A NEEDS ASSESSMENT STUDY OF TANZANIA SCIENCE EDUCATION
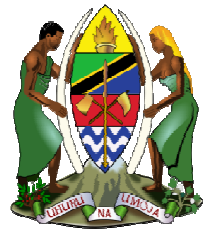
CARRIED OUT UNDER CONSULTANCY BY:

Authors: Dr. Mark Hamilton, Dr. Wilson Charles Mahera, Mr. Frank Jones Mateng'e and Mr. Maregesi Manyonyi Machumu

TABLE OF CONTENTS

ABBREVIATIONS

CAG	Controller and Auditor General
CARMATEC	Centre for Agricultural Mechanization and Rural Technology
COSTECH	Commission for Science and Technology
CSEE	Certificate of Secondary Education Examination
DEOs	District Education Officers
ESDP	Education Sector Development Programme
ESRF	Economic and Social Research Foundation
FAWE	Forum for African Women Educationists
GATCE	Grade A Teacher Certification Examination
GDP	Gross Domestic Product
GNP	Gross National Product
GST	Geological Survey of Tanzania
ICT	Information and Communication Technology
IKS	Indigenous Knowledge Systems
INSET	In-Service Training
MDGs	Millennium Development Goals
MKUKUTA	Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Tanzania
MKUZA	Mkakati wa Kukuza Uchumi na Kupunguza Umaskini Zanzibar
MoEVT	Ministry of Education and Vocational Training
MSTHE	Ministry of Science, Technology and Higher Education
NECTA	National Examinations Council of Tanzania
NEPAD	New Partnership for Africa's Development
NER	Net Enrolment Rates
NHEP	National Higher Education Policy
NIMR	National Institute for Medical Research
NIS	National Innovation Systems
NORAD	Norwegian Agency for Development Co-operation
NRC	National Radiation Commission
OECD	Organization for Economic Co-operation and Development
PEDP	Primary Education Development Plan
PRESET	Pre-Service Training
PSLE	Primary School Leaving Examination
R&D	Research and Development

SEDP	Secondary Education Development Plan
SIDA	Swedish International Development Co-operation Agency
STI	Science, Technology and Innovation
SWOT	Strengths, Weaknesses, Opportunities and Threats
TIRDO	Tanzania Industrial and Research Development Organization
TTCs	Teachers Training Colleges
UDSM	University of Dar es Salaam
UNESCO	United Nations Educational, Scientific and Cultural Organization
URT	United Republic of Tanzania

List of Tables

List of Figures

List of Photographs

EXECUTIVE SUMMARY

Background

Rapid, worldwide change has dramatically altered global educational needs, challenging societies to transform the structures and processes of education. In developing countries such as Tanzania, educational change means providing a quality of education that better addresses the needs of ever-expanding technologies in information systems, communications, medicine and engineering. The current Tanzanian educational system, which was meant to serve an agriculturally-based society, will not allow teachers and students to adapt to meet the economic and social demands that such global transformation is bringing. As a result, there is a wide discrepancy between the knowledge, skills and competencies that school graduates have and the needs of society.

In Tanzania, the need for educational reform that meets the demands of the 21st century workplace, particularly in science and technology, cannot be over emphasized. Its schools must produce graduates who can generate knowledge, think creatively and solve the kinds of complex social and economic problems they will face in society. In this era of global communication and collaboration, Tanzania must produce professionals who can work together to address the needs of an increasingly complex, technological-driven economy. The educational system can no longer afford to produce graduates with no employable skills. Rather, Tanzania must engage in the kinds of reforms that will develop students' lifelong learning, critical thinking, problem solving, and collaborative working skills—those of tomorrow's 'knowledge workers'.

The present needs assessment study serves as a first step in the reform of science and technology education in Tanzania. One of its primary purposes is to determine the specific gaps or weaknesses in services, infrastructure and opportunities in the educational system. The findings will provide direction in the redesign and implementation of the proposed Government of Tanzania / UNESCO science and technology education initiative.

Problem Definition

The problem of science, mathematics and technology education is two fold. On the one hand, there is the capacity of the system—human and material—to produce knowledgeable, capable

graduates, upon which the development of a technologically competent labour force depends. On the other hand, employing such a labour force requires innovations in medicine, telecommunications and information systems, agriculture, engineering, technical services and manufacturing to fuel job creation and national development. Policies, systems and practices in both of these areas must be in place in order to meet the challenges of attaining and maintaining social and economic progress in Tanzania. In other words, there must be a coordinated effort between the education and employment sectors to ensure that the education system is producing not only qualified graduates, but those whose knowledge and skills are both in demand and which will meet the development needs of the country.

Unfortunately, issues of student performance, quality of teaching, and students' lack of readiness for jobs in science and technology are widespread in Tanzania. Data gathered during the study show a lack of human and material resources throughout mainland Tanzania and Zanzibar. The needs appear to be more dire in rural versus urban areas, however, only marginally so. The issues highlighted in the present report are seriously hampering efforts to expand and improve upon the quality of education and, subsequently, the pace of progress towards the realization of national social and economic development goals.

The present study examines the conditions of education and employment in Tanzania. How are students performing? What is the capacity of the system to prepare students in terms of giving them quality education in science and technology? What are the prospects for establishing centres of excellence in science, mathematics and technology education to support this effort? Specifically, what are the potential opportunities, needs and strategies for establishing such centres in Tanzania—given its particular challenges of social and economic development? The role that science and technology can and does play in this process has been widely documented. However, what is still lacking, especially in Tanzania, is a systematic analysis of how Tanzania's education system can be strengthened to promote the development of science and technology. A primary objective of this effort is to enhance the nation's capacity to create jobs while producing people with the necessary skills and competencies to meet the technology demands of national development in a technological age.

Context and Findings

A review of the literature reveals that there is a strong correlation between the advancement and application of science and technology and economic growth (Bernardes, et.al, 2006; Utz and Aubert, 2008). In view of this perspective, the Tanzania Vision 2025 development plan

correctly associates Tanzania's weak economic base to the low-level utilization of science and technology, which in turn has resulted in low productivity and growth. According to the Tanzania Vision 2025 plan, 'Education should be treated as a strategic agent of mind-set transformation and for the creation of a well-educated nation, sufficiently equipped with the knowledge needed to completely solve the development challenges which face the nation' (URT, 2000). Unfortunately, this transformation has yet to be achieved, despite some progress in the development of the science and technology sector.

On the one hand, there have been improvements, both in the expansion of the technology sector, and in the education system that supports its growth. On the other hand, the pace of expansion in technology largely has been limited to ICT. Conditions in education as a whole have likewise improved. Yet there are other, deeper problems of quality of education, equity of access (i.e., especially for girls and women) and the employment readiness of science and technology graduates at all educational levels.

At first glance, the technology sector of Tanzania appears to be expanding at a relatively rapid pace, especially with advances in information and communication technology (ICT) worldwide, including Africa. This change is taking place partly through increased access to and expansion of the telecommunication services, facilities and networks. For example, the market revenue of the communications sub sector grew from US 143 million dollars in 1998 to 359 million dollars in 2003. By 2008, the average growth of the sub-sector stood at 14% (Utz and Aubert, 2008; URT, 2009). The government of Tanzania thus has adopted a number of policies related to the promotion and use of ICT in achieving social and economic development objectives. These include the 2003 Tanzania National ICT Policy and the 2007 ICT Policy for Basic Education. However, these changes mask deeper issues, in which the rate of technology expansion in Tanzania is relatively slow in most every other area of the technology sector. Further policy initiatives are therefore critical to meeting the needs of the other technology sub-sectors. For example, while the national development plans, MKUKUTA and MKUZA, appear to include science and technology goals, objectives, needs and strategies, their proper integration is lacking (Tema and Mlawa, 2009). Education sector policy is likewise lacking a clear, well-integrated focus on the pivotal role of science and technology education in the overall development of the education sector as a whole, and in the achievement of national development goals.

Following the launch of the Education Sector Development Programme (ESDP) in 2001 significant achievements have been recorded in terms of increased enrolments in both primary

and secondary education. Gross enrolment ratios for primary education increased from 78% in 2000 to 106% in 2004, whereas the net enrolment ratio increased from 59% to 91% during this same period (Utz and Aubert, 2008). Yet these important gains mask more fundamental issues and problems, which threaten to undermine the progress made. Data from the present study and from other sources point to alarming trends in popular satisfaction with the quality of education in Tanzania, in which the ability of children and young adults to gain adequate access to quality education increasingly is under threat.

While education is considered fundamental to the creation of knowledge in today's global marketplace, recent findings suggest that many children find school 'useless and uninteresting'. In Dar es Salaam, for example, children's dislike for school has 'increased from 2% to 24%' (URT, 2009). Findings from the present study likewise reveal widespread dissatisfaction among students and teachers alike with the state of education, particularly in science and mathematics. Secondary school students find themselves without teachers, forced to seek out special classes and courses to take the place of adequate preparation in these subject areas. For their part, primary schools lack teachers of mathematics and science as well. Many primary-school teachers are asked to teach science and/or mathematics, yet do not have adequate qualifications, are poorly trained and unable to apply learner-centred and context-based approaches to teaching.

Surveys conducted with teachers themselves reveal a lack of awareness of context-based approaches in particular, including the application of 'real-world' problem-solving activities that draw on local issues in, for example, health or the environment. Unfortunately, these inadequacies do not become evident until the secondary-school level, where many students have already fallen behind in their learning of science and mathematics content. And while university/college students express satisfaction with the quality of pre-university preparation received in mathematics and science (66% of the 42 students surveyed), they likewise expressed doubts about their ability to meet the demands of an increasingly technological and global marketplace.

Despite significant achievements in improving access to quality education in Tanzania over the past two decades, continued poor performance in mathematics and science at the primary- and secondary-school level raises concerns over whether or not the education system can supply graduates who possess the competencies required of them within the emerging technology sector. Failure rates in both mathematics and the sciences remain high, with little improvement at either the primary- or the secondary-school level. For example, mathematics scores on the

UNESCO Needs Assessment Study of Tanzania's Science Education

'O' level national examination have varied widely, between 20 and 40% for the past three years. National and local leaders in both the private and the public sector who were interviewed during the study agree that substantial improvements to the quality of mathematics and science education is vital to the kind of sustainable, scientific and technological progress that is necessary to realizing national development goals.

Statistical data gathered during the present study reveal a consistent downward trend in student performance in mathematics and other science subjects. These data have significant implications for the nation's development potential. According to a recent World Bank publication, Tanzania still lacks 'the sound base of an adequately qualified and trained workforce to spur further innovation, technological and economic development' (see Utz and Aubert, 2008). The lack of capacity of the educational system to prepare a competent workforce therefore poses a threat to the attainment of the Vision 2025 goal of 'a Tanzanian Society that will be competitive, knowledgeable, scientific and technologically anchored among the community of nations' (URT, 2000).

It is estimated that nearly 75% of the Tanzanian population relies on agriculture (URT, 2009). Yet the sector's reliance upon traditional means of production has led to a decline in its contribution to GDP during the past decade, from 30% in 1998 to 24% in 2008. The average growth rate for the sector of just over 4% since the year 2000 is far short of MKUKUTA's target of 10% by 2010 (URT, 2009). Findings of the 2007 Household Budget Survey reveal that 38% of the rural households live below the basic needs poverty line as compared to 24% of their urban counterparts—with the exception of Dar es Salaam, where the poverty rate is 16% (URT, 2009). Changes in the rate of development of new technologies in agriculture, as well as other sectors, is clearly needed in order to achieve national goals for economic growth. As the findings of the present report show, these changes depend upon improvements in the educational system as a whole and in science and technology education especially.

Study Rationale

In order to prosper in today's global knowledge economy Tanzania must strive to develop a competent work force to advance scientific and technological innovations. It is with this goal in mind that the Tanzania National Science and Technology policy of 1996 seeks, among other things, to promote the development and utilization of science and technology as vital 'tools for economic development, improvement of human, physical and social well-being' of the country (URT, 1996). A central component of the 1996 policy strategy is the Tanzania Commission for

Science and Technology (COSTECH). First established in 1986 COSTECH replaced the Tanzania National Scientific Research Council (established in 1968) as the country transitioned towards a market-based economy. According to Mukama and Yongolo (2005), the 1986 policy 'marked the beginning of a new era of improved co-ordination and monitoring of R&D activities'. COSTECH's establishment was followed soon by that of the Ministry of Science, Technology and Higher Education (MSTHE) in 1990. Despite these important steps, however, the pace of development, innovation and expansion within the technology sector has not been sufficient to meet national targets of economic growth and development—specifically, those of MKUKUTA, MKUZA and Vision 2025.

According to international models of science, technology and innovation (STI) systems, 'hi-tech' (versus 'low-tech') R&D activities are what fuel the expansion of the technology sector and increased rates of economic growth, which have been possible in Tanzania in the past. Countries such as India and China have found their own ways of expanding the technology sector, in order to fuel national economic growth. The same is true of many African countries, such as Rwanda and Kenya, where leaders are increasingly looking towards science and technology as sources of prosperity and improved well being for their peoples. According to Rwandan President Paul Kagame, 'We will continue to invest in our people and strive to open up the frontiers of science, technology, and research as we broaden our trade links with our neighboring countries and beyond'. He adds that the decision about whether to make this investment is no longer an option for countries of Africa. 'We in Africa must either begin to build our scientific and training capabilities or remain an impoverished appendage to the global economy' (p. ix, Watkins & Verma, 2008). The role of COSTECH thus is to enhance the conditions of research and development of commercially-viable processes and products through funded programmes, coordination and improved collaboration among private- and public-sectors on the one hand, and parastatal institutions of the STI system on the other hand.

The 1996 policy measure made COSTECH a cross-cutting institution, giving it the relative autonomy necessary to work directly with government institutions. It is responsible for 'co-coordinating and promoting research and technology development activities in the country.' According to data collected at the national level, part of COSTECH's mission is to coordinate, promote and facilitate development of the Science Technology and Innovation system. This effort includes the promotion of scientific research, exploration and the development of commercially-viable products and processes to help fuel the expansion of the nation's technology sector. In this respect, COSTECTH is essentially 'the chief advisor to the Government on all matters pertaining to science and technology and their application to the socio-economic

development of the country.' Yet the institution can only do so much with its mandate, without an adequate level of government commitment and investment. Although national investment in research and development has risen significantly, from 1 to over 30 billion Tanzanian shillings during the past year, this figure is still well short of the target set by the New Partnership for Africa's Development (NEPAD, of which Tanzania is a member), or 1% of GDP.

