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The TEAMS Project in Tanzania: From Intervention to Capacity Building

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Abstract

The TEAMS project in Tanzania was established at the University of Dar es Salaam (UDSM) in the mid nineties of the last century as a response to a study which showed the poor state of science and mathematics in the country. The project, a cooperation between science and mathematics educators at UDSM and Dutch counterparts and funded by the Dutch government, was aimed at assisting with the production of more and better-qualified science and mathematics teachers. Specifically the project sought to help in setting up more productive and effective teacher education programs, to build capacity at UDSM via formal Masters and PhD studies of staff, to develop postgraduate programs for leadership development for stakeholders in the education system and to break the isolation of science teacher educators through international exposure. The paper outlines the activities undertaken by the project (which ended in 2004) and the extent to which project objectives have been achieved. The paper closes with a section on experiences and lessons learned from the operations of the project. It focuses on project execution, relations in the project, new teacher education programmes, research, and capacity building and sustainability. The capacity building activities in the TEAMS project are seen as one of the most successful components of the project. The end of the project coincided with the launch by the Ministry of Education and Culture of the Secondary Education Development Plan (SEDP) which requires development of new teacher education programmes, additional leadership in (among others) the areas of curriculum development, assessment, subject advisory and inspection services. It is concluded that the project has made a significant contribution in these areas.

Introduction

The TEAMS project was a science[1] teacher education project at the University of Dar es Salaam (UDSM) from 1996 to September 2004. It was established as one of the projects

[1] In this paper 'Science' is meant to include 'mathematics' in all cases.

in response to the perceived poor state of secondary science education in the country. The project was funded in the framework of the programme for co-operation between University of Dar es Salaam (UDSM) and Dutch higher education institutions. Partners in the project were the UDSM in Tanzania and Vrije Universiteit Amsterdam, University of Twente and University of Utrecht in Holland.

The project operated in two phases, from 1996-1999 with a short extension into 2000, and a second phase that ran officially from October 2000 to September 2004. This second phase was essentially a continuation of the first, but lessons from the first phase were included in the design and strategies employed in the second phase. The observations made below are mostly based on the second phase of the project.

The paper begins with a look at the origins and initial intentions of the project. It then goes on to focus on the activities that were carried out in the course of the project. Finally it reflects on the TEAMS achievements and lessons learned, with particular emphasis on the sustainability.

Origins and intentions of the project

Challenges in science and mathematics education at the start of TEAMS

The problems of secondary science education and science teacher education at the university at the time of the first phase of the TEAMS project were summarised as follows by Chonjo, O-saki, Possi, & Mrutu (1996):

- Secondary school curriculum was overloaded, theoretical and not relevant.
- Teaching approaches in schools were characterised by memorization of large amounts of verbal information to pass examinations. Practical activities and demonstrations were hardly done at all. Those that were only served as a preparation for the practical examinations at O-level and A-level.
- Implementation conditions in schools were problematic.

As a consequence, students came to the university without having been exposed to good science instruction. Their attitude towards learning focused on memorization; the understanding and application of concepts and theories were not included in their study routines. When students prepared to become A-level teachers, they carried this attitude forward into their own teaching practices. As the university curriculum did not prepare them sufficiently for another approach, the new A-level teachers of mathematics and science carried on with the unsatisfactory teaching approaches that are prominent in secondary schools. The lack of adequate in-service education training activities compounds this problem. There are few science education courses, and those that do exist are hardly ever integrated with the pure science or the general education courses (TEAMS 2000).

