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The status of professional development programmes for science and mathematics teachers in Tanzania

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Abstract
This paper discusses the status of teacher professional development programmes (TPD) for science and mathematics teachers in Tanzania. Specifically the study aimed to; determine the TPD programmes available for science and mathematics teachers at Chang'ombe secondary school; find out how the TPD programmes are carried out at Chang'ombe secondary school; and explore challenges to provision of TPD programmes at school. The study was qualitative employing documentary review and semi-structured interviews. The sample size comprised 8 science and mathematics teachers, 4 heads of department and the head of the school. The findings of the study revealed that the majority of teachers teaching science and mathematics at Chang'ombe secondary school were not mentored. Instead they were provided responsibilities without any induction. Within the period of 4 years only four (4) teachers of science and mathematics out of 19 attended different professional development programs. These teachers attended different TPD programmes which were organized by the ministry of education and vocational training and sponsored by Japan International Cooperation Agency (JICA) together with subject association clubs which are organized by TAHOSA at district level. The study concludes that TPD programmes are the panacea for imparting science literacy to students and hence they must be part and parcel of teacher's career.

Keywords: professional development, science, mathematics, teachers, Tanzania

1. Introduction

Teacher professional development (TPD) constitutes a key element for provision of quality education. Teachers are required to attend regularly to new teaching methodologies and strategies of teaching consonant with the ever science, technology and environment. The teaching efficiency of serving teacher will therefore need to be designed and developed through planned and known schedules of in-service training programmes. Due to this in-service training and re-training shall be core and compulsory for teachers in order to ensure teacher quality and professionalism (MoEVT, 1995, p.16). There is concord among scholars about the need and significance of the teacher and her/his competence in the teaching/learning process. In fact the teacher is the heart of classroom instruction (Galabawa 2001; MoEVT, 2007) [4, 12]. The effectiveness of the teacher is measured in terms of his/her competence and efficiency, teaching and learning resources and methods; support from education managers and supervisors (Van den Akker & Thijs 2002; Mosha 2004) [19, 14]. TPD provides opportunities for teachers to explore new roles, develop new instructional techniques, refine their practice and broaden themselves both as educators and as individuals. In order for the country especially developing ones like Tanzania obtain the appropriate development in science and technology, the efforts should be directed to teachers capacity building in terms of knowledge, skills and competences which will be delivered to the students in classrooms, laboratories and outside the classroom. Teachers who are not professional developed, face a number of problems and challenges during classroom teaching or laboratory instructional processes. Through professional development programmes offered, teachers can encompasses a range of activities that are designed to: Support and promote career growth, create succession pathways within organizations, facilitate the development of new skills, improve on existing knowledge, skills and abilities, build confidence, motivation and perceived role legitimacy, facilitate evidence-based practice, enhanced worker adaptability, decreased resistance to change, improved retention, and higher levels of organizational commitment. Capacity building for teachers in both pre-service and in-service is very important and compulsory for improvement of an individual teacher, students and society benefits. In the pre-service programmes, student teachers produced are very weak due to poor preparation before joining teaching profession. Teachers in the teacher training colleges are not provided with good practical knowledge, skills and teaching methodology. The quality of education can be evaluated in part from the effective developed teacher which is the academic standard of teachers attained during the pre-service course training. Wherever pre-service training programmes are inadequate, teachers lack knowledge, skills and techniques for classroom and laboratory delivery and hence become incompetent and unconfident. TPD for teachers is very essential in building the capacity in delivering quality education. The teachers who are competent, knowledgeable and skillful are the resource persons for delivering quality education to the students who can use it in solving different problems in their life. Professional development should help the development and improvement of man and the society in various activities and aspects in his/her daily life (MoVET, 1995). In Tanzania, there are no permanent and remarkable professional development programmes which are planned in order to develop science and mathematics teachers in both pre-service and in-service.