Changes of the past 10 to 20 years in how the government approaches science, technology and innovation—as an integral part of national development—have been significant, and are welcome. For example, giving COSTECH the latitude to consult directly with resource people across and within existing institutions and structures of government, such as universities and ministry directorates, should allow greater exchange of ideas. This arrangement should therefore lead to an increase in the number and quality of STI initiatives and partnerships while fostering the kind of intra-governmental creativity, guidance and problem-solving activity that can help to spur innovation and the expansion of the technology sector. Much work remains to be done, however, in order for these structures to realize their full potential to contribute to national growth and development.

In recognition of the link between science, technology and development the Government of Tanzania has formally committed to the 'reform and revitalization' of the National Science and Technology Innovation System. This effort has two primary goals. One goal is to 'enhance linkages between research institutions, professional associations and the private sector'. The other goal is 'to enhance the economic functions and ensure that STI contributes to economic development and long term competitiveness'. The reform and revitalization process includes the review and re-formulation of a new National Science, Technology and Innovations (STI) Policy. According to officials in the Ministry of Communications, Science and Technology the policy will incorporate the concept of innovation, which was lacking from the previous policy. The aim of the new policy is to 'guide the nation towards more effective utilization of STI capacities and capabilities in order to develop, transform and utilize resources' more effectively. According to the Ministry of Communications, Science and Technology the focus of the new policy is to include the following: clarification of the national STI agenda; institutional, legal and regulatory frameworks; human resource capacity development; STI funding; technology transfer; Indigenous Knowledge Systems (IKS); new and emerging technologies; and strategic collaboration and partnerships.

As part of the STI reform and revitalization process in Tanzania the United Nations Educational, Scientific and Cultural Organization (UNESCO), with the support of the President' Office,

commissioned the present *Needs Assessment of Tanzania's Science Education*. In May 2010, UNESCO asked the Economic and Social Research Foundation (ESRF) to carry out the present study. Its overarching purpose is to gather concrete quantitative and qualitative data on the status, performance, problems and opportunities of science and technology education and employment. The outcomes of the study will be used to advise the government on the appropriate interventions required in order to improve the quality of education and thus enhance the contribution of science, technology and innovation to the nation's economic and social development.

Research Methodology

The geographical, economic, physical, human, and cultural conditions of the 26 Regions of Tanzania are quite diverse. (Since the study began, the Government has increased the number of regions.) Yet these regions share at least three common features significant to the present reform initiative: (a) they are generally scientifically and technologically underdeveloped; (b) the schools and universities still maintain the traditional system of curriculum and instruction; and (c) most graduates of secondary schools, colleges, and universities are either unemployed or underemployed—i.e., having obtained a level of education beyond what is required by the kinds of work that are available to them. In view of these similarities, and in order to properly manage the study, the conditions of education and employment in selected districts of 8 regions of mainland Tanzania—plus Zanzibar and Dar es Salaam—were studied. Data were obtained through interviews, surveys, observations and document analysis, primarily from the following sources: teachers, university students and administrators, employers, parastatal institutions of research and development, centres of science-technology innovation and government ministries.

The study thus was conducted in a total of 9 administrative regions of mainland Tanzania (including Dar es Salaam) and in one region of Zanzibar. Data was collected from schools in two districts, one rural and one urban, within each of the selected regions. The study thus aimed to provide a representative picture of the state of science and technology education, employment and their contribution to socio-economic development in Tanzania. The study team thus considered a number of factors in the selection of regions and districts. These factors included, but were not limited to, geographical location, economic performance and conditions (i.e., regional contribution to GDP of socio-economically marginalized regions), and the presence/absence of higher learning institutions—including colleges, research institutions, schools and organizations—and private enterprises in the technology sector. The study likewise

aimed to provide data on education and employment as these relate to several key sectors of importance to Tanzania's social and economic development, including: medicine/public health, environment, industry, ICT and agriculture.

The study methodology and analyses were designed to examine and highlight issues, trends and factors in science, mathematics and technology education in Tanzania in the following areas:

- Administration
- Policy
- Teacher workforce preparation
- Curriculum and instruction (primary- and secondary-school levels)
- Employment systems for graduates
- Support services and employment development

Certain changes in the methods used were necessary during the course of the study, due to unforeseeable challenges in gathering data on employment—in two respects. First, data on employment—both current employment trends and future ones—were largely unavailable. Second, employers themselves often were unreachable or otherwise reluctant to participate in the study. In order to provide data on employment the study team revised the interview instrument used to gather data from national-level officials, and added interviews with a number of ministries and organizations. Further, the study team interviewed public- as well as private-sector employers, for two reasons. One reason was to increase the quantity of data gathered from employers; the other reason was to assess the extent of the needs for qualified graduates in science and technology, as well as the capacity of the educational system to meet these needs.

The needs assessment study team took the steps described in the present section in order to improve the quantity and quality of data gathered on employment. However, the implications of the challenges highlighted in this section extend well beyond the scope and purposes of this study. These issues of data collection thus are of importance not only to the quality of the findings presented, but also to the capacity of the government to properly assess and plan how science, technology and innovation may or may not contribute to national growth. These challenges of data collection alone therefore represent a serious obstacle to the proper understanding of employment issues in science and technology, the impacts of STI on national development, and the capacity of the current STI system to meet Tanzania's national goals of

social and economic development. The present report addresses these concerns in more detail in the findings and recommendations sections.

UNESCO Needs Assessment Study of Tanzania's Science Education

1.0   INTRODUCTION

1.1   Why Science and Technology Education in Tanzania?

In Tanzania, the need for educational reform to meet the demands of the 21st century workplace, particularly in science and technology, cannot be over emphasized. Schools must help students to become skilful manipulators, synthesizers, and creators of knowledge. Since we are now entering an era of global communication and collaboration, Tanzania must produce professionals who can work in teams to solve complex problems. The educational system can no longer afford to produce graduates with no employable skills. The system is therefore in need of significant reform to develop students' skills of lifelong learning, critical thinking, problem solving, and collaboration with others in order to meet national development goals.

The skills described here are those of tomorrow's 'knowledge workers', as highlighted by the Millennium Project:

> The long-term driving force of modern economic growth has been science-based technological advance… Technologies allow human society to fight disease, to raise crop production, to mobilize new sources of energy, to disseminate information, to transport people and goods with greater speed and safety, to limit family size, and much more. Yet these technologies are not free. They are themselves the fruits of enormous social investments in education, scientific discovery, and targeted technological development to strengthen national systems of innovation' (Millennium Project, 2005, p.92).

Science and technology are keys to socio-economic development in an increasingly interconnected world. It is therefore imperative that developing countries like Tanzania embrace science and technology as a vital tool for accelerating the country's socio-economic development (URT, 1996, p. 3). Science and technology education are thus important to national development in Tanzania, in two respects. First, the use and application of knowledge, skills, modern tools and materials of science and technology add value to human life everywhere in the world. Examples of this aspect of education can be found in advances in medical, environmental and engineering sciences. Science and technology therefore play a fundamental role in wealth creation, improvement of the quality of life, real economic growth, and transformation in any society.

Developed as well as developing nations, such as Taiwan and Korea, became industrialized countries by exploiting advances in, for example, silicon microelectronics achieved during the early 1960s. Most recently, China and India have emerged as industrial leaders in manufacturing and information technology, respectively. Each of these countries has invested quite heavily in people and factories, and their successes have been based on carefully designed plans and strategies. Technology is thus the primary engine of economic growth around the globe and provides the key to unlocking any country's potential. Countries that want to develop therefore must invest significantly in science and technology. This investment is achieved by developing knowledge and skills: the human capacity required to advance in a globally competitive world.

Second, science and technology education in the country are important to national development in ways that are more specific to Tanzania. That is, science and technology education must serve both the needs brought on by the global advancement of technology and market competition, but also social, environmental and economic needs that are specifically important to Tanzania as well. Although the drive to be globally competitive is critical to the nation's economic growth, the educational system must likewise prepare Tanzanians to meet social development needs in health, education and other sectors. To support the implementation of the Tanzanian Vision 2025 for better livelihood, quality of life and the well-being of the nation and its people it is important that Tanzania create a new generation of young people, with highly-developed problem-solving skills. Technical knowledge and analytical skills are especially important in this regard (URT, 1996), in order to meet the needs of Tanzanian society . This new generation must be well-prepared by teachers who are equally well-trained in mathematics and the sciences, equipped with adequate science laboratories, other resources and appropriate subject-matter and pedagogical knowledge.

A developing country such as Tanzania must apply science and technology in a number of sectors and areas. These include especially agricultural and fisheries sectors, as well as the ecological sciences—such as renewable energies, water management, and waste management. All of these areas and sectors likewise demand the development of science and technology, and a rigorous system of science and technology education. Emphasis on the use of science and technology in national growth strategies—to include the development of higher education— therefore makes sense; it is clear that the current level and quality of technical skills is not adequate to meet the development needs of the Tanzania. GDP has risen over the past five

years, but not as much as one might expect in the presence of a healthily expanding technology sector—particular with the privatisation of parastatal institutions:

> Manufacturing's share of GDP remained at a modest 8.4 % in 2000, which is almost the same level as recorded in the mid-1980s. Likewise, the manufacturing exports, worth only US$ 43 million in 2000, correspond to just 6.5 % of Tanzania's total exports. There are about 179,000 people employed in the manufacturing sector (2000/01, see table 9). The industrial sector remains overwhelmingly concentrated in Dar es Salaam, which generates as much as 70 – 80 % of the total industrial output of the country (LO/FTF, 2003).

With respect to the capacity of the educational system to meet Tanzania's national development goals, findings of the present study reveal acute shortages of human and other resources in nearly all primary and secondary schools across the country. The need is particularly acute in science, mathematics and technology education. Table 1 (below) shows staffing levels for mathematics and science teachers (chemistry and physics) at the secondary-school level for selected districts across the country. While this is not a scientific sample, these figures do substantially represent the dire staffing situation found in all of the regions under study, without exception. For example, whereas the figures for secondary-school mathematics teachers for Masasi District of Mtwara Region and Dodoma Municipal show that urban areas may fare somewhat better than rural ones, the difference is minor when considering the depth of the need for qualified teachers in mathematics (especially) and science.

Table 1: Staffing levels for Mathematics, Physics and Chemistry in secondary schools in four selected districts

District	Mathematics			Physics			Chemistry		
	Req	Avail	Short	Req	Avail	Short	Req	Avail	Short
Dodoma Municipal (Urban)	150	35	115	114	26	88	114	36	78
Nyamagana (Urban)	123	42	81	78	29	49	78	27	51
Masasi (Rural)	120	17	103	72	9	63	72	9	63
Kasulu (Rural)	117	10	107	78	16	62	78	14	64
TOTAL	**510**	**104**	**406**	**342**	**80**	**262**	**342**	**86**	**256**

Source: Study data collected from participating DEOs, June – July 2010.

There is a need for Tanzania to transition from the current, resource-driven economy while expanding the growth and potential of the economic system. Science and technology enable the country to 'utilize knowledge in mobilizing domestic resources for assuring the provision of

peoples' basic needs and for attaining competitiveness in the global economy' (URT, 2000, p. 4). The importance of science and technology education and development towards better utilization of existing resources on the one hand, and towards the development of the nation's human and other future capacities for the continued expansion of economy/society on the other therefore cannot be overstated. The following section describes some of the specific conditions of science and technology education, which highlights the need for investment and reform of the education sector.

1.2   What are the Concrete Conditions of Science and Technology in Tanzania?

Substantial effort has been made in mainland Tanzania and in Zanzibar during the past two decades to promote the development of science and technology at all levels—including several policy initiatives (URT, 1996). Most notably, PEDP and SEDP, the Primary and Secondary Education Development Plans, respectively, have greatly expanded access to education across the country. Yet the quality of education has suffered, in large part due to the incapacity (i.e., limited resources) of the educational system to meet the increased demand as these programmes have been implemented. However, although both policy and programme initiatives highlight the importance of pre-service and in-service teacher training, quality of education, and books and other materials, measures to address these issues have not been fully implemented and/or have been poorly articulated within policy/programme documents. In fact, while policy initiatives in science and technology (including education) have brought some progress in meeting national development goals, the unclear or incomplete policy provision in science and technology has not delivered the kind of growth that one might imagine of a nation committed to a strong, technology-based development plan.

The inadequacies highlighted here have adversely affected the capacity of the education system to provide access to quality education for all students, but especially for girls and children living in rural areas. Figure 1 shows that girls' performance in mathematics and science subjects on national examinations during the past five years has, in most cases, been below than that of boys. (This is especially true of 'O' level examinations, where girls' pass rates trail those of boys by 15 to 20%, in all science subjects and in mathematics in particular.)

Figure 1: Performance of boys and girls in Mathematics and Science subjects O-Level Examinations, 2005 - 2009
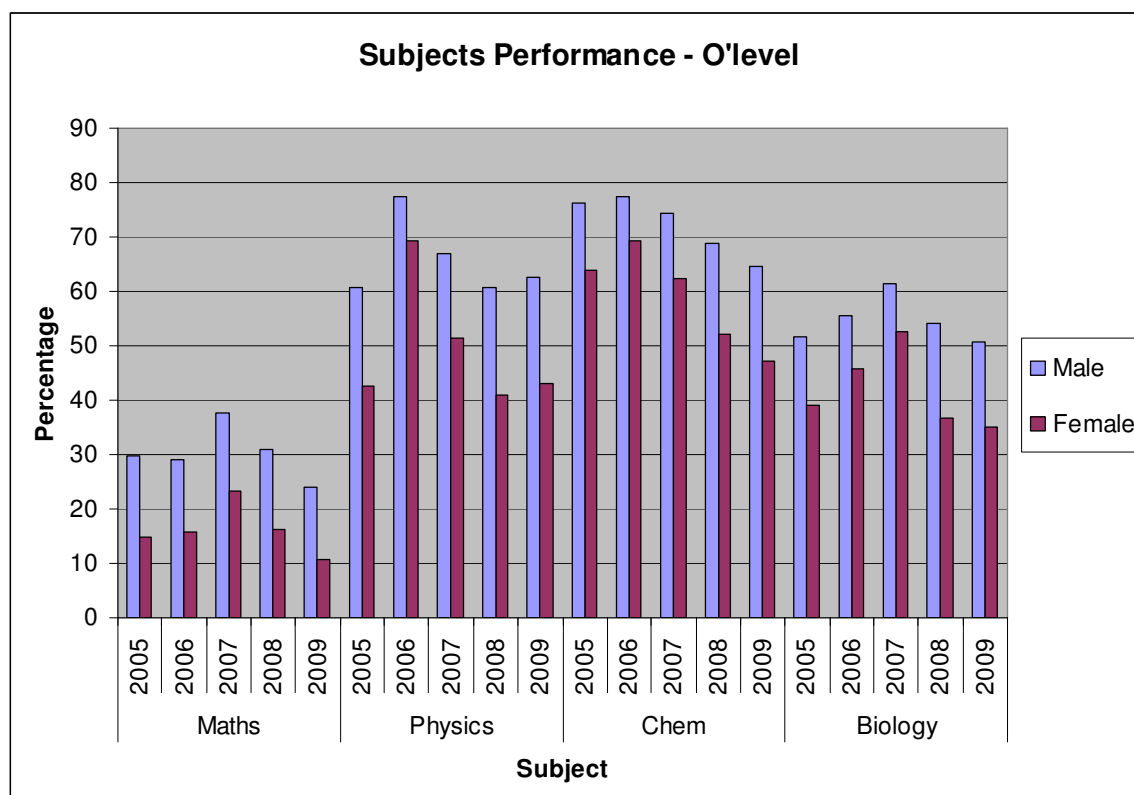
At the primary education level a comparative analysis of performance in science for boys and girls in six selected regions reveals more or less the same scenario whereby an overall girls' performance is below that of boys as shown in Figure 2. Although overall performance in mathematics and in the sciences presents a worrying trend, the differences in performance between boys and girls is an equity issue that needs to be addressed at all levels of the education system. However, overall improvements in education system capacity (e.g., hiring and training of new science and mathematics teachers, at the primary- and secondary- school level) is most urgently needed in order to effectively address issues of inadequate access of girls and young women to science and technology education.