At the time the project started secondary education in Tanzania was very under-developed. Transition rates from primary to secondary education were among the lowest in sub-Saharan Africa. A recent analysis (O-saki 2004; O-saki & Njabili 2004) indicated that the net enrolment rate in secondary education in Tanzania was until recently a mere 6.3%

(rest of Sub-Saharan Africa: 25-39%) and the transition rate from primary to secondary education was around 25%, while the rest of Africa ranged from 50-80%. During the time TEAMS operated, a moderate expansion of secondary education has taken place, but extraordinary expansion is now (2004) being put in motion at the end of the project in terms of the Secondary Education Development Plan (Ministry of Education and Culture 2004). As part of this plan, secondary education is to expand such that a transition rate of 50% from primary to secondary education is achieved by the year 2015. This expansion has major consequences for the number of teachers to be trained. About 6000 diploma teachers will need to be trained by Teacher Training Colleges (TTCs). In the diploma program, each student receives a one year in-college and one year in-school training after the completion of their of A level secondary education. The universities will need to produce about 610 graduate teachers in 2005 rising to an annual production figure of around 2390 by 2015 in order to teach at A-level schools and provide leadership in O level schools as well (TEAMS 2004; MOEC 2004).

The project was initiated to assist with the production of more and better-qualified science and mathematics teachers and to organize Dutch support for this endeavor. Specifically the project sought to:

- help in setting up more productive and effective teacher education programs,
- build capacity at UDSM via formal Masters and PhD studies of staff,
- develop postgraduate programs for leadership development for stakeholders in the education system,
- break the isolation of science teacher educators through international exposure by means of presentations at conferences and seminars, mutual visits and partnerships.

Objectives

Specific objectives for the project were formulated in three areas (TEAMS 2000): pre-service education, in-service education, and capacity building and research.

(1) In pre-service education

The University of Dar es Salaam will develop its capacity for delivering new pre-service teacher education programs in science and mathematics education.

(2) In in-service education

The University of Dar es Salaam will develop its capacity for delivering a leadership training program for science and mathematics education, focusing on supporting teachers/ tutors in improving teaching in schools and colleges; and will develop a plan for expanding/ adapting the program for use at a wider scale. A system of regular curriculum-related in-service activities with teachers, involving other stakeholders and using teacher resource centres and teacher training colleges for delivery will be put in place.

(3) In capacity building and research

The Joint Centre for Science Education (JCSE), with appropriate organisational structures, supported through both the Faculty of Science (FoS) and the Faculty of Education (FoEd), will be established for coordinating and organising the development and delivery of

science education courses in pre-service programs, for curriculum materials development and in-service programs for teachers, for leadership training in science education, and for research and related services in the domain of science education. The JCSE will become nationally and internationally recognised as an important centre for expertise on science education in Tanzania.

Table 1. Outputs of the TEAMS project

Domain	Outputs
Pre-service education	New programs for the BEd (Science), the BSc (Education) and PGDE qualifications. New courses for these programs, as well as for the PGDE have been developed and are implemented. Existing courses have been adjusted where necessary. In particular the fourth year science education courses have been revised. Course outlines and further materials have been produced and necessary equipment is available and being used. A fully operational computer lab for science education students. The lab is used by Masters of Education students, PGDE students, 4th year science education students, as well as by teachers working together with CSE staff on the development of curriculum materials.
In-service education	A tailored version of the Master of Education program in the Faculty of Education. The program has been developed to suit the needs of experienced teachers or tutors who wish to be involved in providing in-service courses or developing materials for use by others. At least two special course options have been developed directed towards science education in-service work, and additional material has been developed for other courses to tailor them to the specific needs of the target group. Market research has been carried out on the needs and modalities for a further postgraduate training program (advanced diploma level) for a wider target group of in-service providers and leading teachers in the system. Based on the results of the market research, a program has been developed and implementation has started towards the end of the present phase (or will start early in the next phase). UDSM staff, in cooperation with others such as teachers and graduates from the Masters of Education program, are regularly involved in development of curriculum materials for use in schools and in (assisting in the) delivery of short in-service programs. An assortment of materials and short programs is available for regular use. ICT infrastructure as a support tool for communication and collaboration between teachers and UDSM staff, through Teacher Resource Centres (TRCs), and the Tanzanian Institute of Education (TIE) has been established.
Capacity building and research	Four junior staff members are in the final stages of their PhD study in a sandwich program with the University of Twente. Additional junior staff members have been identified for similar studies. At least four senior staff members from the Faculty of Science have intensified their professional interests in science education and are regularly involved in pre-service, in-service and research work in this field. They work in close association with science education staff from the Faculty of Education and are cooperating with the Dutch partners in development and research in science education. The Centre for Science Education (CSE) is properly established within the UDSM structures (under the DVC) and has a long-and medium-term development plan as part of the overall UDSM rolling planning process. Its internal organisation is clear and transparent and appropriate management procedures are in place. The CSE has regular co-operative links with other stakeholders in science education in Tanzania (e.g. TTCs, Ministry, TIE, and other projects). The Centre further forms part of a professional network of similar centres in science teacher education in Eastern and Southern Africa, e.g. through exchange of experiences and reciprocal use of produced materials

