Metal industry and technical education in Tanzania : model for matching demand and supply of knowledge and skills

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METAL INDUSTRY AND TECHNICAL EDUCATION IN TANZANIA

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PREFACE

This report is the outcome of eighteen months of M.Sc. research which I carried out in the Netherlands and in Tanzania. It reflects my personal interest with respect to education, in particular in developing countries. In mid 1994 I was offered the opportunity, via the University of Dar es Salaam, to conduct a research in Tanzania into the apparent misfit between technical education and industry's demands, to be part of the Department of Mechanical Engineering's *Design of Improved Production Systems* project. Via literature study and the writing of a report at the Wageningen Agricultural University I gained insight in the problems related to the supply and demand of technically skilled workers in developing countries in general and Tanzania in particular.

In close cooperation and under the supervision of dr. P. Lapperre of the Eindhoven University of Technology I developed a research proposal and in January 1995 I left for Dar es Salaam. Despite an initial draw-back caused by 'bureaucratic imperfection', the following eight months have been a wonderful period and a very useful experience. Reliance on the availability and high standards of numerous services in life, to which I as a westerner was accustomed, disappeared. The experience in overcoming this and adapting my traditional Western standards to new Tanzanian standards has been both frustrating and stimulating - fascinating in every way.

For making this experience possible, I would like to thank several people. First of all dr. P. Lapperre for initiating the research at the University of Dar es Salaam and his supervision during these eighteen months. Also prof. J. Masuha of the University of Dar es Salaam, for offering me the opportunity to work at the University as a member of the DIPS research team and for his supervision and practical advice while in Tanzania, and prof. dr. W. v.d. Bor of the Wageningen University of Agriculture and dr. A. Lemmens of the Eindhoven University of Technology for their advice regarding the contents of my research. Furthermore, I would like to thank the staff of the CICA Academic Centre in Mbagala for their excellent services. Finally I would like to thank my parents and Maurice, without whose support in various ways these past eighteen months would not have been possible.

Eindhoven, March 1996 Raimond Duijsens

EXECUTIVE SUMMARY AND OUTLINE FOR PAPER

1 BACKGROUND AND AIM OF THE RESEARCH

In Tanzania, like in many developing countries, there is a mismatch between education and industry[1]. The aim of this research, which is part of the *Development of Improved Production Systems (DIPS)* project of the Department of Mechanical Engineering of the University of Dar es Salaam[2], is to determine the major causes of this mismatch in Tanzania. As a consequence of being part of the DIPS project, it focuses on two particular research units - institutes providing technical education and metal working companies - in order to answer the following questions:

1 *What are the shortcomings in knowledge and skills of technical personnel employed in metal manufacturing companies as indicated by these companies?*
2 *How can shortcomings in the levels of knowledge and skills of technical personnel in the metal manufacturing companies be attributed to shortcomings of educational institutes?*
3 *How can the identified shortcomings be solved?*

The research was carried out in the Netherlands as well as in Tanzania during the period from October 1994 until March 1996. In the metal working sector data were collected with respect to shortcomings in knowledge and skills of the workers. These served as an input when the causes of the shortcomings were identified in the various institutes providing technical education.

2 PART ONE: RESEARCH IN METAL WORKING COMPANIES

In the first part of the research, two important issues were:

1 selecting companies in such a way that the sample would be representative for the entire population of metal working companies;
2 developing a methodology to measure shortcomings in knowledge and skills, independent of a person's educational background.

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1 See Psacharopoulos, G. *Vocational education theory - why does vocational education fail?* in *International journal of educational development*, vol. 11, no.3 (Oxford, United Kingdom, 1991, page 193-199) and Sifuna, D.N. *Vocational education in schools: a historic survey of Kenya and Tanzania* (Dar es Salaam, 1976, pag 53)

2 The DIPS project is aimed at assisting metal working companies in Tanzania, in particular in the Dar es Salaam region, and it includes 168 companies.

2.1 SELECTING COMPANIES FOR THE RESEARCH

Companies were selected on basis of the following characteristics:
1 *company size*, i.e. the number of employees (≤ 10, 11-99, ≥ 100 employees);
2 *metal working process* (metal forming, removing, joining or coating);
3 *educational level* (vocational education, technical secondary school, technical college).
DIPS required that the research be aimed at the sector ISIC 3.8. The included educational levels were selected on basis of their practical, vocational orientation. The sample was to be representative for the total population with respect to the three characteristics mentioned.

2.2 MEASURING SHORTCOMINGS IN KNOWLEDGE AND SKILLS

In order to measure knowledge and skills, their classification has to be independent of a person's educational level, in order to be used in a wider educational context. *Knowledge* is defined as 'information stored in the learner's mind'. It can be classified according to 'factual knowledge' (referring to procedures) and 'conceptual knowledge' (referring to principles). *Skills* is defined as 'actions and reactions (intellectual or physical), which a person performs in a competent way in order to achieve a goal'. It can be classified according to 'cognitive skills' (decision making, thinking, planning), 'psychomotor skills' (physical action, physical coordination), 'reactive skills' (attitudes, feelings, habits) and 'interactive skills' (dealing with other people purposively). Each of these can be either 'productive' or 'reproductive'. A *productive skill* depends on the presence of a body of knowledge (built up through experience or instruction), composed of relevant general principles and structured into specific strategies of thought or action. The *reproductive skill*, on the other hand, simply applies procedures or algorithms to known situations.

For three reasons the research focuses on skills only. Firstly, for applying skills one needs a body of knowledge and when measuring skills one will, therefore, at the same time, although indirectly, measure knowledge. Secondly, skills are believed to contribute more to the improvement of the functioning of employees at the levels included in this research than knowledge. Finally, it is believed that, especially in developing countries, vocational education should put emphasis on teaching skills in order to make students more versatile and, consequently, to reduce unemployment among this group. The selected educational institutes are, to a large extent, vocationally oriented.

By means of a survey, the shortcomings in the four types of skills (both reproductive and productive) of the metal working employees were investigated (descriptive research). By means of open questions, shortcomings in knowledge were - to a lesser degree - also measured. The survey was carried out during visits to a total of 30 metal working companies. In all cases, the (direct) supervisor of the respective employee was questioned. Several outcomes appeared to be general for each of the three levels of technical education (vocational, technical secondary and technical college), whereas other shortcomings appeared to be specific for one or two levels:

For all levels:
- reproductive skills are less developed than productive skills;
- comprehension of English is limited;
- knowledge of modern metal working technologies is low;
- attitude for striving for excellence is low;
- awareness of safety-related aspects is low.

For technical vocational education:
- cognitive skills (both reproductive and productive) are low;
- theoretical knowledge of basic principles in metal working processes is low.

For technical secondary education:
- cognitive skills (both reproductive and productive) are low;
- practical experience is low;
- awareness of (preventive) maintenance is low.

For higher technical education:
- reproductive interactive skills are low;
- training with respect to management and supervision is low.

3 PART TWO: RESEARCH IN EDUCATIONAL INSTITUTES

The results of the survey in the metal industry did not reveal significant differences in knowledge and skills required for different metal working processes. For this reason, the contents of curricula and subjects were not investigated. Therefore, the research focused, at a higher level of abstraction, on aspects which influence the development of knowledge and skills. Firstly, it was determined whether or not a shortcoming, as mentioned by metal working companies, was inside or outside the stated aims ('goal areas') of the respective institutes. All shortcomings which were within the goal areas were investigated on their relation with respect to two dimensions: instructional characteristics (organization, methods, facilities, costs) and institutional characteristics (student, teacher, school management, family and community).

The research in the educational institutes was mainly by means of interview and observation (explorative research). At each educational level, several institutes were visited[3], each of them selected on basis of a 'mix' of three aspects: *size* (large or small), *location* (urban or rural) and *ownership* (public or private). Furthermore, several other institutes were visited: teacher training colleges and curriculum development institutes of the various educational levels, the National Examination Council and the various ministries involved.

For each of the indicated shortcomings the relation with instructional and institutional characteristics was determined. In the following matrix, an 'x' indicates a relationship, either direct or indirect:

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[3] 3 vocational training centres, out of a total of 42; 3 technical secondary schools, out of a total of 12; 2 technical colleges out of a total of 3.

indicated shortcomings	educ. level			instructional charact.				institutional charact.			
	vtc	tss	tc	o,c	m	f	c	s	t	sm	f,c
low reproductive skills	yes	yes	yes	x	x	x	x	x			
low knowledge of modern metal w.techn.	yes	yes	yes	x		x	x		x		
low striving for excellence	yes	yes	yes		x		x	x			
low awareness of safety aspects	yes	yes	yes	x	x		x		x		
low cognitive skills	yes	yes		x	x	x	x	x			
low comprehension of English	yes	yes		x	x			x	x		x
low comprehension of English			yes	x	x			x			x
low theoretical knowledge	yes			x	x	x	x	x			
low awareness of preventive maintenance		yes		x		x					
low practical experience		yes		x	x	x	x				
low knowledge of management			yes	x	x			x		x	

notes yes shortcoming investigated at the particular educational level

vtc	vocational training centre	o,c	organization, contents	s	student
tss	technical secondary school	m	method	t	teacher
tc	technical college	f	facilities	sm	school management
		c	costs	f,c	family and community

4 CONCLUSIONS

From the review and analysis with respect to the indicated shortcomings in knowledge and skills at the educational institutes, it became clear that these were mainly caused by English as a medium of instruction, since English, directly or indirectly, was found to be related to most of the shortcomings identified. In addition, from observations made during the field work it became apparent that financial means constituted a very serious shortcoming too.

4.1 THE ROLE OF ENGLISH

The use of English as a medium of instruction affects teachers and influences the teaching methodology (directly as well as via the teaching material), which in turn has its effect on the level of the students. Changing the medium of instruction from English to Kiswahili would seem to be a logical decision. However, there are a number of arguments against such a step:

- most (if not all) relevant literature is in English. Co-operation with foreign countries in research or production requires a mastery of English. Introducing Kiswahili would severely frustrate the co-operation and research;

- also with respect to literature, changing to Kiswahili would take a considerable time, not to mention the costs which would be immense, particularly for a developing country such as Tanzania;
- Kiswahili has an inadequately developed technical terminology. Developing a technical vocabulary for this language would take a considerable time.

Against English, however, there are a number of arguments too:
- both teachers and students master the language insufficiently;
- as a result, the teaching methodology remains mainly expositive.

Considering wide use of English in science and technology and their importance with respect to industrial growth and development of economy and society, and considering the immense problems to overcome when switching to Kiswahili, the Tanzanian government should stimulate the use of English, inside as well as outside the school, more intensively.

4.2 THE ROLE OF FINANCIAL MEANS

The financial means of the schools have three different sources (*government, donor organizations* and *school fees*) and influence the quality of the teachers and the availability and state of books and machines, of which the latter is directly related to the most appropriate teaching methodology.

The research has shown that students at institutes which have ample financial means obtain better (examination) results. It would seem, therefore, a logical suggestion to raise the schools' financial means by raising one or more of the forementioned sources. However, this will cause severe complications:
- the government's ability to raise its contributions to the educational sector are hardly existent. It would, however, be interesting to gain more insight in the cost structure of overhead expenses and the efficiency of the various government bodies involved in the educational sector;
- under the present circumstances, donor funding in general contributes positively to a school's performance and both the Tanzanian government and the educational institutes themselves should be pressed to stimulate donor financing. This, however, should be accompanied by a more equal approach towards private secondary schools by the Tanzanian government with respect to regulations concerning fees, appointment and training of teachers and the selection of students.
- school fees should be collected and spent at the level where this is most efficient. Furthermore, school fees could be raised, considering the fact that the number of applications outstrips the number of vacancies by far, at all levels included in the research. However, raising fees would make the educational system more elitair. On the other hand it can be argued that the present structure of school fees in Tanzania is in essence inegalitarian since, in practise, it amounts to a transfer of payment from the poor to the wealthy. An increase of fees at technical colleges is very well tenable. At secondary level, an increase of fees should refer only to private institutes, thus leaving entrance to public institutes in essence meritocratic. However, considering the limited number of public institutes and their geographic location, this would limit access for a large group because

of increased travel expenses. At vocational level, the number of public institutes is rather considerable, and an increase of fees at private institutes, where deemed necessary, will probably not lead to restricted access possibilities at this level.

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CHAPTER 1 PROBLE SETTING

1.1 INTRODUCTION

In order to produce, an industrial company needs capital, labour and (raw) materials. When directly related to the production process, the labour needs to be technically skilled. The supply of this labour is mainly through the educational establishments. The problem setting of this research will, therefore, focus on two interrelated aspects:
- economy and industry (paragraph 1.2);
- education (paragraph 1.3).

1.2 ECONOMY AND INDUSTRY

The industrialization process to support the Ujamaa[4]-policies has, since Tanzania's independence in 1963, been based on import substitution and protection of domestic industries, with nationalization of large parts of the economic life as a characteristic. In the mid 1980s, however, it became clear that the economy was trapped in a vicious circle which always came back to the same point: a desperate lack of foreign exchange. This resulted in an increasing pressure for private-sector involvement in all sectors of the economy. With the succession of president Nyerere by president Mwinyi in 1985, a steady intensification of the liberalization process (the Economic Recovery Programme - ERP) occurred, resulting in agreements with the International Monetary Fund (IMF) and the World Bank in 1989[5]. The government has maintained the policies formulated in the recovery programme approved by the IMF and other donors, albeit at a slower pace than the donors would prefer.