Figure 2: Regional Comparison of Science Performance at Primary Education level by Gender, 2006-2008
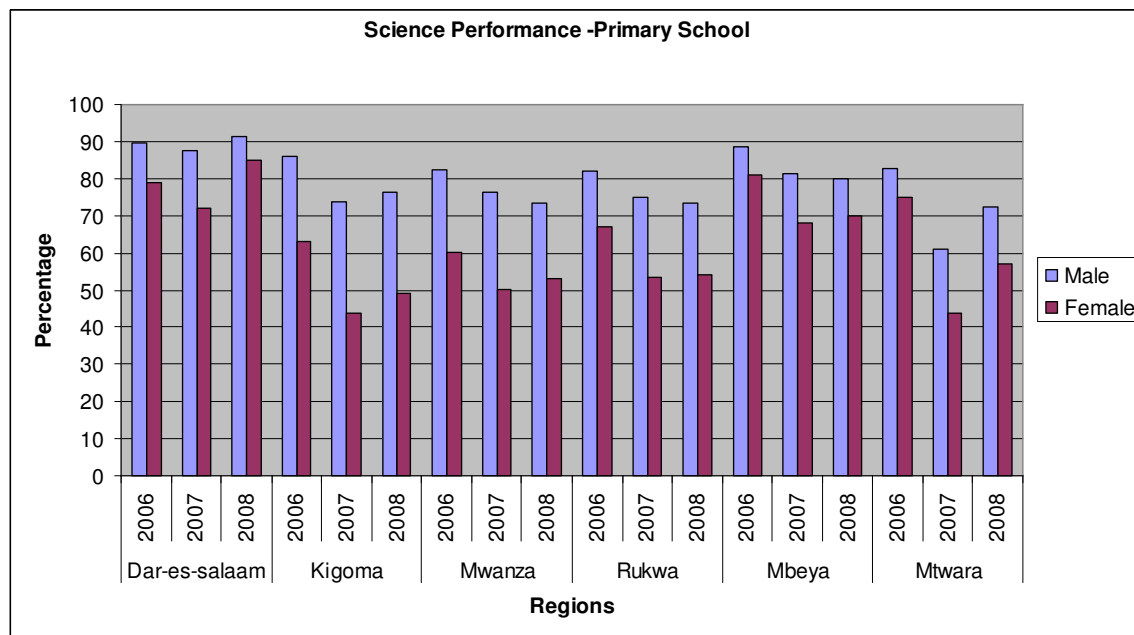
Further, linkages between the private sector, education and STI are weak in terms of partnerships, programmes and other initiatives designed to improve the capacity of the educational system to meet the science and technology demands of markets and national development goals. These three inadequacies—lack of quality teaching, lack of human and other resources, and the absence of clear and productive linkages between educational programmes and private/public-sector demands and innovations—combine to create significant challenges to the achievement of national development goals on both the mainland and in Zanzibar. The present report addresses these issues in more detail in the findings and recommendations sections.

Although policy and programme initiatives have led to significant improvements in education at all levels, the contribution of science and technology to GDP (e.g., in the form of new agricultural and industrial technologies) remains low. The findings from the present study support this conclusion. There are not enough or adequate laboratories and equipment in most primary and secondary schools; critical shortages of teachers and materials in mathematics, science and technology exist in most secondary schools, including computers; and student performance in science and mathematics on national examinations remains low at both the primary- and secondary-school level. These shortages are so dire in all of the districts and the

vast majority of schools under study, across mainland Tanzania and Zanzibar, as to put at risk the capacity of the system to provide quality education into the future.[2]

A number of policies aim at improving infrastructure and promoting innovation, so as to improve efficiencies in agricultural and industrial sectors. Yet these changes take time. For example, Tanzania remains largely dependent upon imports to sustain consumer demand for agricultural and other products; export levels remain modest, however, and are concentrated mainly in the agricultural sector (Watkins and Verma, 2008). There are, of course, exceptions, such as the growth in ICT and concurrent improvements to infrastructures. Still, as noted previously, the country has a long way to go before making the kinds of significant gains projected in the MKUKUTA and MKUZA development plans (Tema and Mlawa, 2009). This is not to take away from the significant achievements of the past twenty years. Rather, the needs assessment focuses on how science and technology must be repositioned, particularly within national development other policy frameworks, in order to meet the country's needs for accessible, quality science and technology education. The present study is designed to provide some assessment of both the current status and capacity of the science and technology education system to effectively contribute to the development of science and technology and the realization of the nation's social and economic development goals.

---

[2] According to Mario Cervantes, Senior Economist for the OECD, such rapid expansion of educational services provision in emerging economies such as China may well threaten the quality of education, long-term (Cervantes, 2010).

2.0   NEEDS ASSESSMENT

2.1   Goals and Objectives

The main goal of this study was to investigate the status of science, mathematics and technology education in Tanzania. To achieve this goal the following specific objectives were formulated to guide the study:

- To establish the current and desired status of science education in Tanzanian education system;
- To establish the extent of the needs for establishing centres of excellence and strategies to be used;
- To identify priorities of reform in science education and development strategies and interventions that will link science to job creation and career skills;
- To identify causes of performance problems in science subjects or courses at various levels of education
- To establish possible solutions and growth opportunities in mathematics, science, technology education and employment.

2.2   Methods

Surveys, interviews, document analysis and observations were the primary methods used to gather data for the present study. The rationale of this approach was two-fold. First, the study aimed to provide quantitative data on the status of science and technology education in terms of student performance, availability and quality of resources (human and material), physical infrastructure, quality and access to education and employment. Access and quality of education focused on both urban/rural populations (i.e., to pick up variations in socioeconomic status) and gender. These included statistical data on the conditions of education and employment gathered locally, regionally and nationally across the Tanzanian mainland and Zanzibar. Second, qualitative data collected via national-level interviews and documents provided a broader perspective on the nature and scope of science and technology education and employment, particularly in terms of policies, programmes and systems. The two components of this methodology were designed to identify key issues, challenges and their impact on education and employment on the one hand, and to provide insight into the scope, nature, opportunities and outlook for education and employment on the other.

The study was conducted in 9 regions of mainland Tanzania and one region of Zanzibar. The regions were selected to represent the wide variety of socio-economic conditions in which people in the country live, as well as the diversity of their backgrounds. Both female and male students, teachers, administrators and government officials participated in the study. Two districts (one urban and the other rural) were selected in each of the following regions of Tanzania mainland and of Zanzibar:

- Arusha
- Dar es Salaam
- Dodoma
- Kigoma
- Kilimanjaro
- Mbeya
- Mjini Magharibi (Zanzibar)
- Mtwara
- Mwanza
- Rukwa

The study was carried out in two phases. The first phase entailed reviewing literature related to science, mathematics and technology. Policy and curricular documents were likewise reviewed. The second phase entailed field data collection, at two levels. Surveys, interviews and observation data collection methods were used to obtain data from the appropriate research participants at the local level. These included District Education Officers (DEOs), parastatals institutions, employers of science graduates, tertiary institutions and public primary and secondary schools. Interviews were conducted at the national level as well. These included officials in a number of ministries, including (but not limited to): the Ministry of Education and Vocational Training; the Ministry of Infrastructural Development; the Ministry of Labour, Employment and Youth Development; the Ministry of Finance and Economic Affairs; the Ministry of Communication, Science and Technology; the Ministry of Education and Vocational Training of the Revolutionary Government of Zanzibar; as well as the Tanzania Commission for Science and Technology (COSTECH), as cited earlier. Parastatal institutions of research and development, such as the National Institute for Medical Research (NIMR), the Tanzania Industrial and Research Development Organization (TIRDO), and the Centre for Agricultural Mechanization and Rural Technology (CARMATEC) were also included in the study, as were the

National Radiation Commission (NRC), the Geological Survey of Tanzania (GST), and the Forum for African Women Educationists (FAWE). A detailed list of institutions covered by the study team is provided in Annex 1.

Data was collected from both primary and secondary school teachers using a survey (i.e., questionnaire). Surveys were used to collect data from university students, administrators and employers as well. The data gathered included information on teaching methods used in science and mathematics, the conditions of teaching and learning, teachers' assessments of students' performance, students' capabilities of meeting the science/technology demands of the job market and of the future employment prospects of graduates. Data from these surveys provided much of the direct evidence of stakeholders' perspectives on education and employment at the grassroots level. Additionally, statistical data on resource needs and availability were obtained from DEOs (where available), in order to further ensure the reliability and generalizability of the study findings.

A total of 133 secondary and 79 primary school teachers (including school heads at both levels) participated in the study. Among secondary school teachers, 46 women and 87 men participated; at the primary-school level, 33 women and 46 men were surveyed. Additionally, 42 students enrolled in institutions at the tertiary level participated. Of these, 12 were attending technical colleges and 30 were attending universities.[3] Tertiary-level student participants provided data on the adequacy of their educational experiences in science, mathematics and technology (e.g., computers) both within their current academic programmes and at the pre-university level (i.e., primary and secondary schooling).

Given unanticipated difficulties encountered in the collection of data from employers, additional data on employment were collected via interviews with national-level officials and the staffs of selected parastatal institutions in the targeted sectors. Unfortunately, statistical data in two key areas—current employment and employment needs—were largely unavailable. These gaps are addressed in further detail in the findings and recommendations sections of the report, with particular attention to the need for available, reliable data on employment— especially in the technology sector. The study therefore had to rely on other sources of data for insight into the state of employment as relates to the capacity of the education system to adequately prepare graduates to meet the demands of science and technology. These sources included interview data and documents collected at the national-level (i.e., from ministry-level

---

[3] Students of Teacher Training Colleges were not included in the survey, as they were on leave from classes.

officials, public-sector employers and parastatal institutions), and survey data collected from both primary- and secondary-school teachers and from students at the tertiary level. Among other things, these data have provided important information on the state of necessary policy linkages between science and technology education on the one hand, and national social and economic development frameworks on the other.

3.0   FINDINGS

Findings from the study are organized as follows: by educational level (i.e., primary, secondary, tertiary); by gender; and geographically (i.e., regionally, rural/urban). Data presented include: student performance; human resources (i.e., teacher staffing); material resources; infrastructure; teacher qualifications; and regional data. There are three primary sources of the data presented in this section: DEO statistics (i.e., resources/infrastructure); examination performance records (e.g., 'O' level mathematics); and the teacher and university/college student surveys. Whereas data on students' examination performance in mathematics and the sciences is presented over time (e.g., 'A' level girls' biology, 2006 to 2009).

There are a number of key findings which emerged from the present study. These findings are organised into five areas: policy; administration; teacher workforce preparation; curriculum and instruction; employment; and support services. While there are significant findings in each area, several are particularly noteworthy:

1. In general, the educational system is not adequately preparing graduates to meet the demands of science and technology, whether in the public or the private sector. University students, educators, employers and national-level participants (such as ministry officials) all report that neither the graduates nor the educational system that is producing them are able to meet current knowledge and skill requirements of the technology sector.

2. Few, if any, formal linkages exist between the education and employment sectors, in terms of efforts to enhance the quality and relevance of educational programmes for adequately preparing science and technology graduates.

3. Structural incentives for students, teachers and faculty to enter careers in science and technology in Tanzania are especially weak, including low pay, poor conditions of work, inadequate support mechanisms (e.g., academic/career advising) and lack of preparation to meet either current or future economic and social needs.

4. Resources are lacking in most every aspect of education, including insufficient numbers of qualified teachers of mathematics and science at the primary- and secondary-school level, inadequate equipment and materials, textbooks and facilities (i.e., laboratories and libraries). While resources needs are greater in rural areas, only a fraction of the

needed resources is available in most every school in the country—regardless of the region.

5. The quality of teaching is inadequate to meet the learning needs of students at all levels, in several respects. First, many primary school teachers lack the minimum academic qualifications—generally and in their subject matters in mathematics and science—to perform competently in the classroom. Second, teachers at both the primary- and the secondary-school levels are not well trained in the use of appropriate pedagogies. Whereas most teachers surveyed do know and report applying some context-based approaches, student performance in mathematics and science reflect neither thorough subject-matter knowledge nor adequate knowledge/application of the competency-based approaches that are the basis of the science and mathematics curricula. Third, university students, employers and other participants in the study all report that education in mathematics especially—as well as science—do not provide graduates with the knowledge and the ability to apply it in the workplace. Fourth, while the teacher preparation curricula do, at the primary-school level, incorporate learner-centred approaches to teaching and assessment, the structure, organization and implementation of teacher preparation programmes are lacking in this respect. A complete assessment and overhaul of the current teacher preparation system is needed, especially at the primary-school level, where children's formative experiences with learning in mathematics and science have far-reaching effects upon students' attitudes, knowledge and skills development.

The shortage of qualified teachers is particularly troubling, given the weak teacher education and training capacity of the educational system. Although these issues have been known for some time, the depth of the needs—across regions, urban and rural areas, and so on—have perhaps been sorely underestimated, as the data presented here show. Student performance depends upon teacher quality more than almost any single educational input. Yet entire schools across the country are left without teachers in mathematics and the sciences, at both the primary and the secondary level. Much of the problem relates to policy. Existing policies do not clearly and adequately address the problem. These issues are detailed in the next section of the report.