Proposed outputs

In consultation with all project partners and UDSM administration, the project formulated the following outputs in the three domains pre-service education, in-service education and capacity building and research (see Table 1).

Activities and results

During the nearly eight years the project has been active, it has undertaken a large number of activities in all three areas. The following sections elaborate on these activities and look at the results.

Pre-service education

In this domain the project has put emphasis on the development of new courses and the revision of existing ones in the restructured science teacher education program in the FoEd and 4th year courses at FoS. As the new 4-year program was implemented stepwise, the course revision followed a similar year by year format. Through a series of visits by Tanzanian partners to the Netherlands and Dutch partners to Dar es Salaam, the project assisted in the development of science education courses focusing on relevant content, activity-based pedagogy and productive assessment methods. Course outlines and lists of reference materials for lecturers and students were part of the development activities.

Implementation was initially cumbersome and early evaluations of some of the courses indicated very limited success, especially in the implementation of an activity-based pedagogy (TEAMS 2002). However, continued development and support have helped to move the pedagogy in the desired direction. A recent evaluation of seven science education courses (van der Valk et al. 2004) focused on four levels: the intended, the perceived (by the lecturer), the realised and the experienced curriculum. Courses evaluated included methods courses for biology, chemistry and physics, as well as a computer literacy course for teachers. Curriculum documents were analysed, lecturers were interviewed, course meetings were observed, student teachers' portfolios were analysed and students were interviewed and asked to complete a questionnaire.

The results showed that the curricula at all levels had an activity-based approach, provided student teachers with a variety of learning activities and encouraged them to produce a number of personal learning products. The evaluation did however suggest that, at the level of the intended curriculum, the activity-based approach in some course outlines could be better articulated. At the levels of the perceived, realised and experienced curriculum, many problems were revealed, such as lack of sufficient computer facilities, lack of sufficient textbooks, large classes resulting from the expanded student intake and limited availability of demonstration apparatus and laboratory equipment. Some lecturers nevertheless realised active student learning, while others seemed to fall back on the lecturing mode. One positive development is the way interactive pedagogy is now better understood and encouraged by the University's Centre for Continuing Education, itself a product of the TEAMS Project.

An important development was the introduction of portfolio assessment, which was implemented in some of the courses. Student teachers made portfolios consisting of curriculum materials that were useful to them and learning products they wrote themselves. However assessment of these portfolios was problematic because the system had not yet evolved to enable students to separate personal products from collections of photocopied materials and lecture notes taken in class (van der Valk et al. 2004).

The evaluation recommendations amongst others are to:

- develop the activity-based approach further and to *'teach what you preach'*;
- continue and intensify co-operation of lecturers within and across faculties;
- provide encouragement for lecturers to evaluate their courses and to study the learning of their students;
- solve practical problems that impede implementation of the activity-based approach.

These recommendations are now being worked on.

In-service education

The development of the new MEd in the Faculty of Education in science and mathematics educational leadership was a major achievement in this domain. The program was designed to differ from the existing MA (education) program in that it was conceived as a professional rather than an academic program, preparing educational leaders for their professional lives in schools, curriculum centres, examination boards, school boards and other leadership positions (UDSM 2001). Experienced teachers, curriculum developers, teacher educators, science and mathematics subject coordinators in the Ministry of Education and Culture were amongst the first cohort of students. The first group of 8 students who have successfully completed their dissertations will graduate at the end of November, 2004. The program is about to enrol its fourth intake of 11 students, after earlier intakes of 9, 3 and 3 students respectively. The program runs for four semesters. For much of the 3rd, and the whole of the 4th semester, students are involved in a research project. Topics of the research of the first cohort have been in the areas of curriculum renewal, teacher development, examinations and assessment, classroom interactions, and teacher education. The external evaluator of the program has assessed the standard of the resulting theses as excellent. Summaries of six of the theses have recently been published in the UDSM science and mathematics education publication series (Osaki & Tilya 2004). Students also presented their work at the final TEAMS seminar in September 2004.