Some major problems which surfaced during the execution of the ERP are, among others, the (still present) lack of access to credit by private business, the severe shortage of management

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4 Tanzania, since its independence in 1963, has followed a socialist strategy of development, based on two main themes: egalitarianism and self-reliance, commonly known as Ujamaa-politics. This was stated in the programme of the Tanganyika African National Union (TANU) of 1967, more commonly known as the 'Arusha Declaration'.

5 Maliyamkono, T.L. and Bagachwa, M.S.D. *The second economy in Tanzania* (Nairobi: Heinemann Kenya, 1992, page 8-25)

and entrepreneurial skills[6], outdated production facilities and low productivity in the manufacturing industry[7]. Like nearly all industrial sub sectors, the metal manufacturing industry, ISIC 3.8[8], has also been confronted with the above mentioned problems. Because of the importance of this sector, not only for its autonomous (foreign) exchange generating activities, but also for its role as supplier within and outside its own sector, it is important to find a solution for these difficulties, i.e. outdated production facilities and low productivity.

Figure 1 presents the contribution of industry to the GDP in 1992, figure 2 and 3 show the relative importance of the various industrial and metal working (sub)sectors.

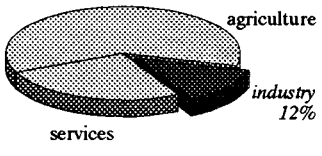

figure 1:
structure of production (1992)
source: 'World Dev. Report 1994'

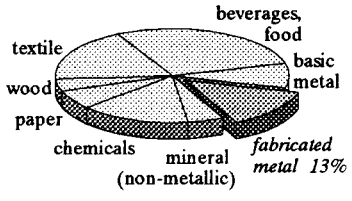

figure 2:
structure of industry (1989)
source: 'Census of Industrial Production 1989'

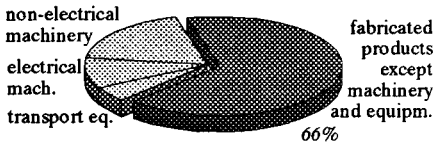

figure 3:
structure of metal industry (1990)
source: 'sector study' (various)

1.3 EDUCATION

1.3.1 THE IMPORTANCE OF EDUCATION FOR DEVELOPMENT

Economic growth has since the 19th century been closely related to industrialization. In this way, the transformation of capital and natural resources contributes to human development in many ways. However, human development can be seen as the result of the development of many resources. Unlike the rather passive factors of production capital and natural resources, the human resources ultimately determine the character and speed of social development. Within and interacting with several institutional mechanisms[9], the major institutional mechanism to develop the know-how and knowledge that are at the heart of the human resources in modern society, is the formal education system. Education is in this way relevant to both emancipatory development and economic development, and revolves around two basic

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6 Carroll, J. *Tanzania Economy* in *'Africa South of the Sahara'* (London: Europa Publications, 1991, page 1019)

7 Masuha J., Mutagahywa, B. and Nyichomba, B. *Phase I of Development of Improved Production Systems (DIPS) - the TDP Project* (Dar es Salaam: University of Dar es Salaam, Faculty of Engineering, 1992, page 1-2)

8 According to the 'International Standard Industrial Classification' - ISIC - of 1968 this industry can be referred to as ISIC 3.8, 'manufacture of fabricated metal products, machinery and equipment'

9 As stated in the *Universal Declaration of Human Rights*, adapted by the United Nations in 1948, these can be divided into institutional spheres: kinship, economical, political, religious, social security and education. Lapperre, P.E., *Man, technology, society and development: from the hunters and gatherers to the First Industrial Revolution 3,5 million years ago until 1760 BC* (Eindhoven: Eindhoven University of Technology, 1993, page 71-75)

economical processes[10]:

- interaction between demands (generally economically motivated) and supplies (generally politically responsive) in determining the provision of school places, the access to these places and the type of instruction;
- distinction between 'social' versus 'private' benefits and costs of different types of education and the consequences of these differentials for educational investment policies.

In most Third World countries education is provided publicly (by the government), and the determinants of demand (private costs versus expected private benefits - therefore the demand is a derived demand) are generally more important than the determinants of supply (determined largely by political processes unrelated to economic criteria other than limitations to public expenditure)[11].

1.3.2 STRUCTURE OF EDUCATION

Formal education in Tanzania is controlled by the state through three ministries: the Ministry of Education and Culture, covering primary and secondary education, the Ministry of Science, Technology and Higher Education, covering higher education, and the Ministry of Labour and Youth Development, covering vocational training. There are some private schools, mainly at the secondary level, established according to conditions issued by the Ministry. Policy issues and curricula for all schools (government and private) are the responsibility of the respective Ministries. Administration of primary and adult education is decentralized with local authorities.

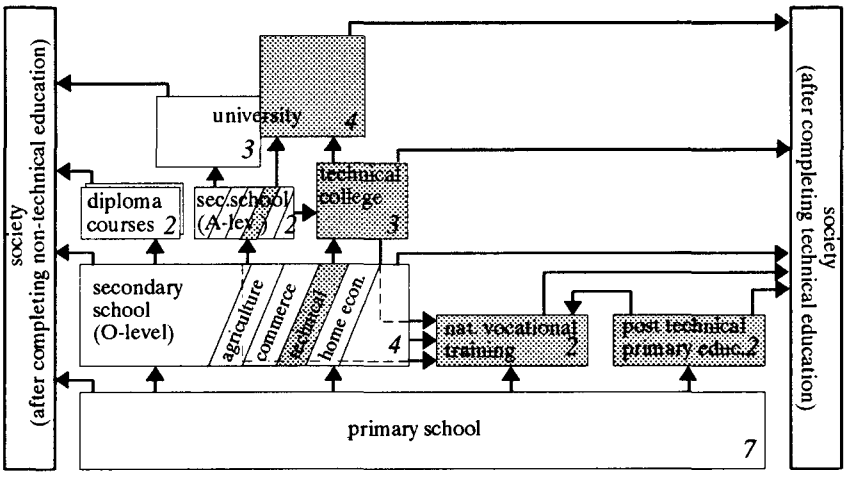

figure 4: schematic review of the education system in Tanzania (Note: shaded areas refer to technical education)
Source: Ministry of Education and Culture, 1980, 1993; Van Dam, A., 1990; Duijsens, R., 1995

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10 Todaro, M., *Economic Development in the Third World* (New York: Longman, 1992, page 337-362)

11 Lapperre, P.E., *Problems of Developing Countries in Institutional Perspective* (Eindhoven: Eindhoven University of Technology, lecture notes, 1993, page 121-126)

Except for private schools, where Ministry-controlled school fees are paid, all primary education in Tanzania is paid for by the government, which allocates about 20% of its recurrent budget to education. In secondary schools a government-stipulated fee is to be payed by the students. Furthermore, each school is meant to meet 25 percent of its catering bill (expenses for food, boarding facilities, etc.) by school-owned workshops. This is typically a remnant of socialist times.

An extensive review of the educational structure of Tanzania can be found in Appendix A. In this paragraph, the focus will be on technical education.

The structure of the education system in Tanzania, as given in figure 3, is as follows[12]: *primary education* starts at the age of 7 for a period of seven years, i.e. Standard I to Standard VII. The teaching related to technology or preparatory subjects at primary schools is restricted to mathematics and (natural) sciences. At the end of Standard VII, pupils sit for a Primary School Leaving Examination. After this, a pupil may chose for 'post primary technical education' (duration 2 years), 'national vocational training' (duration 3 years) or secondary school (duration 4 years, Form I-IV).

At *post primary technical education*, pupils are trained during a two year course to be artisans. After this, they may decide to work, or to enter *National Vocational Training (NVT)*. A course at one of the NVT centres lasts for two years, during which there is a close interaction with industry. After finishing NVT successfully, pupils will have completed Trade Test 3. After several years of working experience, they may return to NVT to pass their Trade Test 2 and subsequently Trade Test 1, each with a duration of one year.

Entrance to *secondary education (O-level)*, is allowed only to those selected on basis of a specially designed formula after the Standard VII-examination. During secondary education, students can chose for an orientation in their subjects, emphasising either agriculture, home economics, commerce or technology. For the latter, a student must take one of the following courses: mechanical engineering, civil engineering or electrical engineering. The students who, at the end of the fourth year, pass the National Form 4 Examination well may enter Form 5: *Secondary Education (A-level)*. The number of students admitted depends on the number of vacancies available. The orientations for A-level are the same as for O-level. After two years, these students sit for a National Form 6 Examination, which leads to the National Higher School Certificate, which is equivalent to the 'A'-level.

Students who, after following technically oriented secondary education, pass Form 4 may enter a *Technical College*, with a duration of three years. After successfully passing their exams, these students are given a Full Technician Certificate.

In Tanzania's *Teachers' Education*, teachers qualify, depending on their level of education, for Teacher Certificates A, C or diploma or BA/BSc with an option in education, the latter at University. The teachers with Certificates A and C teach mainly in primary schools. Those who followed a diploma course will join the teaching profession as a teacher of secondary

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12 Adapted from *Basic facts about education in Tanzania* (Dar es Salaam: the Ministry of National Education, 1980) and Duijsens, R. *Sector Review - Education in Tanzania* (Eindhoven: Eindhoven University of Technology, 1995).

schools for Form 1-4. Other teachers for secondary schools are graduates from the University of Dar es Salaam, where they study Education concurrently with their degree subjects.

After Form 6, or after completing Technical College, students can apply for academic education at *university*. Enrolment requirements include not only high academic qualifications, but also good character references. A non-technical course at university lasts for three years, whereas a technical course, leading to a bachelor degree, has a duration of four years. The University of Dar es Salaam is the only Tanzanian university with an Engineering faculty.

1.4 PROBLEMS RELATED TO DEMAND AND SUPPLY OF TECHNICALLY SKILLED MANPOWER

The problems mentioned in paragraph 1.2 (i.c. shortage of skills, outdated production technology and low productivity) are to a large extent dependent on technology. According to Van Tilburg[13], 'technology' is determined by four interactive components: technoware (objects-embodied), infoware (documents-embodied), orgaware (institution-oriented) and humanware (persons-embodied).

It is beyond doubt that the present status of technological hardware and the way in which this is organized within companies leaves much room for upgrading and modification. The Ujamaa-policies of self reliance and the resulting industrialization strategy of import substitution and protection of domestic industries left little urge for improvements in this field, and at the same time the economic results of this policy gave little possibilities to indeed change the situation.

However, it is equally plausible that the humanware-component is a possible bottleneck in many companies when adapting to the liberal market. After having focused on the educational problems which have risen during and in some cases as a result of the Ujamaa-policies, the situation in Tanzania is similar to many other developing countries: vocational training is in generally low esteem, and there is believed to be a shortage of vocationally trained people. This shortage contrasts with a large demand for vocationally and academically trained people in specific economic areas, especially where technical skills are required, and in this field foreign experts often need to be called upon[14].

1.5 UNIVERSITY OF DAR ES SALAAM: DEPT. OF MECHANICAL ENGINEERING

The University of Dar es Salaam is one of the two Universities in Tanzania with specific technical knowledge which can be of use when trying to solve (technology-related) problems of the metal manufacturing industry. Furthermore, this University is the only University

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13 Van Tilburg, P. and Bertholet, G. *Technology for developing countries* (Eindhoven: Eindhoven University of Technology, lecture notes, 1992, page 4)

14 Szirmai, A. *Ontwikkelingslanden - dynamiek en stagnatie* (Groningen: Wolters-Noordhoff, 1994, page 191-193)

which includes a Department of Mechanical Engineering[15].

With its specific knowledge of technology-related problems of mechanical engineering and manufacturing origin, the Department is expected to assist the industry to face the problem areas (as mentioned in paragraph 1.4) and to develop the national economy. For that purpose, the Department has started a programme called 'Development of Improved Production Systems' (DIPS).

In a recently conducted survey, aimed at determining the technical status of the metal engineering industry, all four components (technoware, infoware, orgaware and humanware) are investigated[16], albeit at a highly quantitative level. Furthermore it focused on an inventarisation, as was the aim, but with this it left little room to directly investigate possible bottle-necks. Finally, the attention was focused to a large extent on technoware and orgaware, and to a much lesser extent on infoware and humanware.

1.6 RESEARCH GOAL

In the light of the above problem setting, there is need for a further, more intensive investigation with respect to the supply of technically skilled personnel to the industry, particularly the metal manufacturing industry. Referring to paragraph 1.3, the educational institutes that should in principle be involved in this research cover the range from (technical) vocational education to universities. Since the bulk of the metal working industry of Tanzania is located in and around Dar es Salaam[17], the same companies as in the earlier industrial survey are selected. The (technical) educational institutes, however, are not concentrated around the capital: they are spread over the whole of Tanzania[18]. Since all these educational institutes are (potential) suppliers to the metal working industry, the selected ones should be located throughout the country.

In concrete terms, the goal of the research can be formulated as follows:
1 identify, in the Dar es Salaam region, relevant bottlenecks in demand and supply of technically skilled manpower;
2 present recommendations to solve these bottlenecks.