3.1 Policy

The present study highlights two primary issues of policy, in the case of both mainland Tanzania and Zanzibar. One is the lack of emphasis and integration of science and technology education within existing education policy and strategy frameworks. The other is the lack of clarity of current science and technology education policies, which in turn undermines their proper implementation. These inadequacies indicate particularly weak linkages between science and technology education and national development goals and strategies within the existing education policy framework.

Although the currently policy of mainland Tanzania is now being reviewed and revised, the issue of linkages warrants further examination. The status of the current science and technology education policy of Zanzibar was not, however, clear at the time of the needs assessment study. Regardless, differing educational needs and quality of service provision (e.g., resources), among other factors, between the Tanzanian mainland and Zanzibar are key to the proper analysis of policy linkages. Still, the same fundamental policy issues are at play, to a greater or lesser extent, within the current education policy provisions of both mainland Tanzania and Zanzibar.

The fundamental issue of policy in science, mathematics and technology education for both mainland Tanzania and Zanzibar is the persistent poor performance at the primary- and secondary-school level. Related to this issue are those of teacher availability and quality. If there are no teachers in so many schools, then how can one expect students at either level to receive a quality education in these subject areas? While both PEDP and SEDP plans have called for increasing the teaching force, these proposals have not been adequately addressed. One possible reason for this is lack of proper implementation. Still, another, more plausible reason is that the role of science and technology to Tanzania's development—and hence, that of science and technology education—have not been clearly articulated within existing policy frameworks.

Tema and Mlawa's (UNESCO, 2009) analysis of MKUKUTA and MKUZA documents highlighted the inadequate integration of science and technology within national development plans of mainland Tanzania and Zanzibar, respectively. In much the same way, the present study found that the role and importance of science and technology to the achievement of Tanzania's

education development goals is neither clear nor adequately integrated. Several issues make these findings apparent:

- Higher educational institutions are not actively involved in research and development activity in science and technology;
- Current teacher education and training policy is weak and lacks a clear implementation strategy;
- Aside from ICT, links between science and technology education and national development are not clearly defined within education policy frameworks;
- ICT integration within education programmes is essentially non-existent, despite its emphasis within the current ICT for basic education policy framework;
- Negative trends in students' performance on national examinations persist in science and mathematics;
- Educational programmes in science and technology at both secondary and tertiary levels are not sufficiently relevant to the demands of the job market;
- Formal programmes in academic and career guidance and/or counselling are lacking for students at both secondary and tertiary levels; and
- Promotion and incentives for students and prospective teachers to enter careers in science and technology are either inadequate or ineffective.

At first glance, some of these issues may appear to be administrative—due to problems of implementation. After all, performance depends upon investment in facilities, equipment and other materials (such as textbooks), as well as adequate school leadership, among other factors. Yet these and other shortcomings of the educational system all point to a fundamental failure of policy goals to appropriately and effectively link science and technology education to its real-life application and proper role in national development.

3.1.2 Policy Aims and Goals

The existing education policy framework shows that science and technology education does indeed have a role to play in national and individual development. For example, the following general aims and objectives of the Tanzania National Education and Training policy (URT, 1995) highlight these linkages:

- To guide, promote the development and improvement of the responsibilities of the citizens of Tanzania, their human resources and effective utilization of those resources in bringing about individual and national development;

- To promote the acquisition and appropriate use of literacy, social, scientific, vocational, technological, professional and other forms of knowledge, skills and understanding for the development and improvement of the conditions of people and society; and

- To enable and to expand the scope of acquisition, improvement and upgrading of mental, practical, productive and other life skills needed to meet the changing needs of industry and the economy.

These objectives clearly imply that science and technology have a role to play in education. References to the use of human resources to promote national development, the acquisition and application of technological knowledge and skills to meet the needs of 'industry and economy' all point to a recognized connection between science and technology education and desired development outcomes. But what exactly is the nature of this role?

As part of the implementation of existing policy frameworks, the Education Sector Development Programme (ESDP) has focused on revitalizing and improving the delivery of education at both the primary- and secondary-school levels. SEDP thus outlines the following 9 main objectives:

(i) to widen access and equity in basic education through equitable distribution of institutions and resources;

(ii) to improve the quality of education through strengthened in-service teacher training, adequate teaching and learning materials, rehabilitation of physical facilities, consolidated pre-service teacher training, and strengthened monitoring and evaluation system;

(iii) to expand and improve girls' education;

(iv) to provide facilities in disadvantaged areas;

(v) to broaden the base for education financing through cost-sharing and establishment of education funds;

(vi) to decentralize management of institutions so as to devolve more powers of management and administration to regions, districts, communities and institutions;

(vii) to promote science and technology by intensifying technical and vocational education and training, rationalising tertiary institutions;

(viii) to promote life-long learning through non-formal and distance education programmes; and

(ix) to involve the private sector to expand provision of both formal and non-formal education and training.

However, although a stated, key objective overall Education Sector Development Plan (ESDP) is to 'promote science and technology by intensifying technical and vocational education and training, rationalising tertiary institutions', the plan does not show the link between the role of science and technology and national development goals. Policy documents and programmes need to articulate more clearly the particular ways in which science and technology education, specifically, contributes to the achievement of desired national social and economic development goals.

An analysis of current policy-related documents shows that the National Science and Technology Policy of 1996, the National ICT Policy of 2003 and the ICT for Basic Education Policy of 2007 (among others) all assign an important role to science and technology education and the needs of Tanzanian society. These linkages are weak, however, in terms of the integration of science and technology education in the National Education and Training Policy of 1995. A key question for the present report remains to what extent the issue of insufficient linkages of science and technology education to national development goals is a problem of integration or one of implementation.

3.1.3 Policy Integration or implementation?

Poor student performance in mathematics, science and technology, issues of teacher competency, inadequate pre-service and in-service training, and the lack of relevancy of educational programmes in science and technology are likely not caused by inadequacies in the policy framework alone. The linkages at the policy level are far too numerous. Rather, these problems are likely due to poor implementation as well, at least in part. Persistent gaps in the provision of teacher training alone provide a number of examples of the problem. For instance, the official secondary school computer studies syllabus for Forms I – IV was introduced in 1997 (URT, 2003). Yet to date there is no formal programme for training teachers on the use of

computers for instructional purposes. While these objectives do appear in PEDP and SEDP, they have not been put into practice within the educational system. Lack of resources may be partially to blame. However, as with the profound shortage of qualified teachers in mathematics, science and technology, policy is supposed to provide direction for the allocation of limited resources to achieve its stated objectives. In other words, existing policies in education do not address the needs of science, mathematics and technology education as a priority when compared with other needs, such as increasing enrolments in primary and secondary schools. Investment priorities should follow from stated policy objectives. Yet the dire shortages of adequate numbers of qualified teachers alone points to a marked disconnect between policy frameworks and programme initiatives on the ground. For example, the majority of teachers who participated in the present study are not computer literate; of the 43 primary and 53 secondary schools visited during the study, none of them currently offers courses on computers to students. In another example, new, competency-based curricula were introduced in 2006-07, in primary and secondary education; national examinations reflect the new curriculum approach. Yet to date teachers have not received adequate training in the use of these curricula, which would seem to undermine progress towards achieving existing policy reform goals designed to improve the quality of teaching and learning.

As a result of inconsistent and incomplete implementation of policy, students are inadequately prepared, and performance is suffering. Less than one fourth of primary- and secondary-school pupils and students are receiving passing marks in mathematics, with little or no sign of improvement. Despite these shortcomings, questions remain concerning policy and programme priorities for the proper integration of science and technology within education policy. As stated previously, the policy framework and strategies are supposed to be sufficiently detailed to provide the proper guidance for their implementation. Yet the current policy does not fully address the nature of science and technology integration: its particular role in societal and economic development, and the requirements of integration in terms of principles and strategies. In much the same way, the role of science and technology education is not adequately defined within MKUKUTA and MKUZA documents, further supporting the conclusion that policy objectives in science and technology are not fully integrated within existing programme initiatives, such as in the provision of teacher training and adequate laboratories and other resources.

3.1.4   *Policy Review and Revision*

According to national policy documents, the current National Science and Technology Policy does provide a framework for the integration of science and technology into national plans and

objectives. This framework is intended to guide the development, transfer and/or adaptation of technologies for national competitiveness and development (URT, 1996). Still, these parameters are not sufficiently clear and precise—in terms of describing the particular role and applications of science and technology on the one hand, and in terms of guidelines for policy implementation on the other. In other words, policy needs to be more clear and precise to ensure the successful transition towards a more knowledge- and technology-based society, which itself represents dramatic social and cultural change from Tanzania's past, agriculturally-based development trajectory. This fact is evident in the data gathered at both the regional (i.e., local) and the national level.

National-level interviews revealed that social and economic development activity in the country in both the private and the public sector still largely depend upon the historically-strong Tanzanian knowledge base in the social sciences, not science and technology. Participants in the study from with the Ministry of Communication, Science and Technology, the Ministry of Labour, and Finance likewise all report that graduates of programmes in, say, political science, economics or sociology are more likely to get jobs—and higher paying ones at that—than science and technology graduates of the nation's universities. One possible exception is agriculture, where research and development capacity is far stronger than in other technology sub-sectors. According to COSTECH, about 70% of current applications for research support are for agricultural projects; another 20% are for social science research; and only 3-4% are for projects in engineering.

The majority of secondary school teachers, university educators and university students participated in the study expressed confidence that students would be able to find jobs of some kind after graduation. Yet these same groups overwhelmingly expressed doubts about their ability to meet the current and future technology demands of the marketplace. For instance, of the 133 secondary school teachers interviewed 70% of them indicated that students are not satisfactorily prepared by the education system to meet the technology demands of the job market. In other words, there appears to be a high level of doubt and insecurity among both educators and students about students' ability to get jobs in their chosen fields. Employers in the private and public sector, including institutions of the National Innovation System in health, industry and agriculture likewise overwhelmingly expressed dissatisfaction and a lack of confidence in job candidates' capacity to apply their university-based knowledge effectively in the work environment. The needs assessment team argues that these data point not only to the incapacity of the educational system to adequately prepare students for careers in science and technology. Rather, the data further and more fundamentally indicate a lack of clarity

among policy makers concerning the role and requirements of a vibrant system of science and technology education in Tanzania. This lack of clarity may be due to the breadth and depth of social and technological change that science and technology innovation and integration represent to Tanzania, especially in view of the particular path of the nation's political, social and economic development.

A recent study of science, technology and innovation in Indonesia, Malaysia and the Netherlands suggests that STI develops in unique ways in every society—while following a single, global model. On the one hand, STI does tend to gravitate towards the development of certain areas of global importance, such as biotechnology. In this respect, the integration of science and technology favours a knowledge generation as increasingly responsive to the needs of society. Yet on the other hand, the study found that each of the three countries under study adapted this same general model to suit their own particular needs. The STI approach adopted by each country varied according to the particular conditions of social, economic, political and cultural development. The less the country presently relied upon science and technology, the less pressure it felt to adhere to a set model of STI. However, in each case STI was defined by the national government as critical to national development (Beerkens, 2009).

Why might decision-makers, policy makers, educators and others in Tanzania be so slow to integrate science and technology into national education, development and individual career plans? Why is policy implementation for STI, including education, so poor? Perhaps because development of a science and technology oriented society is such an unfamiliar concept. As an issue of policy, it is more important than ever for the nation to adopt a clear, specific and well-directed set of policy guidelines to realise the full potential of available human and material resources towards achieving its development goals.

3.1.5   Policy, Resources and the Conditions of Education

Despite the remarkable achievements recorded in enrolment levels, poor performance in Science, Mathematics and English subjects, poor working conditions, poor infrastructure and other challenges to the education sector in Tanzania remain. Failure rates for the National Form IV Examinations in Mathematics in 2004, 2005 and 2006 were at 70%, 77% and 76% respectively. Moreover, whereas the percentage of failures in Physics, Chemistry and Biology in the year 2003 were 43, 35, 45%, respectively, the failure rates for those same subjects in 2004 stood at 45, 35, 43% (URT, 2008). Figure 3 shows that, since 2007, there has been a consistent downward trend in student performance in mathematics and science.

Figure 3: Mathematics and Science National Form Four Examinations performance 2005 - 2009
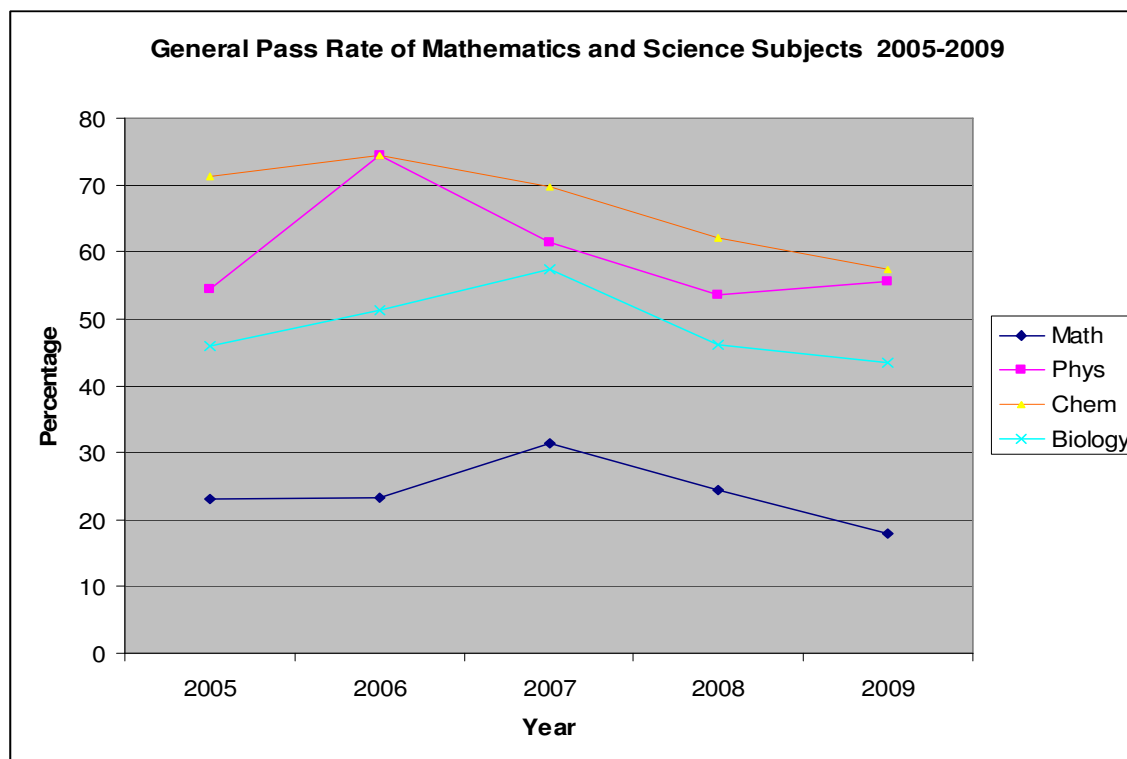
According to data collected from the National Examinations Council of Tanzania (NECTA), while the pass rates for the National Form Four Examination results in Mathematics were about 31%, 24% and 18% in 2007, 2008 and 2009, respectively, the pass rates for Chemistry and Biology fell from 62% and 46% in 2008 to 57% and 43% in 2009, respectively (NECTA, 2007, 2009, 2010). These figures hardly reflect well on the otherwise laudable goals of science and technology education within the existing policy frameworks. These and other policy-related issues of performance and inadequate resources, human and other, place a strain on the educational system as a whole.