Reflection by lecturers and students on the MEd program published in the TEAMS final report (TEAMS 2004) suggests that the first cohort of students has achieved well and is better qualified for professional work. It also indicates that the present design of the program was not different enough from the MA program (as was the original intention) in terms of its practical and professional nature. The reflection therefore recommends that, after four intakes, a revision of the program takes place with more emphasis on its practical nature and on positive change in pedagogical practice in science education at all levels of the education system.

An internal evaluation of the MEd program showed a positive impact of the program on its graduates once back at their regular work (TEAMS 2004). It suggested that the program be made attractive to a wider group of persons by enhancing its practical and professional nature and by developing advanced diplomas using certain parts of the program for curriculum developers, subject advisors, in-service facilitators and others in positions of leadership.

Capacity building

The project has paid much attention to science teacher education capacity building. In particular the Master and PhD trajectories of junior science education staff at the University of Dar es Salaam are seen as a major component of the project. These trajectories are expected to provide the necessary additional capacity for the execution of the multitude of activities in which science educators are engaged. In addition, senior staff have been involved throughout the project in more informal staff development activities through the cooperation with Dutch counterparts on program, course and materials development.

The professional growth that has been attained by many of the staff involved in TEAMS has become apparent. Most of the staff have become leaders in their own right in areas of specialization partly as a result of their involvement in TEAMS. They have been involved in evaluations of major projects at the Ministry of Education and Culture and of international organisations, supervision of a variety of in-service activities and have been appointed to committees responsible for the design of new programs. This growth has been of benefit to the project, but as it turns out it has also been a problem at times, as staff are now less available for core activities of the project.

Research

In its second phase, the project organized three conferences:

1. The Morogoro conference (2000) brought together TEAMS staff with stakeholders in and outside UDSM. It laid the foundation for the project activities and research for the next years.
2. The second conference was an international gathering on science and mathematics education in Arusha (2002), where Tanzanian science educators were able to meet and develop professional relations with regional and international science educators.
3. The third conference, which was also the closing activity of TEAMS, was held in Zanzibar. TEAMS met with staff in the Ministry of Education and Culture, curriculum developers at the Tanzanian Institute of Education (TIE), assessment and examination staff at the National Examination Council of Tanzania (NECTA), as well as the of Ministry of Science, Technology and Higher Education officials and other important stakeholders. The discussions centred around current issues in science and mathematics education with particular attention to the Secondary Education Development Plan and the role of science educators at UDSM could play in the execution of this plan (TEAMS 2004).

Furthermore, TEAMS staff participated in two international conferences, one in Windhoek, Namibia and the other in Swaziland, both organised by the Vrije Universiteit

Amsterdam. In addition, TEAMS staff took part in the annual conference of the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE) in Durban and was a partner in the World Bank study on science and mathematics education in sub-Saharan Africa. The conferences provided the TEAMS staff with platforms for communication with international colleagues. They have also given opportunities to PhD and MEd students to present their studies and receive feedback from participants.

Many of the studies by PhD and MEd students focused on the design and formative evaluation of new curriculum modules in science and mathematics classrooms. The modules were designed and tried out in classrooms using a development research approach (van den Akker 1999; Osaki, Ottevanger, Uiso, & van den Akker 2001). A teacher support scenario was part of the interventions. A study of the introduction of the new modules (Tilya 2002) focused on the introduction of ICT in practical physics at A-level. Kitta (2004) studied the implementation of a new mathematics module on probability with a focus on peer collaboration. The introduction of micro-scale chemistry practical work is the topic of Mafumiko (in preparation), while a fourth study is on the use of web-based materials in the teaching of ecology. In addition, a number of MEd research projects focused on aspects of curriculum development or teacher development.