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15 The Department of Mechanical Engineering is part of the the Faculty of Engineering

16 *Industrial Survey on Metal Engineering Companies in Tanzania* (Dar es Salaam: University of Dar es Salaam, Dept. of Mechanical Engineering, 1992)

17 Of all metal working companies with less than 50 employees, 42% is located in the Dar es Salaam region. For the companies with over 50 employees the percentage is 72 - Bureau of Statistics *Industrial Census 1989, Directory of Industries* (Dar es Salaam, 1992).

18 Of all students at NVTCs in 1994, 60% studied outside the DSM-region. For technical secondary education, there are no institutes within the DSM-region. With respect to technical colleges, 52% of the students follows a course at an institute outside the DSM region. Sources: *National Trade Test Results for Grade III* (Dar es Salaam: VETA, 1994, page 69-90), *CSEE results* (Dar es Salaam: NEC, 1995, various pages) and *Higher and Technical Education Statistics in Tanzania* (Dar es Salaam: Ministry of Science, Technology and Higher Education, 1994, various pages).

1.7 STRUCTURE OF THE RESEARCH

The research will consist of two major parts. The first one will deal with research in metal working companies: designing the selection criteria and consequently selecting companies to be included in the research (chapter 3), determining how to measure shortcomings in knowledge and skills of workers in these companies (chapter 4), designing the survey (chapter 5) and listing the results of it (chapter 6). The outcomes of this survey, i.c. the indicated bottlenecks, will serve as the input for the second part of the research: determining how to measure shortcomings in the educational institutes which cause these bottlenecks (chapter 7), listing these shortcomings (chapter 8) and drawing conclusions (chapter 9). The two parts will be preceded by the listing of the research questions (chapter 2).

Put in a scheme:

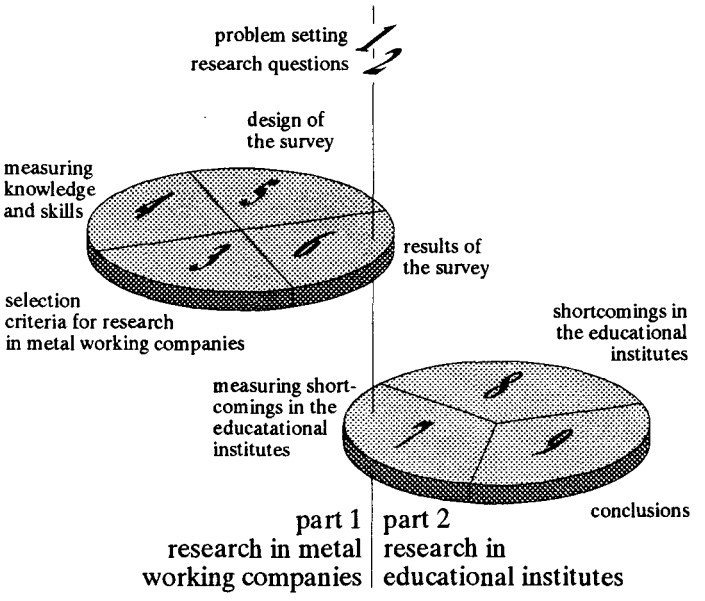

figure 5: overview of structure of the research

CHAPTER 2 RESEARCH QUESTIONS

Referring to the goal of the research, as indicated in paragraph 1.6, the research questions will firstly focus on the identification of relevant aspects with respect to the demand and the supply of technically skilled personnel: research question 1 will deal with the demand side (the metal industry), while research question 2 will focus on the supply side (institutes which provide technical education). For both sides these questions should determine the population (i.e. metal manufacturing companies and education institutes), relevant aspects to make a selection (in case the population size would practically impede te execution of the research) and list the technologies and required skills.

1 What are the shortcomings in knowledge and skills of technical personnel employed in metal manufacturing companies as indicated by these companies?

a How many metal working firms are there in the Dar es Salaam region?
b How can these companies be grouped and how large are the sample sizes of these groups?
c How can companies be selected from the identified groups, on which criteria?
d How can the technologies, applied in these companies, be grouped?
e How can the levels of knowledge and skills of the personnel in these companies be measured?
f How do the present knowledge and skills of the personnel match the demand?

After systematically listing (the shortcomings in) knowledge and skills of technical personnel, indicated by the metal manufacturing companies, it should be determined whether and how these shortcomings are caused by any shortcomings of the educational institutes.

2 How do shortcomings in the levels of knowledge and skills of technical personnel in the metal manufacturing companies relate to shortcomings of educational institutes?

a How can the educational institutes be identified and grouped?
b How many educational institutes can be selected out of the identified groups, on which criteria?
c How can the institutes' curricula be examined, especially with respect to the technology content?
d How can the selected institutes be examined, other than on basis of their curricula?
e How can the shortcomings, indicated by the metal manufacturing companies, be related to shortcomings in educational institutes?

If the number of identified shortcomings in the educational institutes is not too large, the final step in the research will be to present recommendations as to how these shortcomings

can be solved. However, in case the number is too large, there will be need for a weighing of the different sorts of shortcomings, and regarding the restricted period of time this final step will then not be possible to carry out.

3 How can the identified bottlenecks be solved?

CHAPTER 3 SELECTION CRITERIA FOR RESEARCH IN ETAL MANUFACTURING COMPANIES

3.1 INTRODUCTION

The first part of the research will be carried out by means of a survey in the Tanzania metal sector. For reasons, mentioned in paragraph 1.6, this sector will be restricted to the Dar es Salaam region. However, the number of metal working companies included in the DIPS survey (as discussed in paragraph 1.5) will be too large for an inclusion of all these companies and, therefore, the aim is to create a representative sample.

3.2 DETERMINATION OF THE ECONOMIC SUB SECTOR

As stated in paragraph 1.2, the research will concentrate on the Tanzania metal sector, as defined by ISIC 3.8 (manufacture of fabricated metal products, machinery and equipment). This economic sub sector itself consists of five sub sectors.

table 1: sub sectors in ISIC 3.8

ISIC-code	description of economic activity
3.8.1	manufacture of fabricated metal products, except machinery and equipment
3.8.2	manufacture of machinery, except electrical
3.8.3	manufacture of electrical machinery apparatus, appliances and supplies
3.8.4	manufacture of transport equipment
3.8.5	manufacture of professional and scientific measuring and controlling equipment, not elsewhere classified and of photographic and optical goods

The listed economic activities, as well as the metal working processes and technologies used in these sub sectors, differ. In subsequent order, the activities become more complex and demand a higher degree of sophistication of the technologies used. It can, therefore, be expected that the first sub sector, ISIC 3.8.1, will dominate the metal working industry of Tanzania, like in most other developing countries. Regarding the importance of this sub sector, both with respect to turnover and to the number of people employed, the research will be mainly focused on this sector.

3.3 CLASSIFICATIONS

3.3.1 INTRODUCTION

The possible bottlenecks on the demand side (the industry) may be related to one or more of three distinct factors, namely size, technologies used, and level of workers.

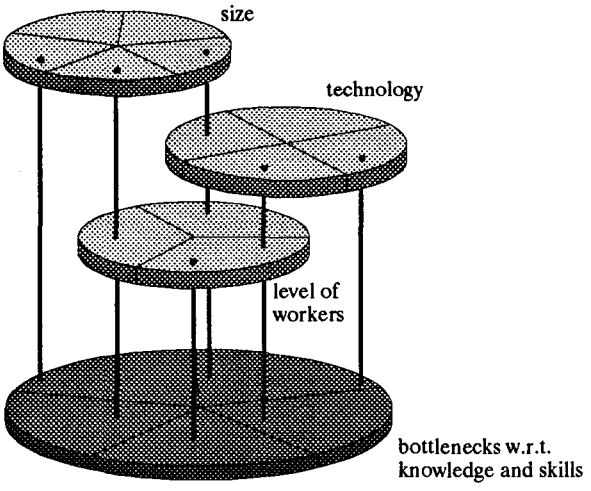

figure 6: interrelated factors on the demand side

It can be argued (proof omitted) that these three factors are interrelated: the size of a company may influence the demanded level of knowledge and skills of its workers (there will be relatively few workers who have completed higher technical education in a small company). The technologies used (and their level of sophistication) may also influence the demanded level of the workers (the less sophisticated the technologies or processes are, the less need there will be for workers who have completed higher technical education).

It should be noted that further elaboration on these factors will only take place if, on basis of the outcomes of the survey in the metal working companies, their influence is significant.

3.3.2 COMPANY SIZE

With respect to the size of the companies, a classification should be made on basis of the number of people employed. A useful division[19,20] is:

- $\leq$ 10 employees;
- 11-99 employees;
- $\geq$ 100 employees.

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19 Keuning, D. *Bedrijfskunde - bedrijfsontwikkeling en -beslissingsgebieden* (Houten: Stenfert Kroese/Educatieve Partners, 1989, pag. 67)

20 Gaillard, H. *Industrial organizations in developing countries - a measuring instrument for research and evaluation* lecture notes, Eindhoven University of Technology, 1991, page 9, and lectures

3.3.3 METAL WORKING PROCESS

According to DIN[21] norm 8580, metal manufacturing can be defined as either creating cohesion (casting), preserving cohesion (forming), decreasing cohesion (removing), increasing cohesion (joining, coating), or changing material characteristics. The material casting process is typical for the basic metal industries of ISIC 3.7 and will not be found in ISIC 3.8. Therefore, this specific metal working process will not be included. Furthermore, group 6 (changing material characteristics), will also be omitted, since this process is not typical for metal working companies. The four remaining groups can be subdivided[22,23] as shown in Appendix B. On basis of this, the selected metal working processes are:

- metal forming;
- metal removing;
- metal joining;
- metal coating.

Furthermore, there are two other important classes of activities in the manufacturing industry, namely those related to power and to repair and maintenance. The former, however, is not directly linked with the execution of the different technical processes as such and therefore not labelled as one of the main processes. Accordingly, repair and maintenance are merely supporting the technical processes and will also not be (included in) one of the categories on which the classification for the survey will be based. This is not to say that both activities, i.c. power supply and repair and maintenance, are not important in the different manufacturing processes and, therefore, they will be referred to as two major subjects in the final survey.

3.3.4 EDUCATIONAL LEVEL OF WORKERS

Finally, the educational level of the workers should be determined. According to figure 7, a technically educated worker in Tanzania will have (at least) one of the following levels:

1 post primary technical education (duration: 2 years);
2 national vocational training (duration: 2 years, 'Trade Test 3');
3 technical secondary education (duration: 4 years);
4 technical college (duration: 3 years, Full Technician Certificate');
5 technical university education (duration: 4 years).

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21 DIN - Deutsche Industrie Normen; Deutsches Institut für Normung e.V. Genormte Begriffe Maschinenbau, DIN-Taschenbuch 241 (allgemeine Begrifen) Berlin, 1993, page 100-103

22 Coenegracht, A.M.M.A. and Kole, S.C.A. *Beroepskwalificaties in de metaalbewerking: een kwestie van ondernemen* Report of 'Onderwijs, Scholing en Arbeidsmarkt in de Metaalsector (OSAM)', Rotterdam, 1989, page 74, and Kalpakjian, S. *Manufacturing, Engineering and Technology (second edition)* Illinois, 1992

23 Van Der Wolf, A.C.H., J.A.G. Kals, J.A.W. Hijink et.al. *Orientatie produktietechniek A en B* lecture notes, Eindhoven University of Technology, 1988

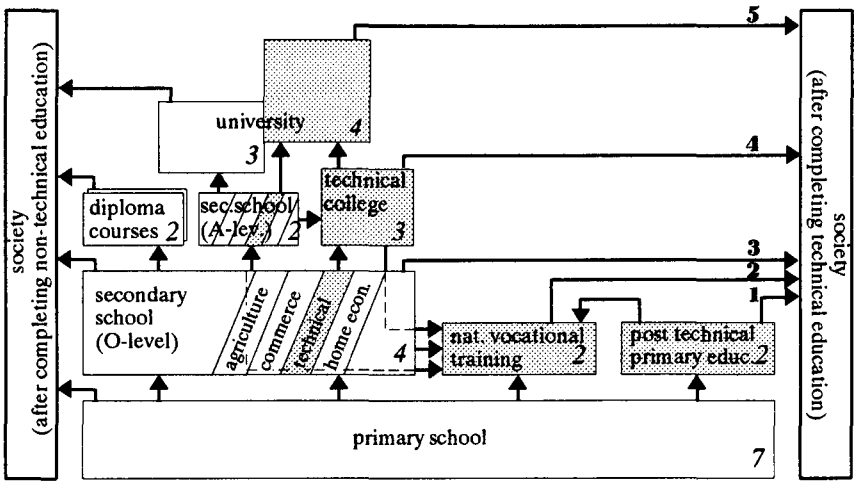

figure 7: educational levels of technically educated workers in Tanzania (Note: shaded areas refer to technical education)
Source: Duijsens, R., 1995

With respect to these technical courses the last group differs from the others, since it is the only course at scientific level. Therefore, the desired uniformity in classification of technical processes and technologies according to the curriculum of each of the above mentioned institutes might prove to be difficult. Many of the bottlenecks for the last group will probably not at all be caused by the education, since universities state different objectives for their courses than the other mentioned institutes (scientific versus more practically oriented). The scientifically oriented objectives are expected to differ greatly from the more practically oriented ones and to be harder to measure. Furthermore, the number of technical engineers in Tanzania, and therefore also in the Dar es Salaam region, will be rather limited[24]. These considerations result in the omission of the academically educated engineers in the survey.

Also, because of its relatively short existence and its very limited appearence, the first group will be omitted.