Acute shortages of teachers have forced many secondary school administrators (especially in community schools) to compromise on achieving existing policy objectives. According to the Education and Training Policy (1996), 'All owners and managers of schools and colleges of

education shall ensure that their teachers have professional qualifications and are registered and licensed to teach' (p. 32). The minimum qualification (per existing policy) for a secondary school teacher in both government and private schools is a diploma (p. 41). Yet findings of the study indicate that out of 133 teachers interviewed in government secondary schools 12% of them are untrained and under-qualified—and lack full certification.[2] Table 2 provides a breakdown of teachers' qualifications by gender.

Table 2: Secondary School Teachers by Gender and Qualification

Sex	Master's Degree	1st Degree	Diploma	No teacher professional qualifications
M	1	26	49	11
F	4	11	26	5
Total	5 (3.8%)	37 (27.8%)	75 (56.4%)	16 (12%)

Both government officials and other participants in the study expressed concern over the ongoing practice in the education system of assigning non-science teachers to teach science classes, due to acute shortages of qualified science and mathematics teachers. In other words, there are significant numbers of teachers who hold diploma certificates in other disciplines or subjects, but who lack the necessary qualifications in the respective science or mathematics subjects they are actually teaching. In one Zanzibar school, a teacher with a diploma in religion had been assigned to teach mathematics in Forms I and II. Some interviewees referred to this arrangement as *UPE[3]: "Ualimu Pasipo Elimu"*—literally, 'Teaching without Education'.

The number of textbooks available in schools is still below target. For example the Secondary Education Development Plan (2004 – 2009) aimed at having textbooks by subject provided at a student-book ratio of 1:1 by 2009; however, according to the Poverty and Human Development Report currently the student-book ratio stands at 3:1 (URT, 2009). Moreover, it aimed at having one librarian in place in every school and college by 2009, however data collected from schools surveys suggest that majority of schools still do not have libraries and the textbooks available are kept in the Headmasters/mistress' offices. In some schools as Photo 1 shows students still

---

[2] These teachers are known as Form IV and Form VI 'leavers', or those who entered the teaching workforce without having graduated from a formal teacher education programme in one of the training colleges.

[3] UPE refers to Universal Primary Education, in which the respondents were implying that educational expansion at the primary-school level essentially amounted to getting teachers into classrooms as quickly as possible—whether or not they were properly qualified for their assigned teaching tasks.

sit on the floor due to shortages of desks. Furthermore, staff development is weak as the majority of school teachers have not gone for training since first being deployed, despite frequent curriculum changes.

Photo 1: Form II students at Kiembe Samaki Secondary School in Zanzibar sitting on the floor

The National ICT for Basic Education of 2007 Policy aims at building a 'highly skilled and educated workforce with aptitude and skills in the application of ICT in every day life' and recognizes the 'need to provide schools, colleges and other educational institutions with the know-how and resources that will include them in the knowledge society' (URT, 2007). Although the ICT policy for basic education acknowledges that the quality of education is affected by the acute shortage of resources and poor working conditions (teachers, laboratories building, laboratory equipment and chemicals, textbooks, teaching materials, incentive systems for mathematics and science teachers, and training, among others) at all levels of the education system it is still unclear as to how the current policies and development strategies will address these shortcomings. More emphasis on science and technology education within education policy and strategy frameworks is required in order to adequately meet the resource needs in science and technology education in ordinary schools and classrooms.

3.2   Administration

Significant strides have been made in Tanzania in promoting access and equity in the education sector. There have been a number of successes, in terms of increased enrolment rates, and increased numbers of primary and secondary schools. Enrolments rose from 5.9 million primary school pupils in 2002 to 8.4 million pupils in 2008, for a Gross Enrolment Rate of 112% and Net Enrolment Rate (NER) of 97%. The number of schools has increased from 12,286 and 1,059 primary and secondary schools, respectively, in 2002, to 15,673 and 3,798 schools in 2008. Secondary education NER increased from 6% in 2002 to 24% in 2008, with the percentage of girls in Forms I – IV and Form V – VI rising to 45% and 40%, respectively (Claussen and Assad, 2010). A number of successful initiatives have been taken in this regard, in order to improve the state of education for girls and women.

The University of Dar es Salaam, through its pre-entry programmes, recorded significant achievement in promoting the participation of girls in the engineering courses from 7% in 2002/03 academic year to 22% in 2008/09 academic year. These gains are illustrated in table 3, below.

Table 3: Enrolment figures for Engineering and Technology students, UDSM

Academic Year	1st Year Enrolment			Total UG Enrolment		
	Female Students	Total Students	% Females	Female Students	Total Students	% Females
2002/2003	22	369	6	86	1185	7
2003/2004	31	312	10	95	1237	8
2004/2005	129	452	29	198	1270	16
2005/2006	116	497	23	276	1441	19
2006/2007	145	560	26	386	1699	22
2007/2008	101	388	26	386	1573	24
2008/2009	59	386	15	360	1604	22

 Source: College of Engineering and Technology

As a result of these and other initiatives to address gender inequity at the university level, similar achievements were made in the Faculty of Science (currently known as the College of Natural Sciences) at the University, where the participation rate for girls rose from 16% in 1996 to 30% in 2005. Despite these initiatives and successes the number of girls in science and engineering disciplines at the tertiary education level remains low compared to that of boys.[1] Moreover, the overall performances on the national examinations at both primary- and secondary-school levels remain a huge challenge requiring urgent attention. Figures 4 and 5 below indicate the consistent, downward trend in pupil and student performance over the past three years, at both primary and secondary education levels.

Figure 4: Overall O- Level and Primary School National Examinations Pass Rate

Overall Pass Rate for CSEE & PSLE
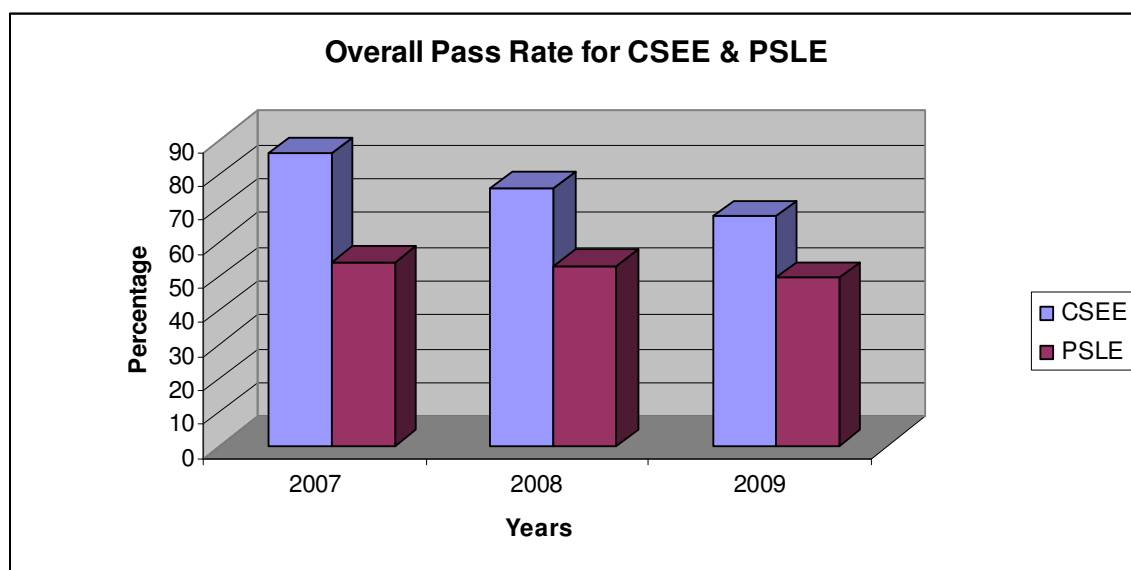
Performance and School Inspections

The School Inspectorate Division is accorded an important role in ensuring the quality of education is maintained. According to the Education and Training Policy of 1995 (URT, 1995. p. 30), school inspection is vital as a means of monitoring the delivery of education, adherence to the stipulated curriculum and set standards, and ensuring efficiency and quality in education

---

[1] Unfortunately, limited data exist on the state of education among technical colleges throughout mainland Tanzania and Zanzibar, both for female students and for students overall. Still, based on student-and-faculty surveys, the authors of the present study do see great potential for improving access for students, both male and female, to a wider variety of quality, tertiary educational programmes. Further study of this potential is recommended.

(URT, 1995). The Controller and Auditor General's (CAG) Performance Audit Report reveals some weaknesses in the current School Inspection Programme. According to the CAG's report school inspections have paid little attention to students' poor performance in mathematics and science subjects as previously illustrated in Figure 3.

Figure 5: Performance Trend for Secondary and Primary National Examinations
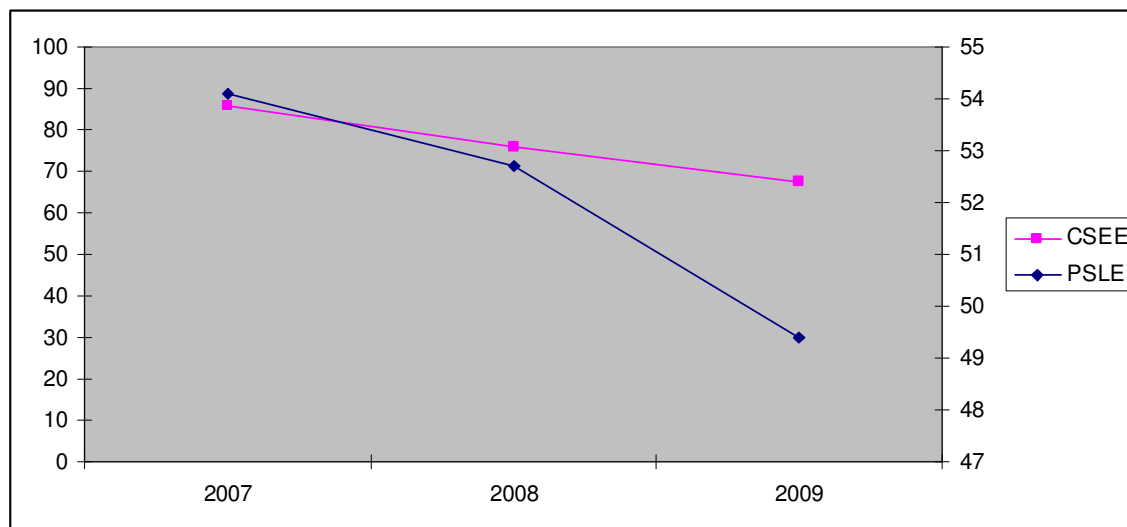
Examining the school inspection guidelines issued to school inspectors, the CAG's report notes that out of 148 items that are supposed to be observed at each inspection only sixteen are addressing the issue of students' poor performance. The report concludes that '*there are no clear priorities on poor performing students in mathematics and science subjects in the School Inspectorate's own annual and operational planning for inspection* to the extent that this arrangement *hampers the possibility for the school inspectors to provide the Government with adequate information, like advice on targeted and cost-effective measures, and on how to improve the education system in the country*' (URT, 2010). Given these serious capacity- and performance-related issues, it is difficult to say that education is being administered effectively and at any level, to the detriment of quality of education in science, mathematics and technology in particular.

Decentralization in Management of Education

In July 2008 the government decentralized the management of secondary education from the central government to local government. The motive behind this move was to reduce bureaucracy in decision making, encourage community participation and increase operational

effectiveness and efficiency of the education system (URT, 2004).[1] Yet the units to which functional responsibilities and authority have been devolved are still organizationally weak. This study reveals that since the decentralization of the management of secondary education to local governments most DEOs at this level remain ill-equipped with the skills and facilities to properly handle their new roles. Despite overall improvements in information management, data systems are not fully operational in some places and non-existent in others, including but not limited to the Dodoma and Kigoma Ujiji Municipal Secondary Education Offices. It is likewise unclear whether leadership at school and district level (i.e., in primary/secondary education) is effectively focused on science and technology education; most schools lack a clear mission that includes science and technology education and its importance in society. Administrators are aware of problems (e.g., the lack of materials, equipment and need for training). However, many of these newly-appointed officials lack the capacity and authority (i.e., autonomy) to solve such problems on their own.

There have been some positive changes in the organisational and administrative capacity of the Tanzanian education system during the past decade. A report on the progress made towards realising the Millennium Development Goals (MDGs) says the nation has made substantial gains in enrolments of both boys and girls at the primary-school level, although overall performance at both primary and secondary education levels, as indicated in Figures 6 and 7 maintains a downward trend in all subjects but even far worse in science and mathematics subjects. Data gathering capabilities at all levels have improved significantly as well, according to reports on the progress the country has made towards achieving the Millennium Development Goals. Some District Education Offices (DEOs) were able to provide the needs assessment team with detailed information on teacher deployments and needs, textbooks, materials and other factors.[4] The recent decentralisation of secondary education in Tanzania is one major example of reform designed to improve 'efficiency and responsiveness' (SEDP, 2008) in education service delivery. However, as the data collected during the study show, the decentralisation effort has thus far been unable to address serious issues in the provision of adequate human and material resources, and infrastructure development.

Decentralisation, or the redistribution of several functions of secondary education from the central to the local (i.e., district) level places responsibility (and some, limited authority) for

---

[1] See SEDP 2004-2009 p.11.