The problem has increased especially when the curriculum of Tanzania shifted from content-based curriculum to competent-based curriculum. The majority teachers have low understanding of the competence-based curriculum and hence continue with the previous one. The outcome have been that science and mathematics teachers fail to deliver the concepts to the students and hence no valid, reliable and

quality education to our students. Motivation to science and mathematics teachers is very important so as to make them expert in various scientific works such as experiments and other scientific practical. All these cannot be achieved if these teachers are not evolved seriously in the professional development programmes. The researchers then decided from their heart to find out if there are professional development programme (training of the trainer) at Chang'ombe secondary school and explore challenges they encounters on its implementation.

1.2 Purpose of the study

The purpose of the study was to investigate whether there were TPD programmes for science and mathematics teachers in Dares Salaam and explore the challenges faced in implementing the programmes. Specifically the study aimed to:

1. Determine the TPD programmes available for science and mathematics teachers at Chang'ombe secondary school.
2. Find out how the TPD programmes are carried out at Chang'ombe secondary school.
3. Explore challenges to TPD provision programmes at school.

1.3 Significance of the study

A successful investigation of professional development in the study would help teachers to be aware of different professional development programmes provided and provide an avenue for them to attend. The study was therefore, expected to give necessary insights into government, policy makers, head of schools, educational planners and teachers especially science and mathematics teachers on different TPD available at Chang'ombe secondary school, effectiveness of TPD, challenges for implementing TPD and what the government could do to plan for more effective TPD for science and Mathematics teachers.

2. Review of related literature

Teachers are the key factors in the process of teaching and learning especially in science and mathematics subjects. They are the most resource persons for the development of the students in knowledge, skills, altitudes and values for solving authentic problems for themselves and societies in general. There is a need to equip teachers with necessary knowledge and skills in science and mathematics subjects so that they associate in their activities of teaching for students understanding when actively involved in teaching and learning process (Osaki &Agu, 2002) [16].

2.1 Teachers' qualifications and performance of students

Qualifications of teachers have a great impact in the academic achievements of students because teachers play the central role in the formidable endeavor through imparting the needed knowledge and skills in the minds of students. They are expected to be builders of the mental defense who help to build an invisible fortress of solidarity and loyalty in every citizen's mind, and constructors of economic infrastructure who are required to produce a dedicated workforce for the developing economy (Wang & Fwu, 2007) [3].

Education and Training Policy (2014) explain that the minimum qualification for a secondary school teacher in both government and non-government secondary schools shall be possession of a valid diploma in education obtained from a recognized institution. The diploma teachers are expected to teach in Form One and Form Two, while graduate teachers normally teach from Form Three up to Form Six. (Shomari, 2000) [18] Contends that, there are many primary schools, whose output is poor, but also, there are secondary schools both private and public whose outputs are poor. This is caused by poor teaching contributed by poor teaching qualifications possessed by teachers, who mostly use the talk and chalk teaching methods. It is suspected that poor teaching may have originated from the teachers training colleges which use of specific uniform curriculum, for academic and professional preparation.

All other things being equal, highly qualified teachers produce greater student achievement than comparatively less qualified teachers. The teacher quality has gradually become a focal issue in the field of teacher education (Wang & Fwu, 2007) [3]. Alexander (2005) [1] conducted a study on the effects of teacher qualifications on student achievement in middle school mathematics in Texas; he made a comparison of academic performance in mathematics between students taught by well qualified teachers and under qualified teachers. From his study, he revealed that students who were taught by well qualified teachers performed better in the mathematics test than students who were taught by under qualified teachers.

Quality of teachers as a factor for poor academic performance of students in schools is also mentioned by different scholars. Kiwia and Odada (1991) [8] reported that teachers are not well prepared in their colleges or universities. Student teachers are complaining about the unfairness or unsatisfactory supervision during teaching practice. The lack of enough supervision has resulted from economic difficulties that make tutors to not spend enough time to assess students' teachers. Instead the assessment had been done hastily so as to spare time to go to other activities for which they could earn money. The follow-up of the students and maintaining the links with teachers colleges after graduation has virtually been impossible because student teachers are posted to the very remote schools in other regions. The inadequacy preparation of teachers has affected the quality of teachers which also affects the quality of students who pass through the hands of those teachers.