3.3.5 COMBINATION OF SELECTION CRITERIA

Based on size, metal working process and educational level, there are in theory 3x4x3=36 combinations. These different combinations are presented below.

[24] Duijsens, R. *Sector Review - Education in Tanzania* Eindhoven University of Technology, 1995, page 69

table 2: combinations of company size, metal working process and educational level of technical worker

company size	educational level and metal working process											
	national vocational educ.				technical sec. school				technical college			
	f	r	j	c	f	r	j	c	f	r	j	c
≤10 employees												
11-99 employees												
≥100 employees												

Note: f metal forming
r metal removing
j metal joining
c metal coating

CHAPTER 4 EASURING KNOWLEDGE AND SKILLS

4.1 CLASSIFICATION OF KNOWLEDGE AND SKILLS

In order to determine the shortcomings in knowledge and skills, there is need for a classification of these. Firstly to work within and start from a complete listing, in order not to miss aspects which may be of importance with respect to knowledge and skills, particularly in an industrial (production) setting. Secondly to be able to interpret the categories as well as the outcomes correctly, and to make a translation of these to the school curricula both easy and possible. Romiszowski[25] presents a classification in which knowledge and skills are defined independently of one's level of education and which is, therefore, very suitable for this research. According to this classification, the definitions of knowledge and skills are:

knowledge information stored in the learner's mind,

skills actions and reactions (intellectual or physical), which a person performs in a competent way in order to achieve a goal.

4.1.1 INTRODUCTION TO KNOWLEDGE

Based on the general categories of capability, i.e. 'remembering' and 'understanding', there are two categories of *knowledge*: 'factual knowledge' and 'conceptual knowledge'. Each of these categories consists of two parts:

- *factual knowledge* consists of fact systems and algorithms (procedures)
- *conceptual knowledge* consists of concept systems and rule systems (principles).

The complexity of factual knowledge increases from 'facts' to 'procedures', whereas that of conceptual knowledge increases from 'concepts' to 'principles'.

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[25] Romiszowski, A.J. *Designing Instructional Systems* (London: Kogan Page, 1984, page 241-268)

4.1.2 INTRODUCTION TO SKILLS

Skills can be divided into four distinct categories:
- *cognitive skills;*
- *psychomotor skills;*
- *reactive skills;*
- *interactive skills.*

Each of these four skills can be either *productive* or *reproductive*: a productive skill depends on the presence of a body of knowledge (built up through experience or through instruction), composed of relevant general principles and structured into specific strategies of thought or action. The reproductive skill, on the other hand, simply applies procedures or algorithms to known situations. Complexity increases from 'reproductive skills' to 'productive skills'. The four categories of skills merely reflect different and distinct aspects of skills, not an increasing (or decreasing) complexity.

4.2 KNOWLEDGE & SKILLS IN VOCATIONAL EDUCATION: EMPHASIS ON SKILLS

In the listing and definition of the different types of skills, the knowledge content forms a basis for both the reproductive and the productive skills. Reproductive skills depend on the presence of factual knowledge, in which the reproduction of known facts and algorithms will lead more or less automatically to a desired outcome. Productive skills, on the other hand, are closely related to the presence of conceptual knowledge: applying concepts to a new problem, which should lead to a new solution. (However, productive skills and reproductive skills should not be regarded as two distinct types. Many more or less complex tasks depend partly on productive skills and partly on reproductive skills. Most activities can be regarded as 'mainly reproductive' or 'mainly productive'.) In the light of this, it is decided to focus this research on examining the presence of skills, rather than of knowledge: for applying skills, one needs a body of knowledge, and when measuring skills one will, therefore, at the same time, although indirectly, measure knowledge.

Apart from this, there are two other practical considerations which lead to the omission of measuring knowledge. The first is that courses in vocational education should contribute to the improvement of the functioning of employees, departments and organizations. Courses can only do so when the result is displayed by an increase in visible skills. Increasing knowledge and understanding will not display such an improvement.

Another reason to focus on skills rather than on knowledge is that, at present, much discussion takes place with respect to the relative importance of knowledge and skills in vocational education. Although the goals and the direct application of results of the learning process in formal education, compared with on-the-job training, are much more complex, the concept that vocational education should focus on teaching skills, is gaining ground[26]. This discussion

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[26] De Groot, A.D. *Begrip van evalueren* (Den Haag: VUGA, 1986) and Gleeson, D. *Skills training and its alternatives* in: D. Gleeson (red.) *Training and its alternatives* (Milton Keynes, 1990)

is in many aspects a political one, in which it can rightfully be stated that emphasizing the teaching of skills should not be complemented by a decrease of critical conscience and flexibility of pupils and students. However, according to different views, the curricula of institutes of vocational education, especially in developing countries, should aim more at the application of practical skills. In this way, graduates can be more versatile and, consequently, unemployment among school leavers could decrease.

4.3 THE SKILLS SCHEME

Since it has been decided to focus the research on measuring the presence of skills, the different forms, which were introduced in paragraph 4.2, can be further elaborated. In the following table, the four types are listed (each one both productive and reproductive). Each cell includes one or more examples, printed in italic.

table 3: classification of skills

main skill category		type of 'knowledge content'	
		reproductive skills	productive skills
		applying procedures (algorithms)	applying principles and strategies
cognitive skills	decision making, problem solving, logical thinking, planning	applying a known procedure to a known category of problem *writing grammatically correct*	solving 'new' problems, inventing a new procedure *writing creatively*
psychomotor skills	physical action, perceptual acuity, head-hand (foot) coordination	sensi-motor skills, repetitive or automated action *running*	'strategy' skills or 'planning' skills: arts and crafts *playing football*
reactive skills	dealing with oneself:: attitudes, feelings, habits	conditional habits and attitudes *paying attention, reacting*	'personal control' skills, developing a 'mental set' or a value system *developing personal values*
interactive skills	dealing with others purposively	social habits, conditioned responses *good manners, pleasant intonation*	'interpersonal control' skills *leadership, persuation*

The above mentioned skills, productive as well as reproductive, and the related knowledge content, can be schematically represented:

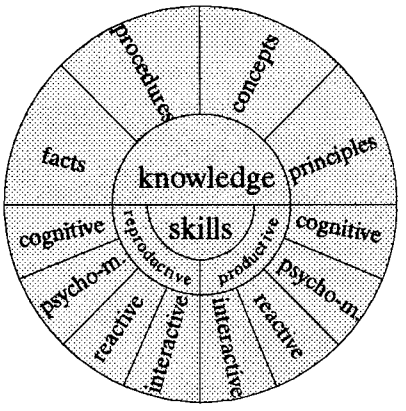

figure 8: the knowledge and skills scheme
Source: Romiszowski, A.J., 1981

4.4 CONSIDERATIONS WHEN MEASURING SKILLS

4.4.1 DIFFERENT FORMS OF EDUCATION

Also a remark should be made with respect to different forms of education. The aim of this research project is to identify bottlenecks in the *formal* education which cause shortcoming in the functioning of employees in the metal manufacturing industry. In order to examine these bottlenecks, the research will start with identifying shortcomings in skills. However, not every shortcoming implicates an education necessity, as has been indicated above and, furthermore, not every education necessity needs to be solved by means of formal education. The form of education that should be chosen depends on three dimensions[27]:

- is a qualification specific or not?
- should the company perform the form of education or another person or institution?
- should the form of education be within or outside the company?

These questions will be discussed in chapter 7.

4.4.2 CHOOSING THE MOST APPROPRIATE FORM OF TEACHING

Depending on the aim, the difference between productive and reproductive skills can lead to a classification of the most appropriate form of teaching. The teaching of reproductive skills requires a different teaching method, compared with the teaching of productive skills. This also applies to the underlying and related forms of knowledge: where facts and procedures are related to reproductive skills, concepts and principles are closer related to productive skills. In chapter 7 these various teaching methods will be discussed.

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[27] Kessels, J.W.M. and Smit, C.A. *Opleidingskunde - een bedrijfsgerichte benadering van leerprocessen* (Deventer: Kluwer Bedrijfswetenschappen, 1989, page 25)

CHAPTER 5 DESIGN OF THE SURVEY

5.1 INTRODUCTION

In the foregoing chapters, the first research question has been addressed. The criteria to select the metal working companies have been drawn up, and also a model for investigating knowledge and skills has been designed, which will enable the determination of shortcomings of these. Subsequently, a survey will be developed, based on this model, in a systematic way. First, the type of research and the accompanying data collection method will be discussed. Secondly the sample size will be determined. After that, the survey will be drawn-up, based on a listing of concepts and related aspects, and on a general model of metal working processes.

5.2 TYPE OF RESEARCH AND METHOD OF DATA COLLECTION

The identification of shortcomings of skills is a descriptive type of research[28]. The aim is to ascertain what these shortcomings are. The second part of the research (answering the second research question) will identify the causes of these shortcomings by means of investigating the supply side, i.e. the technical educational institutes. That part is typically an explorative type of research, and will be discussed in detail in chapter 7.

There are three methods of data collection which are suitable for a descriptive type of research: a case study, a survey and an experiment. The method of data collection most appropriate for this descriptive research is a survey: the characteristics of this method, i.e. a large research population and a large number of features to be investigated, match the conditions of this specific research.

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28 Baarda, D.B. and de Goede, M.P.M. *Methoden en technieken - praktische handleiding voor het opzetten en uitvoeren van onderzoek* (Leiden: Stenfert Kroese, 1990, page 146-149)

5.3 DETERMINING THE SAMPLE SIZE

To determine the sample size (n) for each combination of company size, metal working process and level of education, two aspects are important[29]:
- the confidence interval, which determines the probability that the random interval will contain the estimated value
- the proportion p, which indicates the proportion of the population with a specific characteristic (the population proportion that is attempted to be estimated)

Since the information to be measured will mostly be of qualitative origin (on a nominal or ordinal scale[30]) the confidence interval does not need to be very large. A 80% confidence interval (which means that the estimates for a population fraction p are $p_s \pm 10\%$) will fit for this purpose, resulting in a sample size of at least 11 for each combination in table 2.

(A more comprehensive description of the process of determining the sample size can be found in Appendix C.)

5.4 THE SURVEY

5.4.1 INTRODUCTION

The survey with which the shortcomings in skills will be measured forms the key part in answering the first research question. On basis of the outcomes of the survey, the second part of the research (i.e. in the educational institutes) will be carried out. Since the practical part of conducting the survey is also very elaborative, the survey should be designed according to a strict scheme, in order to make sure that all relevant aspects (on basis of the research model, developed in the foregoing chapter) are included.

An important aspect of the survey is that the number of questions should be limited. This will make the questionnaire comprehensive at first sight, which will increase the interviewed person's willingness to cooperate. Consequently it will enable the interviewer to carry out a relatively large number of surveys in a given period of time. Ideally, the size of the questionnaire will enable the interviewer to carry out each survey during a single visit.

It should be noted that designing a survey is a rather complex process, which includes many decisions. It would take a disproportionate number of pages in this report to completely reproduce all the steps and considerations involved in this process. The following paragraphs are a mere summary of this, the complete process is described in Appendix D.

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29 Mendenhall, W. and Sincich, T. *Statistics for engineering and the sciences (3rd ed.)* (New York: Collier McMillan, 1988, page 299-300)

30 Data on a nominal scale have no (numeric) order and are mutually exclusive. Variables on a ordinal scale are categories with intrinsic order but without intrinsic numerical properties - Weisberg, H.F. and Bowen, B.D. *An introduction to survey research and data analysis* (San Fransisco: Freeman, 1977, page 125-126)

5.4.2 LISTING THE VARIABLES

First, the theoretical variables should be determined. This will be done on basis of four research questions:

1 What is the level of skills of workers in the metal working sector?
2 Does the presence of these skills depend on the size of the company in which the worker is employed?
3 Does the presence of these skills depend on the level of education of the worker?
4 Does the presence of these skills depend on the sort of metal working process in which the worker is employed?

The theoretical variables derived from these questions are:

1 skills
2 company size
3 educational level
4 metal working process

However, the theoretical variables in this present form cannot be adequately measured. They need to be translated into rough variables, which represent the theoretical variables, and which can be measured. All variables, both theoretical and rough, can be listed as follows:

table 4: theoretical and rough variables

theoretical variable	rough variable		possible values
1 skills	1.1-8	cognitive, psychomotor, interactive and reactive skills (reproductive and productive)	fully present to fully absent, with all intermediate values
2 company size	2.1	number of employees	from smallest to largest number
3 educational level	3.1	highest level of technical education	all forms of technical education
4 metal working pr.	4.1	metal working process in ISIC 3.8	all groups of metal working processes in ISIC 3.8

With respect to the research entities (i.e. the metal working employees), it is decided not to question them personally, but to submit the questions to their direct superior, and both his name and function will be asked for. Apart from this, the name of the company and of the employee will be asked for, as well as the date of the interview.

theoretical variable	rough variable		possible values
5 company name	5.1	company name	-
6 supervisor	6.1	supervisor's name	-
	6.2	supervisor's function	-
7 employee	7.1	employee	-
8 date	8.1	date	-

5.4.3 MEASURING SKILLS

In order to measure skills, the variables representing these should refer to either 'facts' or 'intended behaviour'. These variables can best be measured when these facts or intended behaviour are stated in terms of examples of situations in which the use of skills is necessary.

The situation should refer to all metal working processes within ISIC 3.8 and should, therefore, be stated in general terms, independent of the respective processes.