[4] However, more often than not district-level data was unavailable. Whether this was due to local data gathering or management capacity or some other issue is unclear.

resource allocation and distribution into the hands of local officials—at least, in principle. Whether or to what extent these changes actually equip district- and school-level leaders with the tools they need to provide adequate resources for ensuring quality of education is less clear. Shortages of teachers, facilities and materials persist in most every region visited, with the exception of a few schools. Although the SEDP target was to have 'adequate qualified teachers for all subjects in all schools and colleges by 2009' (URT, 2004,p.10) the extent of teachers' shortages in mathematics and science subjects is still very pathetic as indicated in Table 4.

Figure 6: Trend of Primary School Examination results of five subjects 2007 - 2009

Primary School Leaving Certificate examinations pass rates by subjects(Grade "A-C")

- Hisabati (Maths)
- Sayansi (Science)
- Kiswahili
- English Lang.
- Maarifa ya Jamii (G.K)
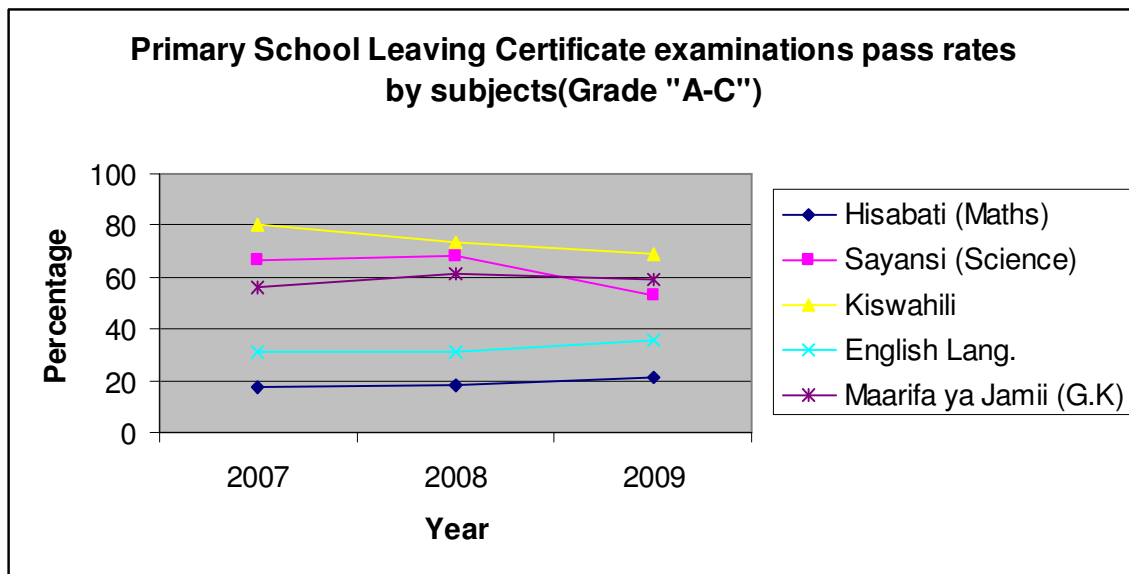
Source: Compiled from NECTA Examination Results Statistical Books, for 2007, 2008, 2009.

Figure 7: Trend of Form Four National Examination Results for seven subjects 2005 - 09

O-Level Subject performance-National Examinations pass rates
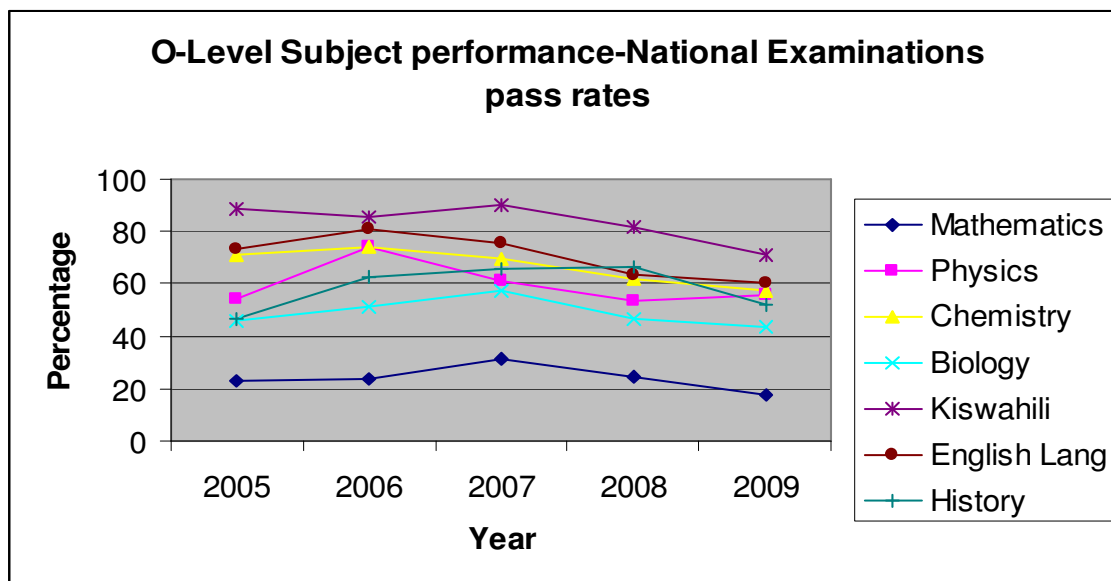
Source: Compiled from NECTA Examination Results Statistical Books, for 2007, 2009, 2010.

Table 4: Mathematics and Science Teachers Establishment in Eight Selected Districts

S/n	District	Mathematics			Physics			Chemistry			Biology		
		Req	Avail	Short	Req	Avail	Short	Req	Avail	Short	Req	Avail	Short
1	Dodoma Municipal	150	35	115	114	26	88	114	36	78	114	44	70
2	Nyamagana	123	42	81	78	29	49	78	27	51	86	41	45
3	Magu	127	39	88	90	18	72	90	27	63	89	35	54
4	Masasi	120	17	103	72	9	63	72	9	63	73	21	52
5	Kasulu	117	10	107	78	16	62	78	14	64	78	15	63
6	Temeke	212	67	145	162	60	102	152	45	107	152	45	107
7	Moshi Rural	136	32	104	62	14	48	62	29	33	92	40	52
8	Mtwara Urban	51	17	34	28	14	14	30	13	17	26	8	18
	Total	**1036**	**259**	**777**	**684**	**186**	**498**	**676**	**200**	**476**	**710**	**249**	**461**

Source: Field Data compiled from DEOs offices, June – July 2010.

A number of serious issues of performance, and teacher quality, exist at both the primary- and the secondary-school level—reflecting these widespread problems of inadequate human and material resources, as well as infrastructure (i.e., secondary-school science laboratories, and primary- and secondary-school libraries). For example, Table 5 indicates that of the 694 laboratories and 188 libraries required by secondary schools in the six selected districts only 49 laboratories and 13 libraries (7% of the requirement for both) are available in the respective areas.

Table 5: Infrastructural requirements (Laboratories and Libraries) in 6 selected districts

District	Science Laboratories			Libraries		
	Required	Available	Short	Required	Available	Short
Dodoma Municipal	108	9	**99**	36	3	33
Nyamagana	90	15	75	34	3	31
Magu	132	11	121	33	0	33
Masasi	102	11*	91	34	5	29
Kasulu	195	8	187	39	0	39
Mtwara- Urban	67	6	61	12	2	10
Total	**694**	**60**	**634**	**188**	**13**	**175**

Source: Data collected and compiled from DEOs of respective districts, June – July 2010

* Of those available, only three are functional while the remaining structures lack laboratory materials and equipment.

The problem of capacity at the district level is two-fold. First, the widespread inadequacy of resources across mainland Tanzania and Zanzibar appears to be a national phenomenon, and therefore dependent more on central planning and administrative functions in both governments. Under the current decentralisation reform, district-level officials still lack the decision-making authority to meet school-level needs for teachers and other resources. Second, it is difficult to imagine district-level officials taking charge of their own affairs in education without substantial training and other forms of technical support—even with the authority, for example, to recruit new science teachers to meet their growing needs.

Administration and capacity issues

As noted previously, data gathered from both teachers and employers suggest that education at the secondary and tertiary levels does not adequately prepare graduates for the demands of the technology sector (i.e., the work environment); it is unclear whether school and district leaders are equipped to deal with these issues. Fully two-thirds of teachers at the secondary-school level expressed doubts about students' preparedness for jobs in the technology sector. For their part, many university students complained of a lack of proper preparation in their pre-university education, especially in science and mathematics. Common reasons cited include inadequate numbers of teachers, teacher competency, lack of materials (such as textbooks) and the absence of laboratories at most secondary schools.

The National Higher Education Policy (URT, 1999) proposes that 'the education sector should be given priority in allocation of resources by the government'. One of the strategies to achieving

that goal is through 'investment into education at the rate of 20% of annual Government expenditure (5% of GNP) and into R&D at a rate of 1% of GNP' (URT, 1999, p.8). This level of investment is consistent with NEPAD (New Partnerships for African Development) principles, as agreed upon by member nations, including Tanzania. Over recent years the education sector has been ranking first in government budget allocations in relation to other sectors. However, from 2005/06 to 2009/10 overall government expenditure on education has stood at an average of 18% suggesting that meeting the policy target of 20% of annual government expenditure remains a challenge. Table 6 shows the trend of annual government expenditure on education for the past five years:

Table 6: Percentage of Government Budget allocation on Education Expenditure

Sub Sector	2005/06	2006/07	2007/08	2008/09	2009/10
Primary Education	55.8%	53.9%	49.1%	50.1%	
Secondary education	14.9%	13.2%	15.7%	10.4%	
Vocational Training	1.3%	1.2%	1.7%	0.6%	
Other Basic Education	5.2%	6.2%	4.5%	5.5%	
Folk Development	0.3%	0.3%	0.3%	0.4%	
Sub-total Basic Education	**77.4%**	**74.6%**	**71.4%**	**67.0%**	
University Education	16.9%	19.9%	23.9%	26.3%	
Technical Education	1.6%	1.6%	1.3%	1.2%	
Other Higher Education	4.1%	3.8%	3.5%	5.4%	
Sub-total Higher Education	**22.6%**	**25.4%**	**28.6%**	**33.0%**	
TOTAL EDUCATION (Tshs)	**100%** 701,124	**100%** 912,015	**100%** 1,107,437	**100%** 1,273,889	1,743,900
Education as % of Total Government Budget	17.4%	18.8%	18.3%	17.7%	18%

Sources: Assad & Kibaja, 2008 (available in URT PHDR, 2009) and MTEF 2009/10-2011/12

Despite the government's stated willingness to change priorities in government budget expenditure in favour of the education sector over recent years, financial allocation to vocational and technical education, as indicated in Table 6, remains far too low to have a meaningful impact on the development of the required skills and knowledge among Tanzanian students to spur job creation. Class sizes for compulsory science subjects such as biology are still overwhelmingly large. According to interviews conducted by the study team in Zanzibar, for example, one biology class size ranges from 450 to 500 students, who are hence split into 7

groups taught by one teacher (both theory and practicals). Student overcrowding in laboratories is a common phenomenon in many schools, both in Tanzania mainland and Zanzibar, as captured in Photo 2 which was taken at Mwanakwerekwe 'A' secondary school in Zanzibar.

3.3   Teacher Workforce Preparation

One of the most fundamental and persistent weaknesses of the Tanzanian education system is teacher preparation and training. Existing and collected data indicate that teacher preparation is inadequate at both the primary- and at the secondary-school level, in several respects. First, as highlighted in the previous section the low performance in mathematics and science among primary-school pupils and secondary-school students indicates that both primary- and secondary-school teachers lack the capacity to adequately prepare their students—especially at

Photo 2: Students at Mwanakwerekwe "A" Secondary School in Zanzibar performing a biology laboratory practical

the primary-school level, in which teachers are either not adequately prepared themselves prior to entering the teacher preparation programme and/or they are not being adequately prepared within the programme itself. A second aspect is the utter lack of mathematics and science teachers—again, at both the primary- and secondary-school levels. The present section addresses the strengths and weaknesses of the current teacher education system, including an assessment of both PRESET and INSET—beginning with the lack of teachers in science, technology and mathematics.

According to surveys of teachers and DEO interviews in the field, all participants in the study agree that there are not enough teachers in mathematics (especially) and science in the primary and secondary schools. Table '4' presented in the previous section gives teacher staffing levels (actual and required) at the secondary-school level, as provided by DEOs in a number of districts/regions included in the study.[3] For example, Dodoma Municipal Council needs 150 secondary mathematics teachers yet lacks 115; for Kasulu, a rural western district the numbers needed and lacking are 117 and 107, respectively. The same two districts/councils are lacking 88 and 62 physics teachers, compared with total requirements of 114 and 78, respectively. In general, based on observations made within Teacher Training Colleges (TTCs) reveal that teacher candidates do not have enough opportunities to practice applying learner-centred and other, effective pedagogical approaches—a problem that has been highlighted elsewhere (e.g., Osaki, 2007). Teachers simply do not have the knowledge and skills needed to teach effectively, as highlighted in the preceding sections of this report. Second, in-service teacher training is essentially non-existent. Aside from the network of Teacher Resource Centers, which are inconsistently and inadequately supported, there is currently no organised, established system of in-service teacher education and training at either the primary- or the secondary-school level.

In science and technology education the inadequacy of teacher preparation and training in Tanzania is partly a matter of policy development, and partly a matter of its implementation. For example, curricula for primary and secondary pre-service education are generally strong in structure and content. Teacher education programmes emphasise practical experiences for teacher candidates in the application of learner-centred instructional approaches. However, teacher candidates at both the primary- and at the secondary-school level do not have

---

[3] Many DEOs did not provide any data on staffing, whether due to a lack of information-gathering capacity or other reasons. However, DEOs throughout the regions under study (at both the primary- and secondary-school level) stated that schools in their districts were particularly lacking in teachers of mathematics and science.

adequate opportunities to apply, practice, discuss, reflect and improve their knowledge and skills in the use of new, competency-based curricula, inquiry- and context-based instructional practices and methods of continuous assessment. Yet teachers' knowledge and ability in the application of these integrated approaches to teaching and learning are crucial to the quality of education. The present section examines these issues, drawing on data from teacher and student surveys as well as interviews with officials at the national level.