Many secondary schools perform poorly in Form Four and Form Six Nation Examinations because the schools possess many teachers who are under qualified with very few qualified teachers (Hemedi, 1996) [5], mainly individuals who have completed Form Six and failed to qualify for further education and training (Mashaka, 2005; MoEVT, 2014) [10, 13]. Coleman *et al* (1969) [2] argue that, a gross disparity in academic achievement between children attending different secondary schools are caused by differences in qualification of teachers in those schools, teachers in secondary schools for Negroes are not well qualified while teachers in secondary schools for whites are well qualified. Therefore, secondary schools for Negroes perform poorly than the secondary schools for Whites. Students' performance in science subjects has been remarkably low and shows a lot of concern to educators and policy makers in Tanzania. If one has to analyze the mathematics and science subjects performance against other arts subjects, would accept the need to explore among others the way teachers receive enough TPD programmes to enhance quality in their teaching. Mathematics and science subjects' performance in examinations has been deteriorating every academic year as indicated in the Table 1.1

Table 1: Students failure rate (%) in Science and Mathematics Subjects Examinations from 2006-2015

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Chemistry	25.7	30.4	37.9	42.9	56.1	56.7	54	49.8	43.5	39.9
Physics	60.9	38.5	46.4	44.5	55.4	56.8	57.5	55.9	53.3	55.7
Biology	48.6	42.5	53.7	56.8	69.5	56.6	69.5	62.9	51.7	46.3
Math's	76.6	68.7	75.7	82.1	83.9	85.4	88.7	82.2	80.4	83.2

Source: National Examinations Council of Tanzania (NECTA, 2016)

In addition, many states, however, are facing the shortage of qualified teachers, in response for that, states have continued to allow under qualified teachers entry into the profession as a means to reduce the shortage (Alexander, 2005) [1]. The prospects are recruited into teaching colleges under crush programs for a duration ranging from one month to one year, then after the completion of the training, they are given a license to be teachers, but in real sense most of these teachers are actually under qualified (Kiwia and Odada, 1991) [8], Alexander, 2005) [1].

Teacher characteristic such as certification, content knowledge, pedagogical knowledge, years of teaching experience, and assignment in-field has the effects on student outcomes (Wang & Fwu, 2007; Alexander, 2005) [3, 1]. Shomari (2000) [18] also reported that poor performance of students in Form Four National Examinations in some of secondary schools that are owned by Tanzania People Defense Force (TPDF) is caused by presence of under qualified teachers in those secondary schools.

2.2 Government policies to professional development of science and mathematics teachers

The education system of Tanzania country depends on the policies which are derived from its philosophy (Education for self-reliance). The professional development plans and programmes will also depend upon the policy of the country as Tanzanian government in education training policy of 1995 stipulates:

> Teacher professional development constitutes an important element for quality and efficiency in education. Teachers need to be exposed regularly to new methodologies and approaches of teaching consonant with the ever changing environment. The teaching effectiveness of every serving teacher will thus need to be developed through planned and known schedules of in-service training programmes. Therefore in-service training and re-training shall be compulsory in order to ensure teacher quality and professionalism (MoEVT, 1995).