For this, a flow chart can be constructed, in which the different (general) phases of a metal working process can be determined. Subsequently, the general process can be divided into several phases, all of them consisting of several interrelated activities. Schematically, the flow chart can be presented as in figure 9 below.

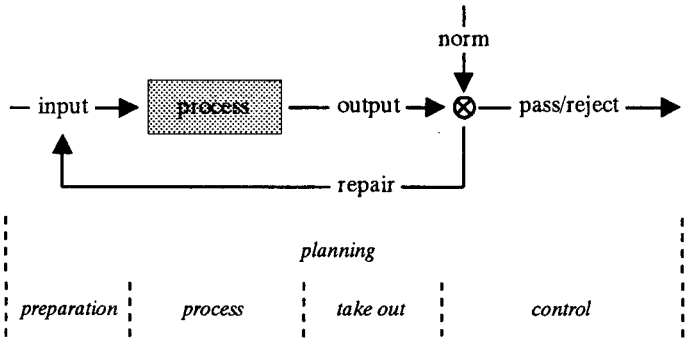

figure 9: schematic presentation of a metal working process

The activities of the different phases can be listed according to this scheme. Each of the activities comprises one or more types of skills.

Finally, the interviewee can express his own view on educational shortcomings by means of an open question.

5.4.4 SCALES AND ANSWERING POSSIBILITIES

As far as the scales are concerned on which the variables will be measured, these will be of ordinal level for the skills variables, as well as for the variables 'educational level' and 'company size'. The remaining variables will be measured on a nominal scale.

With respect to the answering categories it is decided to present the interviewee a fixed set of possible answers to chose from. For measuring the skill variables, the answers will range from 'fully present to fully absent, with all intermediate values', as indicated in the tables mentioned earlier. The precise possibilities very much depend on the formulation of the

questions, and will be determined in the following paragraph. For the remaining variables all answering possibilities will be listed. These fixed answering categories will be complemented by two other distinct categories: 'no meaning' and 'not applicable'. With respect to measuring the skills variables, apart from these last two categories, the range from 'fully present' to 'fully absent' will comprise four alternatives. The remaining (technical) variables will be measured with the use of open questions and, therefore, have no fixed answers.

5.4.5 SURVEY QUESTIONS

For each activity, combined with one of the listed skills, two questions will be paired, one referring to 'productive skills' and one to 'reproductive skills'. There are two measure points (situations) of interest for this. The first is when the worker is entering the firm after finishing education, the second is at present, in an (imaginable) new situation. This leads to a combination model, presented below.

table 5: combinations with respect to measuring productive and reproductive skills

		measure point / situation	
		entering present firm	at present (new situation)
type of skill	reproductive	a	c
	productive	b	d

Situations *a* and *d* are most likely to indicate the worker's level of (re)productive skills, and these two situations will be referred to for each question. It is decided to ask for a person's *ability* to perform in the respective situations, for this term is broad enough to appeal to the interviewee's understanding, but at the same time specific enough for the purpose.

With respect to the other questions, these will be a direct translation of the above mentioned variables with the accompanying possible values.

De final survey which is composed on basis of the above mentioned considerations, is enclosed in Appendix D.

CHAPTER 6 RESULTS OF THE SURVEY

6.1 PRACTICAL EXPERIENCES WHILE USING THE QUESTIONNAIRE

In paragraph 5.4.1 the advantages of a short and comprehensive questionnaire have been mentioned. While carrying out the survey, this indeed appeared to work out as expected: most questionnaires were answered or filled in during the first (and only) visit, i.c. in the interviewer's presence. This enabled the latter to 'control' whether the interviewee's comprehension and interpretation of the questions was according to the interviewer's intentions. On basis of this, the introduction letter has been slightly adapted, in order to make sure that the questionnaire could also be filled in while the interviewer was absent.

Furthermore, hardly any company appeared to have employed workers with 'post primary technical education' as their highest level; where these workers were employed, the interviewees preferred not to fill in the questionnaire according to these, because they deemed this group not representative for the overall level. Also the group of workers with 'university' level appeared very limited. More often than not, the sole employee working in a metal working process with this educational level appeared to be the interviewee. On basis of these experiences, these two groups were omitted from the questionnaire.

Apart from these adaptions, the examined interpretation of the questions gave no reason to major changes.

6.2 OVERALL OUTCOMES OF THE SURVEY

The outcomes of the survey are computed for various combinations. After processing the data, it appears that, on basis of the present number of questionnaires, the sole (statistically relevant) conclusion can be that, for all educational levels, metal working processes and company sizes, the level of productive skills is judged to be higher than of reproductive skills.

Since the second part of the research will focus on educational institutes, the outcomes per educational level will be considered. Because the number of surveys with respect to this division is rather small, the outcomes, as presented in table 6 below, will be used only as an indication. Although, having stated this, it would be possible to take metal working processes within these institutes into consideration, the survey numbers are too small to make the respective outcomes serve even as an indication.

On basis of the survey outcomes, it is not possible to draw statistically relevant conclusions with respect to company size. Also when using non-statistical methods, the outcomes with respect to this variable cannot be used as an indication on which further research can be based.

The survey-outcomes for the various educational levels are presented in detail in Appendix E.

The overall scores of skills versus the different educational levels are listed below. Here, it should be noted that, although the number of measurements of 'capabilities' may exceed 30 and thus (ceteris paribus) could in itself be considered statistically relevant according to a standard normal distribution, the number might depend on less than 30 questionnaires and, therefore, not be based on a standard normal distribution. Where this is the case, the outcomes can be considered to serve only as an indication.

table 6: survey outcomes: skills versus educational level

	all levels		National Vocational Training		Technical Second. School		Technical College	
	reprod.	prod.	reprod.	prod.	reprod.	prod.	reprod.	prod.
cognitive skills	2.49	3.10	2.51	3.11	3.39	2.99	2.55	3.20
psychomotor skills	2.72	3.28	2.76	3.36	2.58	3.23	2.79	3.24
interactive skills	2.55	3.27	2.58	3.26	2.59	3.21	2.48	3.33
reactive skills	2.99	-	3.00	-	3.00	-	2.97	-
all skills	*2.61*	*3.26*	*2.65*	*3.23*	*2.57*	*3.13*	*2.65*	*3.24*

Note: indicated are the average answers, ranging from 1 (not capable) to 4 (very capable); median score is 2.5

From this table, and from the outcomes of the open questions in the survey, it becomes clear that

for *all educational levels*
- the presence of reproductive skills is judged to be lower than the level of productive skills for all skills;
- only reproductive cognitive skills are at median level (≈2.5), while all other skills, both reproductive or productive, are above median (>2.5);
- reactive skills have an equal score, slightly above median (i.e.≈3,0);
- overall skill levels (both reproductive and productive) are lowest for technical secondary schools, while there is hardly any difference between national vocational training and technical colleges;
- comprehension of English is limited;
- there is little knowledge of modern metal working technologies and machines;
- the attitude for striving for excellence is considered to be very low;
- awareness of safety-related aspects is very low.

for *national vocational training*
- cognitive skills' scores (both reproductive and productive) are lowest among the various skills;
- psychomotor skills' scores (both reproductive and productive) are highest among the various skills;
- theoretical knowledge of basic principles in metal working processes is low.

for *technical secondary school*
- cognitive skills' scores (both reproductive and productive) are lowest among the various skills;
- psychomotor skills' scores and interactive skills' scores (both reproductive and productive) are equal and (slightly) above median;
- practical experience is low;
- awareness of (preventive) maintenance is limited.

for *technical college*
- interactive skills appear to have the lowest level among the reproductive skills, but the highest level among the productive skills;
- training with respect to management and supervision is low.

The above mentioned weaknesses at the various educational levels will be focused upon in the second phase of the research, as indicated in second and third research question (chapter 2).

CHAPTER 7 EASURING SHORTCOMINGS IN THE EDUCATIONAL INSTITUTES

7.1 INTRODUCTION

In the second part of this research the deeper causes of the indicated shortcomings will be investigated. As stated in the foregoing chapter, there will be a distinction only with respect to the various educational levels. The contents of the different subjects, included in the various curricula, which cover the basic metal working processes will not be discussed.

Although the main focus of the first part of the research was to indicate shortcomings with respect to the various skills, from the listing of paragraph 6.2 it has become clear that both knowledge and skills should be regarded. The emphasis within and between these groups might thereby differ for the various educational levels.

Since, in this second part, the contents of metal working related subjects at the various educational institutes will not be investigated, there is need for a model which, at a higher level of abstraction, takes aspects into account which influence the development of knowledge and skills. For this, two models are applicable, which both take an objectives-oriented view[31]: a model which focuses on educational aims, and a model which focuses on three dimensions which influence the success or failure of any educational activity.

7.2 THE FIRST RESEARCH MODEL: GOAL AREAS

According to Goodlad[32], there are twelve goal areas for schools. For reasons of clearness, these areas can be combined into the following eight:

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31 'The distinguishing feature of an objectives-oriented evaluation approach is that the purposes of some educational activity are specified, and then evaluation focuses on the extent to which those purposes are achieved. The information gained from such an evaluation could be used to reformulate the purpose of the activity, the activity itself, or the assessment procedures and devices used to determine the achievement of purposes.' - Worthen, B.R., Sanders, J.R. *Educational Evaluation - Alternative Approaches and Practical Guidelines* (New York: Longman, 1987, page 62)

32 Goodlad, J. *What schools are for* (Bloomington: Peacock, 1979, page 34-57)

1 intellectual development;
2 mastery of basic skills or fundamental processes;
3 vocational education (career education);
4 enculteration, citizenship;
5 interpersonal relations;
6 autonomy;
7 creativity;
8 self-concept, self-realization, moral and ethical character.

Various school types may put different emphasis on these areas, and may even omit certain areas. After establishing the relative importance of these areas for the different educational levels included in this research, it can be decided if one or more of the indicated shortcomings may be outside the field of goal areas. If this is the case, then these shortcomings will not be taken into account. The main purpose of this research is to investigate and determine areas within the present, stated aims of the respective institutes (aims which may need modification and improvements with respect to the methods and facilities used to establish these), but not to restate the present aims.

A more extensive listing of these goal areas can be found in Appendix F.

7.3 THE SECOND RESEARCH MODEL: STRUCTURE FOR EVALUATION

7.3.1 GENERAL CONTENTS OF THE MODEL

Hammond[33] has classified factors which influence the success or failure of any educational activity into three dimensions, as is indicated in figure 10. With respect to the applied knowledge and skills model of Romiszowski, as discussed in chapter 4, the dimension 'behaviour' has been redefined accordingly.

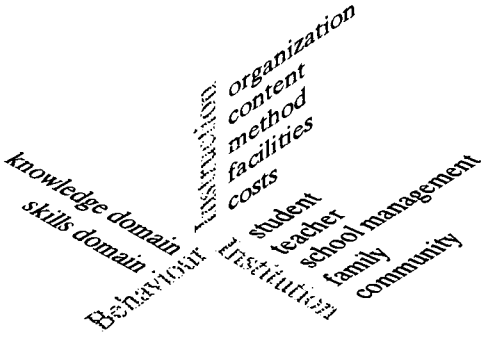

figure 10: structure for evaluation
source: Hammond, R.L., 1973

[33] Hammond, R.L. *Evaluation at the Logical Level* (Belmont, 1973, page 26-34) in Worthen, B.R. and Sanders, J.R. Educational Evaluation - theory and practice (Belmont, C.A.:Wadsworth, 1973)

According to the foregoing paragraphs, not all aspects will be taken into account. The dimensions and the aspects which will be taken into account can be described as follows:

- *Instruction* Characteristics of the educational activity
  - *Organization* Time, scheduling, course sequences, school organization (vertical, horizontal)
  - *Method* Teaching activities, types of interaction, teaching/learning theory
  - *Facilities* Space, equipment, expandable materials
  - *Costs* Funds required for facilities, maintenance, personnel

- *Institution* Characteristics of the individuals and groups involved
  - *Student* Age, grade level, sex, family background, social class, ability, interests
  - *Teacher* Age, sex, personality, educational background, work experience, work habits
  - *School Man.* Age, sex, personality, educational background, work experience, work habits
  - *Family* Culture, income, educational level
  - *Community* Geographical setting, demographics, economic and social characteristics

- *Behaviour* Objectives of the educational activity
  - *Knowledge d.* Factual and conceptual knowledge
  - *Skills domain* Cognitive, psychomotor, interactive and reactive skills (reproductive, productive)

It should be noted that the third axis of this model, i.c. 'behaviour', aims at the objectives of the educational activities and is, therefore, more or less similar to the 'goal areas'-approach introduced in paragraph 7.2 and will, therefore, be omitted.

7.3.2 INSTRUCTION METHODS

The instruction methods, as indicated in paragraph 4.4.2, will receive extra emphasis. Since there are various forms of teaching knowledge and skills, it will be important to identify whether, at the various educational institutes, the survey outcomes with respect to knowledge and skills (as presented in paragraph 6.2) are related to the (mis)match between teaching method and know-ledge/skills content. Elaborating on the knowledge and skills scheme, the various methods with respect to the knowledge and skills for which they are most appropriate, are presented in figure 11.