3.3.1   The Problem of Access Vs. Quality

The rapid expansion of the educational system is at least partly to blame for problems of poor preparation of both primary and secondary teacher candidates. Increasing numbers of teachers are entering degree and training programmes in universities and colleges nationwide. Existing staff are generally well-trained and experienced. However, these institutions are too few and not fully staffed. The problem of understaffing is particularly acute at the primary-school level, where there are only two colleges equipped to handle science teacher candidates. Further, in addition to the generally inadequate numbers of teaching staff, primary school teachers often lack the proper academic qualifications. Yet they are generally knowledgeable and experienced in the application of learner-centred pedagogy and curricula, albeit not in depth. Further, class sizes, lack of materials and other issues are such that primary teacher training staff are not providing teacher candidates with proper training in the use of context- and inquiry-based approaches to teaching. Some Teacher Training Colleges (TTCs) have class sizes of 200 to 300 students, making the application of such pedagogical approaches—particularly critical to developing a deep understanding of science and mathematics content—difficult at best.

On the one hand, the problems of teacher education and training are well documented; officials at national and local levels, in university colleges of education and teacher training institutions and District Education Offices (DEOs) across the country have long voiced the need for greater investment of resources in pre-service and in-service preparation and training programmes. On the other hand, recent revisions to teacher education curricula and the addition of new university colleges and training institutions unfortunately have not resulted in substantive changes in the structure of training programmes or in the application of appropriate pedagogies. For example, at the secondary-school level, demonstration schools are largely underused for training purposes. Funding of teaching practice is inadequate; and classroom-based assessments of teacher education students are largely based on paper-and-pencil examinations rather than on appropriate, practice-based assessment of teacher candidates' knowledge and skills in teaching. The lecture-and-seminar format of teacher education is wholly inadequate to the preparation of secondary school teachers, teacher

trainers, education administrators, curriculum specialists and other professionals graduating from the nation's colleges of education.

In sum, the very pedagogy embodied in the competency-based curricula for primary and secondary schools, primary teacher training institutions and secondary teacher education and training programmes remains largely unimplemented in ordinary school classrooms across the country—mainly due to the poor conditions of training and lack of implementation of existing curricula. Large class sizes are widely blamed as the cause of poor performance of pupils and students at all levels, including teacher education—and are thus cited as a major reason why teachers do not apply constructivist (e.g., learner-centred) pedagogical approaches. Yet the structural issues of changing curricula and expanding enrolments without available, adequate in-service and pre-service teacher education systems and programmes in Tanzania during the past 10 to 15 years present a more fundamental set of problems.

3.3.2   *Teacher Preparation and Student Performance*
The study team argues that the absence of a comprehensive, coherent and fully-functioning teacher preparation and training system is—aside from the problems of policy and administration cited previously—at the heart of the consistently poor performance among primary and secondary schools across the country. Performance in the sciences and mathematics has been particularly affected by the incompleteness and inadequacy of the current teacher education and training system. Teacher qualifications, in terms of subject-matter knowledge and pedagogical skill, is most lacking in science and mathematics. Paradoxically, Grade A Teacher Certification Examination (GATCE) pass rates would seem to indicate just the opposite. For example, teacher candidates passed the science portion of the examination at a rate of 98% and 97% in 2008 and 2009, respectively. Upon closer scrutiny, however, one notes that pass rates in all subjects varies between 90 and 100%, with the exception of mathematics (at 86% in 2009). These scores are difficult to imagine, in view of the consistently poor student performance in mathematics and science at the primary-school level.

Given the lack of knowledge among primary school teachers in the study about context-based approaches to teaching, combined with the low performance in science and mathematics on national examinations, the poor classroom conditions and the significant pressure to get teachers into the classroom, it is likely that teachers are not being thoroughly assessed during pre-service training. Teacher candidates' examination scores are simply inconsistent with these other findings. System expansion, especially at the primary-school level, has been largely

incomplete due to the lack of human and material resources needed, according the data gathered on teacher deployments, textbooks and facilities.

As it stands today, the quality of education risks lagging substantially behind access, which is itself at risk in the face of inadequate pre-service and in-service training capacity. The education system therefore cannot maintain the significant gains already made in enrolments, drop-outs, promotion and student performance in the absence of adequate, consistent pre-service and in-service training. This is particularly true of science and mathematics education, where pupils, students and teachers all express frustration and doubt over their own knowledge and preparation. University students participating in the study likewise and consistently cited problems of teaching and teacher quality in their pursuit of a quality education—especially in mathematics and the sciences, at both the primary- and secondary-school level. Such strong trends in these data cannot be ignored when considering teacher preparation and training as possible causes and solutions to performance problems, and as a fundamental indicator of educational quality.

3.4   Curriculum and Instruction in Elementary and Secondary Schools

Curriculum and instruction in science, mathematics and technology pose a number of challenges. This is especially true of primary and secondary school science. First, the MoEVT adopted a competence-based curriculum in 2007. National examinations at both education levels were subsequently aligned with the new curriculum. However, as noted in the previous section of the report, teachers have not been trained in the use of the new curriculum. Second, the pre-service teaching curriculum is not being implemented as intended. Overcrowding and understaffing of the TTCs are partly the issue. Yet there are other issues, namely the absence of appropriate methods of teaching and learning, and insufficient opportunities to apply them in the classroom—at all levels.

Whereas the curriculum calls for teacher candidates to learn how to use learner-centred approaches in the classroom, few if any new teachers have the opportunity to practice applying them. Third, neither the science curricula nor current instructional practices place sufficient emphases on the use of context- and inquiry-based teaching and learning. This inadequacy raises a fourth issue, that of curriculum integration. Context-based approaches to teaching and learning lend themselves to the integration of science, technology, mathematics and the social sciences—which better reflect the nature of real-world problems. Yet the current curriculum does not feature these approaches, which can help students to make important connections

between science concepts and their application and value in society. This approach provides for more meaningful, deeper understanding of science content and students' capacities to apply concepts in science and technology in their work and lives (Fensham, 2008). The absence of these important approaches to teaching, learning and teacher preparation in curriculum and instructional practices is the single greatest challenge to improving the quality of science and technology education, at both the primary- and the secondary-school level.

3.4.1   Opportunities for Practice

Data gathered from a number of participant groups, both locally and at the national level, as noted previously indicate a lack of practical application of concepts in science, mathematics and technology in ways that best reflect the nature of everyday problems and challenges in work and society. For example, whereas university students in mathematics, the sciences and engineering possess the technical knowledge required in their respective fields and disciplines they lack the capacity to apply this knowledge effectively on the job. Employers in both the public and the private sector confirmed the inability of the majority of graduates they hire to put their knowledge into practice. For their part, secondary school administrators and teachers are generally confident that most of their students will be able to get jobs upon graduating. However, as noted previously, they are far less certain that these students' knowledge and skills will meet the technical demands of the current job market.

Photo 3: Some laboratory equipment at Kikuyu Secondary School in Dodoma

The problem of the practical application of knowledge in science, mathematics and technology is two-fold. On the one hand, there is a lack of practical application of science in laboratories, primarily via experiments and other, classroom-based activities. On the other hand, there are limited opportunities for pupils and students to solve problems or complete projects of the kind they may encounter after completing their studies. Yet both kinds of activities are critical to the development of the practical skills required to succeed in the job market. The present section details the problem, based on findings from the present study.

The analyses of the needs assessment team show that the current competency-based science curricula do emphasise scientific inquiry via exploration and experimentation. These curricula are designed to develop students' capacity for developing competencies, or the capacity to perform real tasks versus simply developing knowledge and cognitive skills. The current curricula likewise feature learner-centred instructional approaches, such as group work. Yet the current curriculum structure and content do not adequately promote the use of context-based approaches to teaching and learning. Students need to learn how to apply knowledge of science, mathematics and technology, which they do in the laboratory in some cases—

especially at the university level, where equipment and facilities are more commonly available. However, they need to learn how to apply knowledge in real-world contexts as well. These approaches help to deepen students' knowledge while assisting them in applying knowledge in contexts they will likely face on the job (Fensham, 2009). Whereas some teachers participating in the study reported doing so, the vast majority of teachers surveyed were unable to describe or to recognise context-based approaches, such as problem solving, in a given context (e.g., health or agriculture).

3.4.2 Context-Based Learning Teaching and Learning

The competency-based curriculum does address the development of actual science-related competencies. It does not, however, adequately address the practical application of science-related knowledge and skills graduates, which graduates will need to develop in order to tackle the kind of real-world issues and problems they will one day face in an increasingly complex and technologically interdependent society. These issues and problems are found in social, environmental, economic, cultural and development contexts, among others. Examples include public health, trade and industry, agriculture and engineering. Curriculum and instructional practices need to recognise and make use of the integrated nature of science, technology and society while raising the awareness and capacity of graduates to enter the job market prepared to meet these kinds of challenges.

3.5   Employment Systems for Science and Technology Graduates

One of the most significant findings of the present needs assessment study has to do with the lack of any formal linkages between educational institutions and the technology sector. One issue has to do with the apparent absence of any formalized effort to link educational programmes of study to current and future employment needs, trends and developments in the technology sector. This link would include the integration of real-world applications of science and technology within programmes of teaching and learning, particularly at the secondary and tertiary level. The other issue is more a matter of providing adequate guidance, advising and counselling to students—in selecting educational experiences (i.e.,. programmes and courses of study) on the one hand, and in selecting a career and finding employment on the other. The present section details these issues and findings while highlighting some of the possible linkages that may be explored and developed.

There are positive signs that the technology sector is expanding, with potential benefits to science and technology education and employment. Increased investment in research and

development capacity, internet and telecommunications, business development and infrastructure such as roads and ports for expanding trade all tend to favour the expansion of jobs and other employment opportunities. Educational programmes, particularly at the university level, are indeed changing to meet these needs. It is now possible, for example, for students of mathematics at the University of Dar es Salaam to take courses in environmental sciences, or for students to specialise in biotechnology or microbiology. Still, these programmes lack the practical, applied kinds of learning experiences and infusion of current innovations in the sciences and in technology of a truly vibrant tertiary educational system. In short, knowledge generation in the technology sector—via both parastatal and private-sector organizations—is weakly connected to knowledge generation in the education sector.

3.5.1 Needs for Collaboration, Improvement and Expansion

On the one hand, educational programmes do not adequately account for the demands of current applications in science and technology. Teaching and learning programmes are particularly weak in context-based teaching and learning, for example, of the kind that can adequately equip students with the knowledge and skills needed on the job market. Strong on the vital, theoretical aspects of knowledge, universities in Tanzania tend to be weak in providing practical learning experiences that expose students to real-world applications of concepts in science, mathematics or engineering.

On the other hand, institutions of higher education are not participating as actively as they might in the development of the technology sector. These limitations are depriving students and faculty of opportunities to learn and keep pace with changes in the technology sector. On the other hand, there are few prospects of employment for science and technology graduates in the Tanzanian market. However, the state of development of the technology sector has been improving. Science and technology is currently benefiting from a good deal more investment than in the past. First, the government has increased investment in the expansion and support of research and development activity. The increased budget allocation to COSTECH is significant at 30 billion Tanzanian shillings. Yet this figure is still far short of the targeted 1% of GDP highlighted earlier, which would amount to 10 times the current level of investment or over 300 billion Tanzanian shillings. Stronger linkages between educational, private-sector and parastatal institutions can address these needs and challenges, however, which include the following:

- Skill-gap or SWOT (Strengths, Weaknesses, Opportunities and Threats) analyses have been lacking at the national level, to accurately determine the current and future direction of

development of the technology sector. These include projected requirements of the labour market in terms of graduates' knowledge, skills and competencies.

- Formal systems and support programmes are needed for career guidance and job placement, in order to assist science and technology students in course selection, making career decisions and finding employment—especially in tertiary institutions.

- Internships, research and development projects and other forms of collaboration between educational institutions and private-sector firms are needed, establishing valuable links between the employment sector and the tertiary educational institutions in particular. These kinds of linkages can expand opportunities for knowledge creation, application, skills development and problem-solving for students prior to graduation. Collaboration between parastatal institutions of the National Innovation System (NIS), universities and private-sector enterprises can help to fuel expansion of the technology sector while enhancing the quality and relevance of educational programmes.

Support for science and technology education at all levels is mainly from the bilateral and multilateral aid organizations (e.g., UNESCO, SIDA/SAREC, the World Bank, NORAD). In contrast, support for mathematics, science and technology from local and regional organizations and institutions is relatively insignificant.

Still, parastatal institutions within the NIS are actively engaged in activities to support the development of new products and processes. Some of these activities, such as developing new testing and treatment processes for combating malaria (at the National Medical Research Institute, or NMRI), are research based. However, other of these activities are more purely consultative. For example, TIRDO personnel advises farmers on the development of processes to produce and preserve juices, remove harmful substances from cassava and even produce flour from locally-grown crops. This 'value-added' approach can yield promising results, in terms of creating new business, jobs and expanding markets. The trouble is, these efforts—whether they involve research, experimentation or the application of existing technologies—lack the kind of systematic planning and coordinated institutional investment of human and other resources that is required to truly develop the technology sector. Moreover, there is little or no collaboration between parastatal institutions of research and development and higher educational institutions, from which both kinds of institutions would likely benefit.

3.5.2 *Support for Education and Employment*

Most respondents interviewed at both the national and school levels agreed that there is need to provide additional support for mathematics, science and technology at all levels of the education system. The kind of support often cited included: improving teaching and learning materials, improve both pre-service and in-service training for staff, improved incentive for both students and mathematics and science teachers, and improved infrastructure. National policy initiatives taken over the course of the past decade were intended to increase the emphasis placed on science and technology in education and development. While some important steps have been taken, much more work needs to be done to promote the development of systems of education and employment in Tanzania's emerging technology sector.

The National Higher Education Policy (NHEP) targets 'the development and promotion of a strong indigenous base of science and technology to enable Tanzanians to solve their development problems' (URT, 1999, p. 8). But also to 'encourage researchers, scientists, and technologists within the country through incentive schemes for purposes of further enabling them to make their scientific contributions to society' (p.9). Objectives of secondary education also include, 'to instill a sense and ability for self-study in science and technology, academic and occupational knowledge, skills' and 'to prepare the student to join the world of work'. According to the current NHEP, training and research objectives are to expand the numbers of science and technology graduates from the nation's schools 'to achieve the target of 600 scientists and engineers per one million [people] by the year 2005' (p. 8). But the policy does not specifically set any recruitment targets for science and technology students at the tertiary level. Further, neither the current status of employment nor the projected societal needs for qualified graduates in science and technology have been assessed in recent years.

Photo 4: A portion of a classroom temporarily used as a laboratory at Mtapika Secondary School in Masasi District.

An interview with the Ministry of Labour, Employment and Youth Development revealed that the last labour survey was conducted in 2005/06, some five years ago. Moreover, the survey did not provide specific information on employment trends per sector or occupation. According to the Ministry's Director of Policy and Planning plans are underway to carry out another labour survey in the East African region during the 2010/11 financial year. The survey should provide some useful data for the purposes of improving planning capacity, commitment of educational resources and the availability of employment opportunities for science and technology graduates. However, a more complete assessment, such as a SWOT or skill-gap analysis (as stated previously) in order to determine the appropriate planning, resource allocation and implementation strategies.