The professional development may be obstructed by the policies of the country. Teachers may be eager to implement new methods in teaching science and mathematics to students but the policy may resist it and hence continue insisting teaching using the traditional methods. For example the use of constructivism teaching approach is modern teaching methods which can make students construct knowledge and concepts. Teachers preparation is currently in the process of adopting the constructivism and social learning theories where by teachers are being trained to design and provide learning tasks/activities to learners which give chance to learners to interact with his/her environment, to use their prior knowledge, work collaboratively and solve problems in their life, such activities include; experiments, portfolio, field trips, research project works, class discussion, mind mapping, hands-on activities and pre-testing. In practice, for example 13.6% of teachers practice the constructivism in teaching chemistry (Kagisi, 2009) [6], Shemwelekwa, (2008) [17] showed none of the teachers in Tanga region practice the constructivism theory in teaching mathematics while Lushinge (2009) [9] showed that 62.5% of the teachers in secondary in Nyamagana district were incompetent towards this theory. Kagisi, (2009) [6] showed that many teachers (82%)had not get any in-service training on the approach since they joined teaching profession therefore teachers lacked both theoretical and practical knowledge on teaching chemistry by applying the constructivism theory.

3. Research Methods

The study area

The study was conducted in Dares Salaam Region, specifically in Temeke district at Chang'ombe secondary school. Temeke has many schools which offer science subjects both o-level and advanced level and hence the researcher was able to collect relevant data. Chang'ombe secondary school is a government secondary school which is under the control of Dar es Salam University College of education (DUCE), a constituent college of the University of Dares Salam (UDSM). It is located within DUCE closely to the National stadium. The school has 44 teachers 19 out of them are science and mathematics teachers. The number of students is 616 making a ratio of 1:14.

Participants and sampling techniques

In this study the projected sample size was 13 (8 science and mathematics teachers and 4 heads of department from mathematics, chemistry, biology and physics and the head of school) basing on their teaching experiences. Since the main interest of the researcher was to investigate whether there were professional development programmes for science and mathematics teachers in Dares Salaam and explore the challenges faced in implementing the programmes in science subjects in secondary schools, purposive sampling techniques were employed. Purposive sampling was used to sample science teachers from Chang'ombe secondary school basing on their teaching experiences who provided enough information on professional development programmes carried out at Chang'ombe secondary schools. The major reason that led to the use of purposive sampling technique is the kind of information expected to collect from the informants and to increase utility and reliability of the study results.

Data collection tools

In this study I made analysis of invitation letters for professional development programmes, reports of attendances on professional development programmes, programme calendar for the professional development in the school, school timetable and documents resulted from attended programmes. For that reason, the study used both published and unpublished sources of data as documentary review so as to get useful information. Semi structured interviews was employed by the researcher to collect data because it is flexible in nature and that allows the researcher to collect much information from the respondents. More specifically, semi structured interviews schedule was simple to be administered because they allow removal or adjustment of questions seem unsuitable. More over semi structured interview allowed direct contact for checking accuracy and

relevance of data collected. Through this technique, the in-depth information was from 8 science teachers and mathematics teachers and 4 heads of department and the head of the school.

4. Results and Discussion

Qualifications of teachers have a great impact in the academic achievements of students because teachers play the central role in the formidable endeavor through imparting the needed knowledge and skills in the minds of students. They are expected to be builders of the mental defense who help to build an invisible fortress of solidarity and loyalty in every citizen's mind, and constructors of economic infrastructure who are required to produce a dedicated workforce for the developing economy (Wang and Fwu, 2007) [3].

The study revealed that most of the teachers teaching at Chang'ombe secondary schools are qualified teachers whereby 10 out of 19 are degree holders 2 are masters holders and 7 Diploma holders. This qualification is stipulated in the Education and Training Policy of 1995

> The minimum qualification for a secondary school teacher in both government and non-government secondary schools shall be possession of a valid diploma in education obtained from a recognized institution. The diploma teachers are expected to teach in Form One and Form Two, while graduate teachers normally teach from Form Three up to Form Six.

All other things being equal, highly qualified teachers produce greater student achievement than comparatively less qualified teachers. The teacher quality has gradually become a focal issue in the field of teacher education (Wang and Fwu, 2007, Kitta &Fussy, 2013) [3, 7]. Alexander (2005) [1] conducted a study on the effects of teacher qualifications on student achievement in middle school mathematics in Texas; he made a comparison of academic performance in mathematics between students taught by well qualified teachers and under qualified teachers. From his study, he revealed that students who were taught by well qualified teachers performed better in the mathematics test than students who were taught by under qualified teachers.