With respect to teaching reproductive skills, the student is taught a fixed pattern of actions (algorithms, with only one correct solution to a problem), because it is important to execute a task faultless: incorrect actions interfere with the learning process and are hard to unlearn. For these skills it is advisable to use an instructional way of teaching, which is a form of the *expositive methods.*

However, when teaching productive skills there is usually more than one correct solution to a problem. In these situations students preferably develop their own solution by means of trial-and-error, in order to enable them to discover underlying principles themselves - typical for a *discovery method*[34].

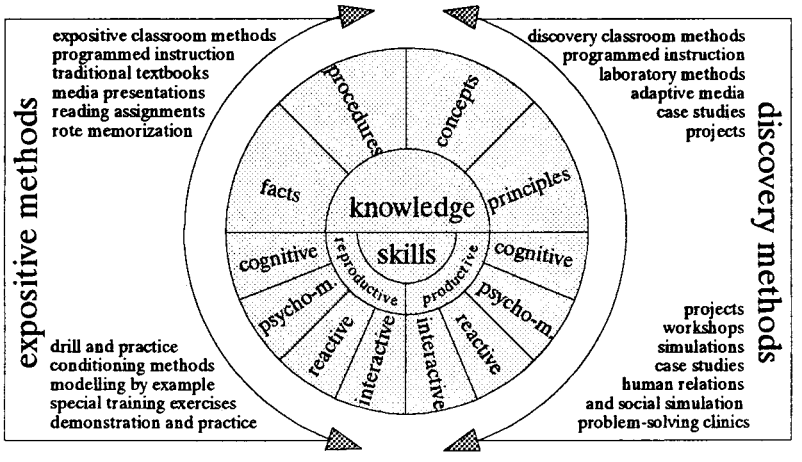

figure 11: teaching methods with respect to different knowledge and skills

Furthermore, referring to figure 11, the knowledge underlying the different reproductive and productive skills also requires different approaches in teaching methods. Where facts and procedures are closely related to reproductive skills, concepts and principles are closer related to productive skills and, therefore, the teaching methods should to a large extent be the same.

table 7: choice of appropriate form of teaching

	reproductive skills	productive skills
imparting the knowledge content	expositive methods (dependent on the type of knowledge)	discovery methods (principle learning is always involved)
imparting the practical application	expositive methods (demonstration, practice) (knowledge and skills may be combined)	expositive methods (demonstration and prompted action)
developing proficiency	supervised practice of whole task and/or special exercises; continuing feedback of results	discovery methods (guided problem-solving); continuing feedback of results

source: Romiszowski, A.J., 1981

7.4 TYPE OF RESEARCH AND METHOD OF DATA COLLECTION

In order to determine the presence and influence of the above listed aspects, the most appropriate type of research is an explorative type of research. The method of data collection is a

[34] Romiszowski, A.J. *Designing instructional systems - decision making in course planning and curriculum design* (London: Kogan Page, 1981, page 300-304)

combination of interview and observation, the latter mainly with respect to the aspects 'instruction method' and 'instruction facilities'[35].

7.5 EDUCATIONAL INSTITUTES

The schools which should be included in the research should be of three levels:
- National Vocational Training Centre;
- Technical Secondary School;
- Technical College.

Most of the listed aspects can be investigated within the various schools during visits. In order to have an unbiased population, the schools should differ with respect to their main characteristics, i.e.
- *size* large or small (with respect to number of students);
- *location* urban or rural;
- *ownership* public or private.

Although there are no sharp definitions with respect to these characteristics, it is very well possible to make a selection in which the various schools differ quite distinctively.

Furthermore, the aspects 'instruction method', 'teacher' and 'behaviour' can be investigated more profoundly at teachers training colleges. Finally the aspect 'behaviour' will also be investigated at the National Examination Council and the curriculum development institutes of the various educational levels. These institutes will therefore be included.

Appendix G lists the various institutes which will be included in the research.

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35 Baarda, D.B. and de Goede, M.P.M. *Methoden en technieken - praktische handleiding voor het opzetten en uitvoeren van onderzoek* (Leiden: Stenfert Kroese, 1990, page 68-71 and 126-131)

CHAPTER 8 SHORTCOMINGS AT THE EDUCATIONAL INSTITUTES

8.1 INTRODUCTION

In this chapter the causes of the indicated shortcomings in knowledge and skills, as listed in paragraph 6.2, will be investigated. This will be done for each of the three educational levels. Each discussion will be preceded by a listing of the bottlenecks for the respective type of education, as indicated by the metal working companies. After this listing, the outcomes of the research in the educational institutes will be discussed.

First, it will be determined if, on basis of the institutes' *goal areas* (*behaviour objectives*), some of these shortcomings should be omitted. This could be the case when the specific subject for which there appears to be a shortcoming is not included in the institute's educational objectives.

After that, the selected shortcomings will be investigated according to aspects of the dimensions *instruction* and *institution*. For reason of clearness, the shortcomings and the aspects which might possibly cause these are presented in a matrix at the beginning of the respective paragraphs. From these it will become clear that in many cases there is a strong connection between various shortcomings and their causes.

For both the vocational training centres and the technical secondary schools the qualitative outcomes of the research are compared with respect to ownership. With this the indicated bottlenecks and their causes can also be placed in a quantitative setting. Since the ownership of the technical colleges is exclusively public, this comparison was not possible for these institutes.

Finally it should be noted here that the survey outcomes gave no reason for a thorough examination of the contents of the various subjects taught at the respective institutes. However, in a general way, the contents - where applicable - will be discussed under the heading 'organization'.

8.2 SHORTCOMINGS AT THE VOCATIONAL TRAINING CENTRES

8.2.1 INDICATED BOTTLENECKS AT VTCs

From paragraph 6.2 it became clear that the bottlenecks at the Vocational Training Centres (VTCs) were:

- reproductive skills are less developed than productive skills;
- cognitive skills are relatively low;
- theoretical knowledge of basic principles in metal working processes is low;
- there is little knowledge of modern metal working technologies and machines;
- the urge to strive for excellence is low;
- awareness of safety-related aspects is low;
- comprehension of English is low.

8.2.2 GOAL AREAS AND BEHAVIOUR OBJECTIVES WITH RESPECT TO THE SURVEY OUTCOMES

With respect to the goal areas, as indicated by the visited VTCs and the Vocational Education and Training Authority (VETA), most emphasis was on the 'mastery of basic skills or fundamental processes' and 'vocational education (career education)'. Also 'autonomy', 'creativity' and 'self-concept, self-realization and moral and ethical character' were mentioned as objectives, but these receive less attention. Little attention is paid to 'interpersonal relations' and 'intellectual development', while the 'enculteration, citizenship' area was not indicated as being among the five most important goal areas of the respective centres.

From these indicated areas it can be concluded that all survey outcomes should receive attention during the various courses at the Vocational Training Centres, since each of them can be headed by one or more of these indicated areas.

8.2.3 INSTRUCTION CHARACTERISTICS

The indicated shortcomings and their possible causes with respect to 'instruction characteristics' are listed below.

table 8 shortcomings versus instruction characteristics at vocational education level

shortcomings	organization and contents	method	facilities	costs
low reproductive skills	x	x	x	x
low cognitive skills	x	x	x	x
low theoretical knowledge	x	x	x	x
low comprehension of English	x	x		

shortcomings	organization and contents	method	facilities	costs
low knowledge of modern metal working technologies	x		x	x
low striving for excellence		x		(x)
low awareness of safety-related aspects	x	x		(x)

Contents

With respect to contents, the cognitive skills and theoretical knowledge, including the mastery of English, would improve when given more attention. Since both are or can be mainly developed by means of theory lessons, the present emphasis on practical work over theory (the theory/practical-ratio at VTCs is 2:3) contributes to the relatively low development. On the other hand, however, less emphasis on practical work could negatively affect the mastering of reproductive skills (also mentioned as a shortcoming) even further, and the finding of the optimum balance between theory and practical work is a delicate matter.

Method

The present teaching methodology (which mainly relies on expositive methods) in combination with the use of English as a medium for teaching limits the profoundness of most subjects and, therefore, contributes to the low levels of reproductive skills, cognitive skills, theoretical knowledge and comprehension of English. As far as the latter is concerned, it should be noted that, although all teaching should be in English, in many cases part of the teaching, especially during practicals, is bi-lingual. All examinations are in English.

An important cause with respect to the chosen teaching methodology lies in the absence of adequate facilities, both with respect to theory (there is a shortage of books - the student:book-ratio at some courses is 2:1 - and especially for technical subjects the books are often out-of-date) and with respect to practical work (many machines are either old or out of order or both and there are only limited financial means to buy spare parts or materials). Under these circumstances, the choice for expositive methods (which in many cases limits the profoundness of the various subjects) is a forced one, due to the absence of facilities to use other methods. It can be stated with emphasis that the reason for using mainly expositive methods is not caused by a limitation in the teachers' ability to use other methods: the vocational teacher training course covers these methods extensively.

Organization

The reasearch within the various VTCs made clear that the low urge to strive for excellence and low awareness of safety-related aspects have organizational causes: both topics are covered in the courses and, therefore, there is reason to believe that it is merely a matter of putting more emphasis on these and of finding other more appropriate teaching methods[36].

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36 All VTCs, both government owned and private, are obliged to cover all topics which are listed in the respective syllabi. There are three general subjects which are compulsory for any course at a VTC: English, mathematics and entrepreneurship. The syllabi are developed by VETA, while the examinations are developed by an independent commission in close cooperation, however, with VETA. Due to these strict regulations, VTCs hardly have any freedom in determining and organizing the contents of the various subjects.

Facilities and costs

The age of the machines and the limited financial means to cover the costs of spare parts and materials to be used during practical work also contribute to the low knowledge of modern metal working technologies. These financial difficulties are especially present at public VTCs which do not receive (additional) funding from (international) donor organizations[37]. Apart from the students' fees, which are government set and irrespective of the type of VTC[38], private VTCs appear to have ample financial means, provided by donor organizations[39]. In this way they are able not only to spend more money per student, but also to allocate it according to their own views, independent of government interference.

Since there is intensive collaboration between industry and VETA with respect to the development and contents of courses (including on-the-job analysis and the advise and comments of experts) and the training of teachers (both in teaching theory and in industry), there is no reason to assume that the omission of profound knowledge of modern metal working technologies is caused by other factors than the limitation of financial means.

For many of the indicated shortcomings, the bottom line is that the indicated causes, listed above, find their origin in a lack of financial means. This affects the availability of adequate means (both for theory and practicals[40]), and thus, in an indirect way, limits the possibility of using other teaching methods. In these cases, where the absence of financial means indirectly affects the listed shortcoming, the relation is indicated in the table with '(x)'.

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37 Government VTCs are for their financing fully dependent on the government, i.c. VETA. Voluntary company spending (sponsoring) on VTCs is decreasing, but still every company in Tanzania is to pay 2% of its taxable profit as a VTC's Training Levy. These funds are centrally collected and allocated to the various government owned VTCs.

38 School fees for students are government-set, with a maximum of Tsh. 30,000/- for day students and Tsh. 60,000/- for boarding students. For government owned VTCs these fees are collected and subsequently allocated by VETA, for private VTCs the fees remain within the training centre. The maximum is set to assure equal opportunities, irrespective of a student's background. Furthermore, each student is to pay Tsh. 2,500/- in order to sit for the Trade Test 3 examinations. Irrespective of the type of school, this examination fee is collected by VETA.

39 Donor organizations active in vocational training and education in Tanzania include SIDA (Sweden), DANIDA (Denmark), NORAD (Norway), DGIS (The Netherlands), IDC (Italy) and SDC (Switzerland) - Biervliet, W. and King, K. *Trends in agency policies and support to basic education in Tanzania* in *NORRAG News No. 11* (The Hague: CESO, 1991, page 100-102).

40 For practicals, the number of books at most VTCs is sufficient (circa one per student). For the theory lessons, however, the number of books is far too few. At some VTCs the books which are available are the teachers' books, while at other VTCs they are property of the school and can be annually borrowed. The students have, for theoreticals, to rely on the notes taken during classes. In some cases the teacher may present handouts. For practicals, there is for some parts a shortage of materials or tools. Where this is the case, students have to perform in groups. Shortages are especially present at government VTCs. At privately owned VTCs which receive donor aid, the situation is in most cases not so bad.

8.2.4 INSTITUTION CHARACTERISTICS

The indicated shortcomings and their possible causes with respect to 'instruction characteristics' are listed below.

table 9: shortcomings versus institution characteristics at vocational education-level

shortcomings	student	teacher	school management	family and community
low reproductive skills	x			
low cognitive skills	x			
low theoretical knowledge	x			
low comprehension of English	x	x		x
low knowledge of modern metal working technologies		(x)		
low striving for excellence	x			
low awareness of safety-related aspects		(x)		

Students' background; family and community
Many of the indicated shortcomings find their origin in the educational background of the students. Most of them are Standard VII-leavers and compared to their colleagues at the VTCs who have followed secondary education up to Form 4, they are at a disadvantage with respect to the theory subjects, i.e. English, which is the official language at VTCs. Also the student's environment (family and community) does not foster the use of English. Furthermore, the Tanzanian education, especially at primary schools, is known for its high teacher-/pupil-ratios of 1:40 up to 1:65 - a situation which forces teachers at these schools to use the most basic expositive methods and tight 'rule' over a class. In turn, this makes the students rather passive and less receptive for other methods at higher or following educational levels.

