Individuals were asked to respond to the open-ended question, "In what ways has participation in a professional development programme helped to improve your knowledge?" All the participants positively gave examples of improved knowledge. Some participants' responses revealed changes in personal teaching styles. For example, one participant cited a change in his role as he said:

I think of myself as more of a facilitator now instead of a classroom teacher. I used to stand in front of the class for the 40-80-minute period each day and try to teach them everything I knew. Now I make them responsible for their learning; my class is not taught by a teacher with 80 students sitting at desks. We are now learning as a team.

Others said they have changed their instructional approaches:

This programme has totally changed my performance. I started out with the lecture method and then added various activities, but now I'm trying to integrate the necessary activities in the teaching process throughout the period. We even started professional development in our school. What I gained from this course gave me the 'push' I needed to change my classroom teaching.

The participants were asked to conduct a small piece of research on how professional development programmes are implemented in those schools. The findings show that heads of schools are aware of what professional development is all about but only few are implementing it in their schools. The

findings from this research show that the performance of those schools that implemented this model of professional development effectively had greatly improved, particularly in terms of NECTA results over the past three years. In one of the schools, the teachers who were interviewed had this to say “We are working as a team, rather than as separate troops fighting separate battles, but we are not sure if we have the right weapons. We have the knowledge yes, but do we know how to impart it correctly?” Other participants acknowledged the importance of the professional development programme: “We have information about professional development, its importance and how teachers may benefit from it, but the problem is that we have never attended any kind of professional development programme or conducted one in our school”. The question is how can teachers change with little help?

In many of the schools visited it was reported that those teachers who had received professional development had changed their method of teaching science and mathematics. They had more information about books in the school library than they had before and many of them, especially older ones, had significantly changed the way in which they taught, as they had moved away from the formal learning of students to participatory and discovery learning. Finally, we believe that several teachers who had participated in a professional development programme have changed their beliefs about teaching. These findings concur with those of Chimerine et al. (1994 p.47-48), who found that “teachers who participate in professional development programmes usually change their beliefs about teaching”. This external evaluation also examined the degree to which teachers were encouraged to interact professionally to support the exchange of ideas. The findings suggested that the professional development approach should be used in education to bring about the changes that are expected to occur.

The programme should provide outside consultants and materials, such as subscriptions to professional journals and books for students, to support the implementation of the programme. The coordinator, teachers and students should be able to fulfil the role of “critical friends” to provide feedback and advocate for the success of the programme. Critical friends bring to schools an objective viewpoint, knowledge of broader educational issues and the skills to facilitate school reform (Sparks, 1994 p. 95). Because schools and districts rarely have full-time professional development coordinators, it is important that someone has the role of being a critical friend for the implementation of this programme in the district context.

Conditions needed for the success of the science and mathematics professional development programme

- ***Let the mission drive the process.*** In Tanzanian schools, professional development is geared to achieving the standards and mission of schools that have been developed with the help of subject associations in the region or district concerned and to meeting the improvement goal in each school's educational plan.
- ***Listen to those closest to the situation.*** Moreover, in these associations, teachers attempt to link professional development with the needs of individual teachers as well as schools in general in terms of academic achievement. Teachers play a major role in school performance and so they are always charting its direction. Therefore, since teachers are closest to the situation in which teaching and learning occur, they know best what they need, based on

what works and what is not yet perfect in the classroom situation. Therefore they have to be key participants in designing and implementing the programme.

- ***Make a long-term commitment.*** From the writer's experience, professional development must be planned as a lifelong process of continuous learning that is best received when it occurs as a natural outcome of one's work. Therefore, as the designers of professional development teachers should make a long-term commitment to the programme in order to achieve excellence.
- ***Develop a symbiotic relationship.*** Experience shows that most effective staff training programmes occur when there is a partnership which benefits all stakeholders. In this case therefore, there must be a good relationship between participants and their leaders/colleagues.
- ***Select your participants carefully.*** In addition to being caring, sensitive, empathetic and mission driven, the participants must believe that the teachers' professional development programme is valuable because, if they do not, it will be a waste of time. They must make sure they know the benefits they will gain from the programme.
- ***Be consistent.*** Once one has introduced some kind of programme do not drop it and add new programmes and approaches every year. Teachers are always worried about change, and if one is not consistent over time, many teachers will be rightly sceptical and simply wait out the latest trends. (The African News 13/12/2007). Long-term commitment to a long-term vision is critical.
- ***Address fundamental beliefs first.*** A change in human behaviour occurs only when preceded by a change in the fundamental belief structure of the individual. Organisational change is preceded by a shift in the culture of the group. Do I really believe that all children can learn? Do I believe in teamwork? What does empowerment mean to me? Can I teach without a textbook? Will I feel comfortable taking risks and occasionally failing? Only when these fundamental questions are answered, through the experiences of the teachers, can a climate of change exist in schools.
- ***Trust one another and yourself.*** The real experts exist in the classrooms of every school system. A successful professional development programme will create opportunities for participants to discover, discuss and share what works and why. If we want our students to be self-actualised, we must select and build self-actualised teachers and role models.
- ***Involve the students.*** Professional development that fails to include students as active participants in the process is unlikely to achieve the desired results. Students must be viewed as colleagues and not passive learners. They have something to share with you in a classroom. Put them before you whenever you establish any programme that will touch them.
- ***Make training relevant.*** Professionals are not different. They have something in common to share. Always think about the relevance of the programme before you begin it. Does it fit the mission? Will it help teachers in the classroom? Is it consistent with our beliefs? Does it address content areas? Our partnerships demonstrated to us that students learn best when

they are engaged in work that affects them directly, that has meaning for their lives and draws on their experience.

- ***Institutionalise it.*** In the 1980s, the Tanzania government opened Instructional and Staff Development Centres known as Teacher Resource Centres (TRCs) all over the country to provide for the in-service training needs of primary school teachers. These centres were initially located in former primary schools and served as a focal point for teachers' professional development to improve quality. While you do not need a new facility to underscore the importance of staff development, a district does need to make it an important, on-going part of its operation (Koda, 2006).

Conclusion

Professional Development for Science and Mathematics Teachers is not a new approach in Tanzania but the way in which it is implemented means that participants do not realise its importance. Few teachers and education administrators are aware of it. This paper has advocated reaching more science and mathematics teachers and having a more uniform understanding of the concept. Its input into the professional development task will bear fruit if administrators and teachers work closely in a collaborative manner.

It is very difficult to obtain data or literature that show that the professional development approach leads to better teaching. No-one can claim that this approach is the best. In essence, professional development relies on the transfer of knowledge. It must inculcate in teachers new knowledge and skills that will change their behaviour, which must subsequently result in students mastering the subject matter. Unsurprisingly, the complex nature of professional development renders it a challenging one. One study concluded that students in schools whose teachers had attended a professional development programme had better results than those in schools where that programme is lacking. Although this paper used a quasi-experimental methodology, it could be a promising avenue for future professional development research.

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