4.1 Teaching experience for science and mathematics teachers at Chang'ombe secondary school

Teaching experience is a crucial factor in delivering quality education especially in science and mathematics. This is true due to the fact the experienced teachers always have attended different professional development programmes compared to the less experienced teachers.

From this study, it was revealed that, the teachers are still young in the field of teaching profession. Among 8 teachers interviewed, 2 have experience of five years, 4 teachers have teaching experience of four years and 2 teachers have the teaching experience of three years. Teaching science and mathematics need experience in many aspects such as experimentation skills and other practical skills as one teacher responded:

> When I arrived in this school I faced problems in preparing biology practicals and when I asked for the help the response was that there were no professional teachers for practical.

4.2 Teacher professional development programmes present at Chang'ombe secondary school

The study revealed that teachers posted at Chang'ombe secondary school were not mentored. All teachers interviewed including the heads of departments said that they were not mentored by the time they arrived for teaching and they continue receiving teachers posted to their departments without even a small induction as was responded by one teacher;

> When I arrived here at the first time, I was send to the head of department who gave me teaching subjects without introducing me to the staff members. There was no single induction conducted even at the level of department.

Teacher professional development**s** conducted at Chang'ombe school were very few. These are subject associations whereby each subject appoints one science teacher to attend the association three times a year. The most subjects which showed active attendance were chemistry and biology. Chang'ombe is the centre for Biology club association in Temeke District where by the school can be represented up to 3 biology teachers as the advantage of hosting the association. Also one respondent said that, there are programmes which are organized by the ministry of education and vocational training where she has attended 3 times. Very few programmes are conducted at Chang'ombe secondary school as the effort of the school administration. There are short workshops conducted at the mid of term and at the end of the year where they evaluate the academic achievement as witnessed by one respondent:

> We don't have internal programmes in this school except in evaluating the performance after the form four, form six results and the annual examination where we meet together and exchange ideas on how to set good items, scoring and standardizing the students' scores.

4.3 Dissemination of knowledge and skills to other science and mathematics teachers

It was impossible for all science teachers to attend professional programmes conducted due to few teachers and teaching load they have, so dissemination of knowledge and skills to the remained teachers was inevitable. The study however revealed that the ways teachers disseminate the knowledge and skills to other teachers is not effective because of the poor organization and follow up by the school administration. This was said by one respondent:

> When the teachers' returns back from workshops and seminars, no initiatives which are taken by the administration on disseminating the knowledge and skills to other teachers and if it happens the teachers do not attend. Also the time for sharing the information is very limited to an extent that nothing is achieved.

Teachers are not ready to learn from others the knowledge, skills and altitudes unless if they are paid. It is possible for a new teacher to acquire mathematics and scientific skills by cooperating together with those with experience. It is wonderful for a science teacher to fail to prepare biological reagents and standard solution for scientific experiment while in the same school there are teachers who are able to do those. One respondent said that:

> In a previous school where I used to teach biology, there were one teacher who was preparing chemical reagents for my students but when I arrived here I did not found one to do for me and this forced me to attend workshops which are initiated by TAHOSA. Now I can do them myself and do it to my fellow teachers.

4.4 Modality of TPD Programmes conducted at Chang'ombe secondary school.

The study revealed that teachers are not involved in selecting ideas or topics that are going to be delivered in the workshops and seminars. All the respondents (5/5) said that they were not involved in selecting the topics to be learnt in the workshops and seminars. This is a big problem because teachers are the ones who know the weaknesses they have in delivering quality education in science and mathematics so by not involving them in the selection of the topics they think will be helpful, nothing can be added as new to some of teachers. One respondent said that:

> When the time for workshop reached I received a letter from the headmaster telling me to attend the workshop. It was not pointing out even the theme which is going to be in the workshop. When I asked the head ministers she told me that each and every thing has been prepared by the coordinators of the workshop and thus I was to go blindly.