Teachers
As far as the teachers are concerned, they are mainly graduated VTC-students who have followed additional teacher training. With respect to the mastery of English, they often encounter the same difficulties as their students. Because of this, the English which the students will learn at VTCs, other than during the theory subject 'English', is also of a relatively low level. In turn, the limited mastery of English for both students and teacher also hampers the use of 'reflective' or 'discovery' teaching methods, in which communication and discussion are essential.

The limited knowledge of modern metal working technologies is mainly caused by the lack of adequate facilities to teach these, especially at schools which receive no (additional) funding from (international) donor organizations. Furthermore, during training at the teacher training college and subsequently in industry, each teacher in principle must be able to learn about these technologies. However, since the training in industry as part of the teacher training course is limited to four weeks, the mastery of these technologies will not be as profound as desirable.

The low urge to strive for excellence can partly be explained by the functioning of the primary education, and consequently the student's attitude at further (post primary) education, which tempers his or her enthusiasm to discover and experiment, and consequently to gain more interest in all facets of any metal working process. However, this is not supported by a low score of reactive skills.

Finally, the level of salaries, particularly at public VTCs, is by most of the staff (both at VTCs and at VETA) considered as too low when compared with salaries paid in industry. However, apparently this difference does not lead to a considerable drop-out of teaching staff and consequently to a loss of experience in the various VTCs[41], at least not until the moment when there are no more promotion opportunities within the VTC and the maximum salary scale is reached[42].

Management
The management of the VTCs has very limited influence on the course contents and its organization. All this is determined centrally by the Vocational Education and Training Authority (VETA). With respect to organization of the VTCs it is hard to find causes of the indicated shortcomings in the management and its capabilities of the various VTCs.

8.2.5 Ownership and output of Vocational Training Centres

When the private VTCs are compared with the public VTCs, there are no government imposed selection criteria, neither for teachers nor for students, on basis of which one type of VTC is favoured above the other type: all VTCs are free to select their teachers and all teachers, once engaged at a VTC, are trained at the Vocational Teachers Training College in Morogoro. Furthermore, all students are to apply on their own initiative, and their background will, therefore, not differ between the two types of VTCs, even more so since the school fees, irrespective of the type of VTC, are limited to a maximum. Finally it is likely that students base their choice for a VTC on its geographical location[43] rather than on its ownership.

The main difference, therefore, is with respect to financial means. The vast majority of

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41 The age composition of teachers at public VTCs:
22-30 years 19%
30-40 years 56%
40-55 years 25%
(Source: VETA, 1995)

42 Within the public VTCs a teacher usually begins his or her career as a 'vocational industrial training assistant' (VITA, one grade). Successive promotions are to 'vocational industrial training officer' (VITO, three grades), 'senior vocational industrial training officer' (SVITO, two grades) and 'principal vocational training officer' (PVITO, one grade). In theory, a teacher at a public VTC can be promoted six times. (Source: VETA)

43 The number of VTCs, notably with respect to the ones which offer metal working courses, is limited and geographically they are spread over the whole of Tanzania. Since students receive no travel allowance, their choice will in most cases be based on location, rather than on ownership of the VTC.

private VTCs are able to spend more money per student than the public VTCs (as is indicated in paragraph 8.2.3). In this way, the former are able to use more modern teaching equipment (books, machines and materials) and, not hindered by government regulations, to attract better teachers (by offering better conditions, e.g. to compensate for an unfavourable geographic location of a VTC, as was experienced at visits during the research). Therefore, it may be assumed that students of private VTCs perform better than students of public VTCs (i.e. obtain higher pass rates for their examinations) and that the reason for this lies in the fact that the private VTCs can allocate more financial means per student than the public VTCs. When the examination results for Trade Test Grade 3 are compared, it becomes clear that the private training centres (including mission-run institutions) indeed attain higher average pass rates for the Trade Test 3 examinations as is indicated in figure 12.

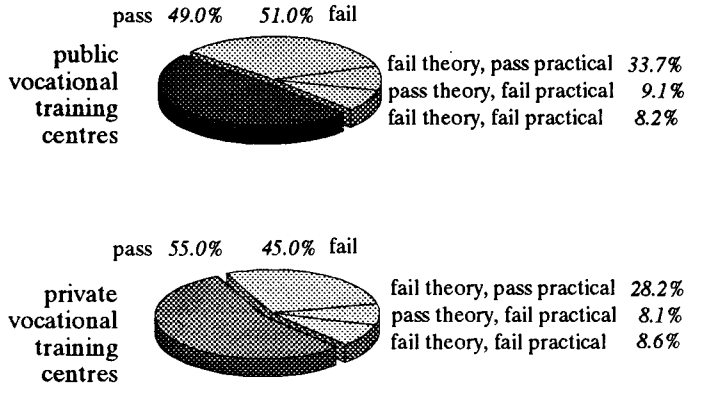

figure 12: examination outcomes (1993) versus ownership of vocational training centres
Note: a student passes for his/her examination only when he/she passes both theory and practicals
Source: VETA, 1994

From these diagrams it becomes clear that private vocational training centres perform better: their overall passing rate (passing theory, passing practical) is higher than that of public VTCs. However, on basis of the Trade Test 3 examination results of 1993 only, it cannot statistically be proven that the difference in passing rates is significant. From Appendix H it appears that there are too many small VTCs (public as well as private) which cause the overall variance to be too large. On basis of the research findings presented in the foregoing paragraphs it would be useful to further elaborate the examination outcomes of several years. On basis of the qualitative findings it is expected that a statistical analysis of data covering a longer period will support the indicated differences in performance.

Further research with respect to the relation of financial means spent per student and the quality of an institute (or type of institute), i.e. the institute's examination results, should be executed in order to support these findings. Apart from the expected positive correlation between an institute's financial means and its examination results it would be useful to investigate the efficiency rate: at what expenses do the better financed VTCs obtain the (apparent) better results?

8.3 SHORTCOMINGS AT THE TECHNICAL SECONDARY SCHOOLS

8.3.1 INDICATED BOTTLENECKS AT TECHNICAL SECONDARY SCHOOLS

The outcomes of the survey in the various metal working companies indicated the following shortcomings with respect to workers who have completed the technical orientation of secondary education:

- reproductive skills are less developed than productive skills;
- cognitive skills are relatively low;
- practical experience is low;
- there is little knowledge of modern metal working technologies and machines;
- the urge to strive for excellence is low;
- awareness of safety-related aspects is low;
- awareness of (preventive) maintenance is low;
- comprehension of English is low.

8.3.2 GOAL AREAS AND BEHAVIOUR OBJECTIVES WITH RESPECT TO THE SURVEY OUTCOMES

The goal areas which are most important, as indicated by the schools, are 'intellectual development' and 'mastery of basic skills and fundamental processes', and to a lesser extent 'vocational education (career education)' and 'self-concept, self-realization, moral and ethical character'. The other areas were hardly or not at all mentioned.

On basis of this, all indicated shortcomings can be listed under the indicated goal areas and, therefore, should receive attention here.

8.3.3 INSTRUCTION CHARACTERISTICS

The indicated shortcomings and the 'instruction characteristics' which may cause these, are listed below.

table 10: shortcomings versus instruction characteristics at secondary education level

shortcomings	organization and contents	method	facilities	costs
low reproductive skills	(x)	x	x	x
low cognitive skills	(x)	x	x	x
low practical experience	(x)	(x)	x	x
little knowledge of modern metal working technologies	x		x	x
low striving for excellence		x		(x)
low awareness of safety-related aspects	x	x		(x)

shortcomings	organization and contents	method	facilities	costs
low awareness of (preventive) maintenance	x		x	
low comprehension of English	(x)	x		

Method

Since the first two shortcomings, with respect to reproductive skills and cognitive skills, are equal for all educational levels, their causes are to a large extent also equal: the teaching methodology has to rely mainly on expositive methods, because of an absence of adequate means which are needed when using other methods.

Organization and contents

Shortcomings with respect to organization of the course contents and/or the contents itself are in none of the cases the single factor causing the listed shortcomings. In some cases there is little attention for certain aspects (which should be covered more thoroughly according to the curriculum), but this is often caused by a shortage of adequate means. Where this is the case, the relation is marked by '(x)'.

There are, however, some shortcomings which have a direct cause in a lack of organization and contents: there is little or no attention for modern metal working technologies, regardless of the fact that teaching of these could be hampered by a shortage of means. Furthermore, although the teaching of both 'awareness for safety related aspects' and 'awareness of (preventive) maintenance' are best supported by adequate means to demonstrate their working and importance, these two topics are hardly covered in the curriculum of the various technology-related subjects.

As for the vocational training centres, the issue of 'striving for excellence' is covered in the various courses, and a noticed shortcoming in this might, therefore, be caused by not putting enough emphasis on this. However, this shortcoming will mainly surface during the execution of practical work and thus, under the present circumstances, receive less attention than desirable - out of necessity. On the other hand, the striving for excellence can also be seen as a topic that should surface throughout the course in any (technical) subject and which should not be related to every distinct subject - it is psychology-related as well as technology-related. During the present teacher training course for technical teachers, however, there is less attention for general education subjects (e.g. psychology) than for pure technical contents (at least when this course is compared with that of a general science teacher[44]) - a situation which could to some extent contribute to the indicated low level of striving for excellence.

Facilities

For the theoretical means, the student-/book-ratio is even worse compared with the majority of the institutes at VTC level (10:1). For the practical work means, the situation is often deplorable: the number of machines is often in itself too small to be used by all students and, furthermore, many of the machines are out of order. Therefore, the teaching of practical work

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44 Science subjects are mathematics, physics, chemistry and biology

is often no more than a demonstration, either on a working machine or on one which is not functioning (often, the demonstration is on a blackboard, without a machine). This situation, of course, also contributes to the 'low practical experience', as indicated by the survey outcomes. Even the government has admitted that, under these circumstances, one cannot expect the students to sit for a practical work examination, and in recent years this part of the National Examination has been modified into a so-called 'alternative for practical', in which practical work topics are presented and answered in writing.

A further cause of the absence of means for practical work education and training is that awareness of (preventive) maintenance can hardly be fostered. Also the awareness of safety related aspects may very well suffer because of this.

Costs

Like for vocational training centres, the main causes are of a financial origin: the budget of the schools does not allow the purchase of books, spare parts or materials to be used for practicals. Often the only way for a school to conduct practical work is by carrying out production orders for third parties, which enables both the purchase of materials (to be used for the assignment) and the practical work training of students. The profits of these projects can be used for purchasing spare parts. In most cases, however, these profits are insufficient for this, let alone that they can be used for supplying the workshops with up-to-date machinery. The absence of this equipment is an important cause for the indicated 'little knowledge of modern metal working technologies'.

8.3.4 INSTITUTION CHARACTERISTICS

With respect to 'institutional characteristics', the indicated shortcomings and their causes are presented in table 11.

table 11: shortcomings versus institution characteristics at secondary education-level

shortcomings	student	teacher	school management	family and community
low reproductive skills	x			
low cognitive skills	x			
low practical experience				
little knowledge of modern metal working technologies		(x)		
low striving for excellence	x			
low awareness of safety-related aspects		(x)		
low awareness of (preventive) maintenance				
low comprehension of English	x	x		x

Student, Family and Community

As already stated for vocational education, many of the indicated shortcomings find their origin in the educational background of the students, i.e. primary school. While at primary level the language of teaching is Kiswahili (English is just one of the subjects), at secondary level the students have to switch to and use English as the official medium. Although selection for secondary education is on basis of, among others, the final National Examination score for English and, therefore, only the best students are allowed to enter further education, this proves to be a major burden for comprehension in many aspects. Since the use of English is restricted to school, a student's natural environment does not stimulate the use of it. Also the passiveness of the students coming from primary school (as a result of the forced teaching methods at these schools) is a cause for the low development of knowledge and skills.

Finally the low striving for excellence can, as for vocational education, be partly explained by the student's attitude developed during primary education. The teaching methods there may have tempered his or her motivation and enthusiasm to discover and experiment, but the high(er) scores for reactive skills do not support this conclusion. Therefore a possible reason for this indicated shortcoming may have an anthropological background, which is beyond the scope of this research.

Teacher

As far as teachers for technical subjects are concerned, they are mainly Form 4-leavers who hold a Full Technician Certificate (FTC) of a Technical College in one of the technical subjects. Their level of English is, therefore, of a higher standard than that of their colleague teachers at vocational training centres. The teacher training course for technical teachers in secondary education puts much emphasis on the technical subjects, and since all these subjects at the teacher training college are in English, the indicated low level of English is not likely caused by an inability to teach in proper English.

Also the relatively weak knowledge of modern metal working technologies is not caused by a lack of knowledge on the side of the teachers: during the teacher training course and the training and work experience in industry each teacher in principle must be able to master these. However, much of the technical training at the teacher college for technical secondary teachers is in-door (contrary to the teacher training for vocational teachers), and the college lacks machines which are according to the latest technologies.

Finally, the absence of many necessary facilities and the often low motivation of students contribute to a low motivation of teachers. However, unlike the situation at many VTCs where promotion opportunities can compensate for unfavourable working conditions until the age of approximately 40 years, the low salary levels[45] and limited promotion opportunities at secondary level also contribute to a low motivation of teachers. Many of them seek employment outside the educational sector already at a young age and as a result the experience

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[45] Average teacher salary at (public) secondary school is Tsh. 59,200/- per annum (1987) - Syrimis, S. *Sector review: the financing of education in Tanzania* (Paris: Unesco Educational Financing Division, 1988, page 38)

among the teaching staff on average is rather low[46].