Some of the strategies of the current national science and technology policy (1996) include:

- To deliberately increase public investment towards planned inventions and innovations in science and technology

- To increase funding in R&D This is being done, according to COSTECH. Increased to 30 billion this year, but well short of the target of 300 billion (i.e., 1% of GDP)

These initiatives are intended to spur the growth of the technology sector by fostering the development of commercially viable products and processes. These developments should, in turn, create jobs and other economic opportunities, increasing government revenues while improving the conditions for domestic and international investment. However, a great deal more investment in such initiatives will likely be needed in order to reach these goals.

4.0   RECOMMENDATIONS

Based on the findings presented here, the needs assessment team recommends the following:

- Establish national and regional centres of excellence to effectively link science and technology education to its real-life application. These centres would be designed for promoting the use of context- and inquiry-based teaching, training and learning. The centres should likewise work to foster the development of educational partnerships between schools and universities on the one hand and private enterprises and innovation centres on the other. Examples of activities could include university internship and cooperative learning programmes in industry and development; competitions and fairs to promote science/technology exploration and innovation among school-age children and their teachers; and career/ employment fairs for college/university students.

- Establish and strengthen an effective system of teacher preparation, including pre-service and in-service training components at both the primary- and secondary-school level. This system would emphasis the use of context- and inquiry-based instructional methods in science and mathematics.

- Provide supplementary curriculum guides for improving teachers' capacities to implement existing curricula while improving their abilities to use context-based and improvisational instructional practices. Use these materials to foster the development of mobile, 'school laboratories', in which the local environment and materials become resources for teaching and learning.

- Develop a mechanism for monitoring and evaluating progress on key objectives for the advancement of mathematics, science and technology education, involving stakeholders at all levels—including parents.

- Integrating science and technology education into all socio-economic national policies and taking steps to ensure proper implementation. These efforts should include key policy recommendations of the Perth Declaration, especially those designed to promote

interest in science and technology among students, teachers and parents while linking education more closely to potential career opportunities.

- Establish partnerships between Tanzanian industry, science and technology colleges and universities and similar institutions abroad. These partnerships could include advisory boards, activities for knowledge and technology exchange, workshops and student- or teacher-led action research projects to improve the quality of education in science, mathematics and technology.

Although this is not a complete list, the team makes these recommendations in order to address the needs highlighted in the report while taking into account the political and resource challenges posed by any large-scale reform. However, as noted previously, significant human, material and financial investment is unavoidable, if the educational system is going to meet the nation's social and economic development goals

5.0   CONCLUSION

One conclusion that can be drawn from the present study is how Tanzania's education sector, the private sector and the National Innovation System are relatively disconnected from one another. While there are examples of limited collaboration, such as private enterprises working with university faculty, they are generally random events. COSTECH is trying to change this, such as by offering support to qualified research projects and giving awards in science and mathematics education. There have likewise been programmes to support job placement through the Ministry of Labor, and perhaps other initiative. Yet given the lack of confidence among study participants in science and technology students' ability to find jobs in their fields, it is unlikely that current educational programmes are influenced as much as perhaps they should be by developments outside of school classrooms.

The problem of the lack of interconnections between the technology sector and the education sector is affecting national development in two important ways. One way is in the resulting lack of capacity of the educational system to produce qualified graduates in science and technology—those who posses the knowledge, skills and competencies to meet current and future demands. These demands are not limited to those of the private sector, but extend to development needs in the public sector as well. Tanzanian institutions charged with solving problems in public health, food security and other areas are commonly unable to find qualified science and technology professionals to fill positions in research, policy or support functions.

The other way in which these weak linkages are affecting national development is by limiting the capacity of the technology sector to meet the development needs of the country. Lacking in qualified personnel, and the kind of creative collaboration and innovation that so often derive from a vibrant educational system, both private and public sector institutions cannot contribute to national growth as much as they might otherwise do. The result is a development plan hampered by an inadequate educational system, which cannot fulfil its intended role of educating children to meet the country's current and future needs. Although further study is needed in order to determine the specific potential of the technology sector for fuelling national economic growth and development, it is clear than much greater investment in science and technology education is needed. However, such investment must begin with a clearer set of policies linking the expansion and development of technology sector with the achievement of fundamental objectives of Tanzania's social and economic development.

UNESCO Needs Assessment Study of Tanzania's Science Education

6.0   REFERENCES

Bernardes, A.T., Ruiz, A.M., Ribeiro, L.C., and Albuquerque, E.M. (2006) *Modeling Economic Growth Fuelled by Science and Technology*. Universidade Federal de Minas Gerais, Cedeplar, 2006. – 24p. Texto para discussão ; 294

Cervantes, M. (2010) *OECD Reviews of National Innovation Systems and STI Policies*. OECD Directorate for Science, Technology and Industry. Geneva: OECD.

Claussen, J. and Assad, M.J. (2010) *Public Expenditure Tracking Survey for Primary and Secondary Education in Mainland Tanzania*. Dar es Salaam: United Republic of Tanzania.

Fensham, P.J. (2008) *Science Education Policy Making: Eleven emerging issues*. Paris: UNESCO.

LO/FTF (2003). *Profile of the Labour Market and Trade Unions in Tanzania*. J. Assens and K. Jensen (eds.) Dar es Salaam: The LO/FTF Council.

Millennium Project (2005). *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals.* New York: United Nations.

Mukama, B.C. and Yongolo, C.S. (2005) *Development of S & T System and Experience of Tanzania on S & T Data Collection*. Presentation at the Regional Workshop on Science and Technology Statistics 17 – 22 September, 2005, Entebbe, Uganda.

NECTA   (2006)   National   Primary   School   Leaving   Examination   Results   Statistics: Regional/Districts, General and Subjects Rankings

---------   (2007)   National   Primary   School   Leaving   Examination   Results   Statistics: Regional/Districts, General and Subjects Rankings

--------- (2007) National Form Four Examination Results Statistics

------- (2008) National Primary School Leaving Examination Results Statistics: Regional/Districts, General and Subjects Rankings

UNESCO Needs Assessment Study of Tanzania's Science Education

--------- (2009) National Form Four Examination Results Statistics

--------- (2010) National Form Four Examination Results Statistics

Osaki, K.M. (2007) *The Challenge of Science and Mathematics Education in Tanzania.* Presented at the Workshop to Launch the National Science INSET Programme. Dar es Salaam: Ministry of Education and Vocational Training.

Tema, B.O. and Mlawa, H. (2009) *Assessment Report on Integration of Science, Technology and Innovation in MKUKUTA and MKUZA*. Dar es Salaam, Tanzania. UNESCO.

URT (1995) The National Education and Training Policy. United Republic of Tanzania.

--------- (1996) The National Science and Technology Policy for Tanzania. United Republic of Tanzania.

---------(1999) The National Higher Education Policy. United Republic of Tanzania.

---------(2000) Tanzania Development Vision 2025. United Republic of Tanzania.

---------(2003) The Tanzania National ICT Policy. United Republic of Tanzania.

---------(2007) The Tanzania National ICT Policy for Basic Education. United Republic of Tanzania.

---------(2009) Poverty and Human Development Report, Research and Analysis Working Group MKUKUTA Monitoring System Ministry of Finance and Economic Affairs. United Republic of Tanzania.

---------(2008) *A Performance Audit Report on School Inspection Programme For Secondary Schools In Tanzania: A Report of the Controller and Auditor General*. United Republic of Tanzania.

---------(2010) *A General Report of the Controller and Auditor General on the Performance Audit (VFM) Reports for the Period Ending 31st March, 2010.* United Republic of Tanzania.

Utz, A. and Aubert, J.E (2008) Fostering Innovation, Productivity, and Technological Change in Utz, R. (ed.) *Sustaining and Sharing Economic Growth in Tanzania,* Washington, DC: World Bank Publications.

Watkins, A. and Verma, A. (2008) *Building Science, Technology, and Innovation Capacity in Rwanda: Developing Practical Solutions to Practical Problems*. A. Watkins and A. Verma (eds.) Washington, DC: World Bank Publications.

ANNEXES

Annex 1: List of Institutions covered by the study team

1. Ministry of Finance and Economic Affairs
2. Ministry of Infrastructural Development
3. Ministry of Communication, Science and Technology
4. Ministry of Labour, Employment and Youth Development
5. Ministry of Education and Vocational Training, Tanzania mainland
6. Ministry of Education and Vocational Training, Zanzibar
7. United Nations Educational, Scientific and Cultural Organization (UNESCO)
8. Commission for Science and Technology (COSTECH)
9. Tanzania Industrial and Research Development Organization (TIRDO)
10. Centre for Agricultural Mechanization and Rural Technology (CARMATEC)
11. National Radiation Commission (NRC)
12. Geological Survey of Tanzania (GST)
13. Forum for African Women Educationists (FAWE)
14. African Assay Laboratories (T) LTD
15. University of Dar es Salaam (UDSM)
16. University of Dodoma (UDOM)
17. St. John's University of Dodoma
18. Bugando University College of Health Sciences (BUCHS)
19. Mbaya Institute of Science and Technology
20. Amani Primary School
21. Bogwe Primary School
22. Boma Primary School
23. Butimba Primary School
24. Buzebazeba Primary School
25. Chang'ombe Demo. Primary School
26. Haloli Primary school
27. Ichenjezya primary School
28. Igekemaja Primary School
29. Ilungu Primary School
30. Isunta primary school
31. Itiji Primary school
32. Kajificheni Primary School
33. Kambo Primary School
34. Karanga Primary School
35. Kiembe Samaki Primary School
36. Kyou Primary School
37. Likonde Primary School
38. Maendeleo Primary school

39. Mahaha Primary School
40. Mailisita Primary School
41. Makole Primary School
42. Makomu Primary School
43. Maromboso Baptist Primary School
44. Matemboni Primary School
45. Mbokomu Primary School
46. Mbonde Primary School
47. Migongo Primary School
48. Mkapa Primary school
49. Mkoani Primary School
50. Mkuyuni Primary School
51. Mlimani Primary School
52. Mnarani Primary School
53. Msipazi Primary school
54. Mugabe Primary School
55. Muungano Primary School
56. Mwanakwekwere Primary School
57. Mwenge Primary school
58. Ngarenaro Primary School
59. Nkomolo primary school
60. Ntyuka Primary School
61. Raha Leo Primary School
62. Shishani Primary School
63. Arusha Secondary School
64. Ashira Secondary School
65. Benjamin Mkapa High School
66. Bogwe Secondary School
67. Butimba Secondary School
68. Dodoma Secondary School
69. Hailesselassie Secondary School
70. Hasanga Secondary
71. Hazina Secondary School
72. Hwazi Secondary School
73. Ihanda Secondary School
74. Isangu Secondary
75. Itumbili Secondary School
76. Jang'ombe Secondary School
77. Kalemela Secondary School
78. Kaloleni Secondary School
79. Kaloleni Secondary School
80. Kantalamba Secondary School
81. Kibasila Secondary School

82. Kiembe Samaki Secondary School
83. Kigoma Secondary School
84. Kikuyu Secondary School
85. Kiloleli Ward Education Cordinator
86. Kimoshi Secondary School
87. Kimoshi Secondary School
88. Lubugu Secondary School
89. Machinda Secondary school
90. Magu Secondary School
91. Mailisita Secondary School
92. Masasi Girls High School
93. Mawenzi Secondary School
94. Mbeya Secondary
95. Miburani Secondary School
96. Mkolani Secondary School
97. Mlole Secondary School
98. Moshi Technical School
99. Moshono Secondary School - Arusha
100. Mtapika Secondary School
101. Mtwara Technical Secondary School
102. Mugabe Secondary School
103. Mwanakwekwere "A" Secondary School
104. Nalyelye Secondary School
105. Ng'amba Secondary school
106. Nkasi Secondary school
107. Nkomolo Secondary Schoool
108. Old Moshi Secondary School
109. Rahaleo Secondary School
110. Saint Francis Girls Secondary school
111. Temboni Secondary School
112. Turian Secondary school
113. Twayyibat Isslamiyat Secondary School
114. Weruweru Secondary School
115. Wiza High School

Annex 2: Terms of Reference for the Needs Assessment of Tanzania's Science Education

ToR for a Needs Assessment Study of Tanzania's Science Education

Under the supervision of the Natural Sciences Sector and the Education Sector Programme Specialists of UNESCO Dar es Salaam Cluster Office, the Consultant shall as part of the current reform of Tanzania's education sector focusing on improving the performance of students in science education, and, of the reform and repositioning of the national science, technology and innovation system focusing on the education functions of the National Innovation System undertake the following assignment:

1. Conduct a Needs Assessment Study of Tanzania's science education sector from March – April 2010 in eight (8) randomly selected regions including Dar es Salaam and one region in Zanzibar, a total of 10 regions with the objectives to:

a) Determine the current and desired status of science education in Tanzania's elementary and secondary schools, tertiary education institutions and the Ministry of Education and Vocational Training (MOEVT), Regional and District Education Offices;
b) Determine the extent of the needs and strategies to be used to establish centres of excellence in mathematics, science, and technology education;
c) Identify priorities of reform in science education and development strategies, and other interventions that will link mathematics, science, and technology education to job creation and appropriate career skills;
d) Identify causes of performance problems in schools, colleges of education, universities, Ministry of Education and Vocational Training, Regional and District Education Offices and employment; and
e) Identify possible solutions and growth opportunities in mathematics, science, and technology education, and employment.

2. Undertake the Study at two levels by: a) a review of literature and records followed by interviews and observations involving the appropriate officials of government, at all appropriate levels, Departments and Agencies, tertiary institutions, elementary and secondary schools, and b) by interviews, observations and document analyses to determine the extent these Sectoral concerns exist in selected institutions, Regional and District Education Offices.

3. Utilize a survey instrument to be jointly developed with UNESCO Dar es Salaam;

4. Make a half-day presentation of the draft document to UNESCO staff on the findings and obtain their views before finalization of the document;

5. Make a half-day presentation of the final document to select group of stakeholders in the education sector in Dar es Salaam, Tanzania.

6. Produce a well written account of the assessment study using a format to be agreed upon with UNESCO and with enough photographic evidence of the situation on the ground in the selected regions and schools and submit same to UNESCO on or before 31 May 2010 with a financial statement.

Contractor: 2 teams with 1 lead and 1 junior partner each for 30 working days.