The study revealed that teachers attend subject associations which are under Temeke District. Chang'ombe is a center for Biology association club. In this association, they normally meet three times a year (March, May and July). This association is conducted while students are studying and hence only one teacher from each school attends while others continue teaching. Teachers are given allowance of 10,000/= as travel cost and are given breakfast and lunch but other costs are on the hands of themselves. The criteria used in selecting the teachers who attend the workshops, seminars and subject association clubs were mentioned by the head of the school that are: experience, hardworking and the ability of the teacher to disseminate the knowledge after the workshop to other teachers.

4.5 Effectiveness and challenges to professional development programmes

The study revealed that teachers appreciate the importance of TPD programmes in their teaching profession. Those who have attended professional development appreciated that the programmes have improved the teaching skills especially the pedagogical skills. Some said they have gained experimentation skills where they are able now to teach, prepare and teach practical for form five and six.

The study explored the following challenges as posed by science and mathematics teachers:

- Lack of motivation to science and mathematics teachers
- Lack of laboratories and its equipment for conducting experiments
- Lack of fund to organize professional development and small incentives given to teacher attending the programmes.
- Changes of the curriculum without training teachers for them to adapt the changes
- There is biasness in selecting teachers to attend TPD programmes
- Insufficient professional development programmes such as workshops, seminars, mentoring, clinical supervision, train a trainer and peer coaching.
- Teaching load due to few numbers of science and mathematics teachers which results failure to attend the programmes.
- The following are the challenges posed by the head of the school on the development of TPD programmes:
- Some teachers do not provide feedback to the head of the school after attending the programmes
- Attendance of teachers in subject association club is very poor and hence the programmes lack its effectiveness.
- There is lack of buildings were programmes are to be conducted and hence they were to use a small laboratory to conduct workshops.
- The time when the programmes are conducted affects other school programmes.

5. Summary and Conclusion

The research revealed that 19 teachers out of 44 teachers in Chang'ombe secondary school were science and mathematics teachers, where by most of them are degree holders while few of them having masters and diploma. It was noted that 19 out of 44 (19/44) teachers, teaching science and mathematics at Chang'ombe secondary school were not mentored when they were posted to teach science and mathematics in secondary school. Instead they were provided responsibilities without any induction. Within the period of 4 years, four (4) teachers of science and mathematics out of 19 (4/19) attended different professional development programs. The respondent of the research said that, at Chang'ombe secondary school teachers undergo different TPD every year, which are organized by the ministry of education and vocational training and sponsored by Japan International Cooperation Agency (JICA) also they attend subject association clubs which are organized by TAHOSA at district level (Temeke). Most of the respondents satisfied with the way these TPD help them in teaching science and mathematics. Teachers argued that they need more TPD in science and mathematics due to development in science and technology in the world which accompanied with the changes in science curriculum, methods of teaching, and mode of assessment and the number of teachers to attend should be increased.

Conclusively, basing on these findings it is very difficult for teachers to meet the required standard of science literacy to their students. The TPD programmes are not enough and are not regular keeping in mind that both content and pedagogical knowledge for teachers are part and parcel of the teaching career as it changes from time to time and hence TPD programmes are inevitable for teachers. Professional development needs teachers to develop their capabilities in terms of skills and knowledge, so teachers they should not focus how much they are required to be paid but they should think on the skills and knowledge that will be acquired at the end of any TPD. Those teachers who attended TPD should disseminate the knowledge and skills to other teachers when required. Professional development needs teachers' initiatives and efforts; teachers should help new teachers in profession by doing mentoring and clinical supervision. The head of schools should make sure that all science and mathematics teachers who are posted in their schools are mentored. The new teachers in profession should be assigned experienced teachers in the departments. Subject association clubs should be conducted during the holiday or weekends so as to allow participation of all teachers in the respective

department. Also the schools should allocate fund to motivate teachers who attend these TPD rather than giving them only transport allowance.

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