Joint Centre for Science Education

The TEAMS project involved staff from both the Faculty of Education and the Faculty of Science in its activities. It operated through the informal Interfaculty Science Education Group (ISEG). An important objective of the project was to establish the more formal Joint Centre for Science Education (JCSE), housing science educators from both faculties, and to define a clear position for the Centre in the UDSM organogram. The JCSE is seen as the coordinating body for all science education activities (except for offering science education programs which are the responsibility of Faculties), including research and consultancies. Although the proposal for the Centre (UDSM 2004a) has been well received by the UDSM administration, final approval had not yet been received by the end of the project.

Reflections at the end of the project

This final section reflects on a small number of project aspects. The reflection is based on the outcome of a meeting of science education staff involved in TEAMS at the very end of the project as well as on further discussion by the authors who have all been close to the project.

Project execution

Capacity to absorb all suggested changes as outlined in the project document was often limited. This was caused by a number of factors:

- project execution was actively carried by only few of the larger pool of staff potentially involved in the project.
- heavy (teaching) schedules of project staff have made it often difficult to pull them away

from the office and classroom.

- project staff on training (PhD and Master studies) have not been available for project activities until towards the end of the project period. This has made the pool of committed staff even smaller.

Even though project design was based on realistic assumptions about available human resources, it appeared to be too optimistic in hindsight. More conservative planning would have been useful. The project scheduled major activities away from the office and the classroom, either in Tanzania, or in Holland. Especially the latter has resulted in considerable progress, also because of the availability of and access to a variety of experts and resources.

Some project activities have functioned as exemplary activities which have proven to be catalysts in University wide developments. In particular the initiative taken by TEAMS to start the pre-entry programme for girls at the Faculty of Science has developed as one of the main aspects of the university's gender mainstreaming effort (Urasa 2001; USDM 2004b). The development of ICT infrastructure in the Faculty of Education in the early stages of the project has provided the project with the necessary credit to continue and to be accepted. Such activities were answers to very concrete problems that existed at the time. Similar targeted activities also happened in later stages of the project, e.g. when TEAMS started up the review of the undergraduate programmes at UDSM.

Relations of institutions and people in the project

Relations between individual active staff in the project have been excellent during the time the project operated. Both within faculties and across the two faculties they operated as a unit. Even so, reflecting on the operations of the project at the end of the project, staff indicated that communication within the project could have been better. At the level of the faculties, relations at UDSM between the Faculty of Education and the Faculty of Science remained cordial but cumbersome, as seems to be the norm in many universities. Problems that surfaced had to do with investments, ownership of programmes and major activities and initiatives such as the Joint Centre for Science Education. The underlying problem is the multi-disciplinary nature of science education programmes. Both faculties have a stake in these programmes and are aiming for control. In addition, both faculties tend to claim as much course time in these programmes as possible leading to overload.

Relations between the Tanzanian partners and their Dutch counterparts have been cordial at all times, in spite of the fact that they have been operating from different personal and academic cultures.

New teacher education programmes

The project has been instrumental in the design, execution and evaluation of the new science and mathematics teacher education programmes at UDSM. Evaluation of several of the courses at the end of the project indicates that the goal of employing a more activity-based pedagogy in these programmes has been achieved. However, the evaluation has also shown that the observed changes must be seen as only a first step in a longer trajectory of quality improvement. With large and poorly resourced classes being the norm at present at UDSM, (e.g the fourth year methods course, CT 401, originally enrolling 20-30 science

students, now enrols 150 students) the context in which these programmes are being executed is hardly conducive for further quality improvement. What is observed here is a confirmation that:

Educational change is a long-term process without quick fixes;

Teacher support cannot be seen as detached from the context in which teacher development takes place.

Research

With the heavy teaching loads of project staff most of the research was carried out by PhD students on study leave. Little time was available for staff to engage themselves in research except for possible external consultancies and evaluations. Another problem that should be noted here was that science educators in the Faculty of Science would not get any credit for science education research. This is a long-standing issue since the beginning of the project which has never seen an adequate response from the faculty.

Capacity building and sustainability

Capacity building for science and mathematics education, although slow and less immediate in terms of impact must have been the most fruitful component of the project, certainly in a long-term perspective. It has resulted in a group of science and mathematics educators who are capable of assisting the Ministry of Education and other stakeholders with the implementation of the Secondary Education Development Plan (SEDP) of the Ministry of Education and Culture. The end of the TEAMS project coincides with the launch of this ambitious plan which foresees a transition rate from primary to secondary education of the present 25% to about 50% by 2015. The implications for teacher education and teacher development are potentially staggering. The number of teachers to be trained is immense in view of the fact that there may not be enough school leavers of adequate standard to enter teacher education programs. This problem has major consequences for the design of new teacher education programs (TEAMS 2004). Besides the problem of student numbers, the programmes also need to be redesigned for a different intake of less qualified students. The experiences gained by project staff during the project period in programme and course design will be extremely useful in the development of such programmes.

Similarly, through its MEd programme, the project has built capacity for leadership positions in subject advisory services, curriculum development, assessment and teacher education. Feedback on their experiences by the first cohort of MEd students now back at the Ministry, in their schools or NGOs indicates that the programme has adequately prepared them for their roles in those institutions.

Conclusions

It can be justifiably concluded that the TEAMS project has made considerable contributions to the development of science and mathematics education in Tanzania. Its focus on capacity building has contributed in no small measure to its sustainability. Nevertheless, some final reflections on lessons learned are in order.

Project planning may have been too optimistic about what was achievable with a limited number of staff who all had heavy teaching loads. Many of the project activities were undertaken as tasks over and above the normal duties. The project design was based on the assumed availability of more science educators than eventually took part in the activities of the project on a regular basis.

The cooperation within the TEAMS project of science education staff of two faculties (FoS and FoEd) has been rewarding for the staff involved, but has been cumbersome at the administrative faculty level. Competing interests slowed down progress of the project results and has put the sustained activities of the project period in doubt. One of the consequences has been the failure to establish the Joint Centre for Science Education proposed by the project to structure the cooperation between the science educators from the two faculties and to continue with activities started by the project.

The new and revised courses in the undergraduate teacher education programs have developed in the desired direction with a much more activity-based pedagogy than before. However, substantial quality improvements remain necessary in the future. Reform in education is a slow process, and the University of Dar es Salaam is no exception. The reform would be greatly assisted by an encouraging environment of well-resourced classrooms with reasonable number of students and working conditions for lecturers. The capability to offer new and relevant programs using modern teaching methodologies will be an important contribution to the Ministry's Secondary Education Development Plan.

In addition, the project has developed capacity for the design, execution and evaluation of the above mentioned programs, and for leadership positions in education. This is also seen as a solid contribution by the project towards sustainable development of education. However, such a contribution can only really be effective if a conducive context is created by the Ministry of Education and Culture, such the proper and massive support for teacher education and school development. Furthermore the UDSM needs to provide adequate institutional structures, such as the Joint Centre of Science Education, and career prospects for its science and mathematics education staff. Until such time, the contribution that can be made by project staff will remain limited.

The focus of the TEAMS project on program development and capacity building has resulted in limited direct impact on teaching and learning in secondary education in the *short-term*, but shows a considerable potential for *long-term* sustainable development in science and mathematics education. In this respect the TEAMS project is different from other projects elsewhere in sub-Saharan Africa, some of which were more intervention-oriented. For instance, the INSTANT project in Namibia (see elsewhere in this volume) was initially set up to assist the Ministry of Basic Education and Culture in Namibia in solving its immediate short-term problems in science and mathematics education following independence from South Africa. It focused on some immediate needs of teachers and thus had a direct impact on teaching and learning in classrooms in its early years of operation. The project in Namibia started to develop a long-term strategy towards the latter part of the project, once the most urgent needs were satisfied.

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