Schoolmanagement
Like for other shortcomings, the management of the school is very restricted in its ability to set priorities according to the school's specific needs. The only influence they may have is for acquiring projects for third parties, although this ability is severely restricted by the poor state of the machines needed.

Finally, the limited practical experience and awareness for safety-related aspects are not caused by any of the institutional aspects - it is purely a matter of lacking facilities and means to teach these.

8.3.5 OWNERSHIP AND OUTPUT OF TECHNICAL SECONDARY SCHOOLS

Analogue to the problems of the vocational training centres, the bottom line of most of the investigated bottlenecks is a shortage of financial means. However, unlike the private VTCs, the private technical secondary schools are hardly supported by (foreign) donor organizations and in cases where there is active sponsoring, the provided means are hardly sufficient to cover the running costs, let alone to make necessary investments. The number and condition of most text books leaves much to be desired for, and also the present state of technical equipment is rather poor. Also the students' fees (although distinct for both types of schools) are limited to a maximum[47]. Private schools can, therefore, not improve their financial status by means of their students. Therefore, contrary to private VTCs, the private technical secondary schools are in a financial way worse of compared with public technical secondary schools.

Also with respect to teachers and students the private technical secondary schools encounter a backlash. Teachers at public technical secondary schools are appointed, trained and allocated by the government, whereas teachers at private institutes have to apply on their own initiative and their employer (private school) and/or the teachers themselves have to pay for the bulk of their training. In order to be admitted to the teachers training college one of the selection criteria is an interview with respect to a person's knowledge and skills in the field of concern. Therefore, the best teachers are allocated by the government to public schools leaving the private technical secondary schools, unless they have ample financial means, with less

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[46] The age composition of teachers at public secondary schools:
22-30 years 74%
30-40 years 21%
40-55 year 5%
Source: Ministry of Education and Culture *Wizara ya elimu na utamaduni takwimu za schule za sekondari Tanzania, 1995* (Dar es Salaam: MEC, 1995)

[47] There is, however, a difference in annual school fees: the maximum for a boarding student at a government secondary school is Tsh. 15,000/- whereas the maximum at a private secondary school is Tsh. 90,000/-. By imposing additional fees (contribution for buildings, desks, medical provisions, sporting facilities, etc.) many schools are able to raise the student's contribution to his or her education, but these fees are also limited to a maximum (Tsh. 7,000/- for government schools and Tsh. 27,000/- for private schools). However, the total amounts appear to be hardly sufficient to pay for the student's costs of lodging and nutrition.

qualified teachers. As a result, in many cases the teachers at private technical secondary schools are not trained.

A similar situation is the case with the students. Those with the best results for the Primary School Leaving Examination are selected and allocated by the government to public schools. The students who are not selected can, on their own initiative, apply at a private technical secondary school, which leaves the private schools with 'second best' students. Also, although many students at private technical secondary schools are from relatively well-off families, the school cannot benefit from this by letting these students pay accordingly, since the maximum of the fees is limited.

After the nationalization of all secondary schools in 1970 (to avoid the emergence of an elite class which receives a superior education because of its ability to pay), private secondary schools were reallowed at the end of that decade because of the realization that government could not afford the badly needed expansion of secondary education[48]. However, by not allowing the private institutes the same conditions with respect to the level of students and teachers as the public institutes, the government clearly frustrates the functioning and subsequently the emergence of the former and, therefore, obstructs the aim of expansion.

The clear differences between private and public technical secondary schools are reflected in the outcomes of the secondary school examinations (CSSE) as is indicated in figure 11. Since the CSSE examinations are centrally developed and corrected and each secondary school, irrespective of its ownership, has to conduct these, these examinations can serve as an unbiased measuring instrument[49].

From a statistical point of view public technical secondary schools obtain for all listed subjects (mathematics, English and technical subjects) significantly higher average CSSE scores (ranging from 1-very good to 5-very poor) than private ones. Also the average pass rates show similar significant differences. (All statistical calculations for 1993 and 1994 are presented in Appendix I.) On basis of these computations the qualitative outcomes of the research at the technical secondary level (presented in paragraphs 8.3.3 and 8.3.4) are supported by the examination outcomes of the two types of schools.

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48 Syrimis, S. *Sector review: the financing of education in Tanzania* (Paris: Unesco Educational Financing Division, 1988, page 22)

49 It should be noted that a small proportion of the CSSE-outcomes is determined by a student's marks for so called 'terminal examinations': half-year tests during Form 1-3. Although drawn-up by the school, the contents of these tests and the way these should be executed are determined by tight government regulations. The final examination at the end of Form 4 cannot be influenced by a school, neither with respect to its contents nor with respect to the correction, since all this is under the responsibility of the National Examination Council. Therefore, the CSSE-outcomes are virtually unbiased and can serve as an indicator for the intended purpose.

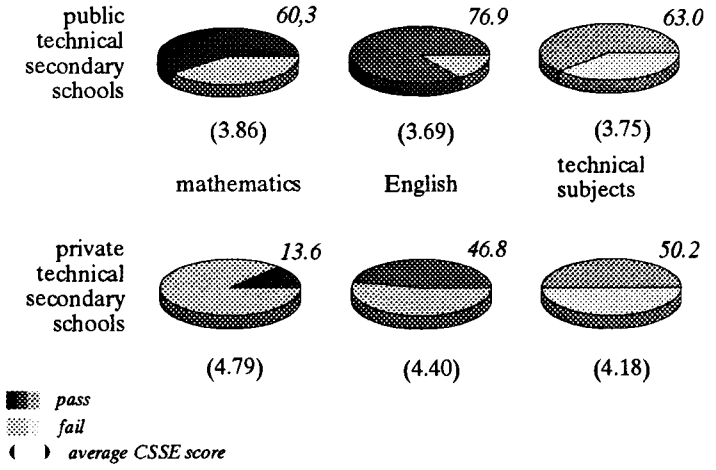

figure 13: examination outcomes (1993 and 1994) and average examination scores versus ownership of technical secondary schools

Notes: average CSSE scores range from 1 (Grade A, very good) to 5 (Grade E, very poor)
the test includes circa 2,100 students at public institutes and 400 at private institutes

Source: National Examination Council of Tanzania (NECTA), 1995

Again it would be very useful to gain more insight in the financial structures of the public technical secondary schools compared with the private technical secondary schools. Contrary to VTCs the support of donors to private schools does not lead to better students. Although Lauglo[50] has accounted the average recurrent costs of a student at a public technical secondary school[51] to be circa Tsh. 3,263/- annually (1981), there is hardly any research into the composition of budgets and expenditures at private secondary schools.

8.4 SHORTCOMINGS AT THE TECHNICAL COLLEGES

8.4.1 INDICATED BOTTLENECKS AT THE TECHNICAL COLLEGES

The indicated bottlenecks at technical colleges are:
- reproductive skills are less developed than productive skills;
- there is little knowledge of modern metal working technologies and machines;
- low comprehension of English;
- the attitude for striving for excellence is considered to be very low;
- awareness of safety-related aspects is very low;
- training with respect to management and supervision is low.

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50 Lauglo, J. and Lillis, K *Vocationalizing education - an international perspective* (Oxford: Pergamon Press, 1988, page 265-267)

51 Excluding the costs of teacher salaries and capital costs of buildings, furniture and equipment.

8.4.2 GOAL AREAS AND BEHAVIOUR OBJECTIVES WITH RESPECT TO THE SURVEY OUTCOMES

The goal areas which were most frequently mentioned at the technical colleges of Dar es Salaam and Arusha and the Ministry of Science, Technology and Higher Education are 'intellectual development', 'mastery of basic skills and fundamental processes', 'creativity' and 'vocational education'.

All bottlenecks should be paid attention to in the contents of these various goal areas and, therefore, should be discussed here.

8.4.3 INSTRUCTION CHARACTERISTICS

The indicated shortcomings and their causes with respect to 'instruction characteristics' are listed below.

table 12: shortcomings versus instruction characteristics at technical colleges

shortcomings	organization and contents	method	facilities	costs
low reproductive skills	x	x	x	x
low comprehension of English	x	x		
low knowledge of modern metal working technologies	x		x	x
low striving for excellence		x		(x)
low awareness of safety-related aspects	x	x		(x)
low knowledge of management and supervision	x	x		

Method

The teaching methodology is mainly based on expositive methods which, to a large extent, are connected to the problem of the absence of adequate means. Furthermore, the use of English as a medium of instruction causes the teaching methodology to be trapped in a vicious circle: the low level of English (especially for students) frustrates the use of discovery-oriented methods, and consequently the forced use of expositive methods frustrates the level of English to be raised to a high enough level. In this way the profoundness of most topics (i.c. reproductive skills and knowledge of modern metal working technologies), covered in the various subjects, will remain low.

Organization and contents

The curriculum of the Full Technician Certificate course is drawn up in close cooperation between the Ministry of Science, Technology and Higher Education and the technical colleges. However, the syllabi present only a framework of the contents and the colleges are free to select their own means (e.g. books) to teach these. The examinations' contents is decided by the National Examination Council of Tanzania (NECTA), which also conducts

and corrects these. Furthermore, NECTA issues the guidelines for the 'continuous assessments', but the contents, conduction and correction of these are determined and executed by the technical colleges themselves[52].

In cooperation with industry and the Ministry, the technical colleges will introduce a new subject 'entrepreneurship'. The aims of this subject are making the students more self-reliant and consequently raising their opportunities for self-employment, to make them strive for quality and excellence, to stress 'supply and demand' as important factors in economic life and to make them more self-reliant. The introduction of this subject, therefore, is very much demand-driven. Furthermore the subject might contribute to making students less passive and more enthusiastic with respect to the various aspects of education in general and metal working in particular.

Furthermore, the curricula will be more module based in the near future in order to give students the opportunity to compose, to a certain extent, his or her own list of subjects. On basis of this, it is hoped, unemployment under school-leavers may decrease, since it facilitates anticipation to the industry's needs.

Facilities

The present student-/book-ratio is between 1:3 (Arusha Technical College) and 1:15 (Dar es Salaam Technical College)[53]. Since the provision of books at the Arusha Technical College is relatively good, students are able to borrow books from the school. At the Dar es Salaam Technical College, the students have to purchase their books. FTC-students receive no book-allowance from their government.

The presence of facilities for practicals are analogue: the Arusha Technical College is able to conduct most practicals, whereas the Dar es Salaam Technical College is forced to cancel a number of practical and laboratory lessons, while others are far from optimal. Both colleges execute work on company or private orders, but the proceeds of these are marginal. This situation is severely hampering the colleges' aim to put most emphasis on teaching skills by means of practical work[54].

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52 During each of the three years, three mid-term tests (contents determined by the teacher) and three end-of-term tests (contents determined by the teacher and the head of department) are conducted, the former accounting for 40% of the Continuous Assessment mark, the latter for 60%. In the third and final year there are no tests during the final term: students sit for their final examination. A student's final mark is determined by a combination of the eight CA marks and the final examination mark, each accounting for 50%.

53 Both technical colleges rely largely on the Tanzania Government for the provision of (financial) means. The government funds, however, show a decreasing trend. To fill this (widening) gap the Arusha Technical College closely cooperates with the German GTZ with respect to organization, contents and facilities. Its machines are mainly provided by GTZ and they are relatively new and in a good condition. Still, the supply matches only 75% of the needs. The Dar es Salaam Technical College cooperates with the University of Huddersfield, U.K., but mainly with respect to method and contents. The college is able to provide circa 50% of the needed means. The Mbeya Technical College closely cooperated with donors from former communist countries, and its supply of means from these countries has shown a sharp decline.

54 For FTC courses, the theory-practical ratio is 2:3

With the present state of facilities the technical colleges are forced to teach basic reproductive knowledge and skills at a unsatisfactory level and have to rely mainly on expositive methods.

Costs

The lack of adequate facilities and the resulting teaching methodology find their origin in the lack of financial means: none of the technical colleges is able to cover all necessary costs. Neither donor organizations nor the conduction of production orders during practicals can supply sufficient funds. Direct consequences of this are the inability to train students with modern metal working technology and, overall, the low profoundness of the various subjects. Furthermore, because of the limited possibility to conduct work, striving for excellence and awareness of safety related aspects receive relatively little attention.

8.4.4 INSTITUTION CHARACTERISTICS

The bottlenecks and their possible 'institutional' causes are listed below.

table 13: shortcomings versus institution characteristics at technical colleges

shortcomings	student	teacher	school management	family and community
low reproductive skills	x			
low comprehension of English	x			x
low knowledge of modern metal working technologies		(x)		
low striving for excellence	x			
low awareness of safety-related aspects		(x)		
low knowledge of management and supervision	x		(x)	

Student, family and community

Many of the indicated shortcomings find their origin in the students' educational background. Although a student's preliminary education should be technical secondary school (O-level) or vocational training (trade test 1, i.e. with several years of working experience) their level of English is still rather poor. To a large extent this is connected to the teaching methodology at these educational institutes, but also the students' family and community background does not foster the use of English.

The boarding fees for the technical colleges are limited to a maximum which is far lower than for secondary education or vocational training[55]. Since all students at the technical colleges already have had to pay for their preliminary secondary education or vocational training one might expect these students to come from relatively rich backgrounds. Still the

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55 The boarding fee for technical colleges is limited to a maximum of Tsh. 15,000/-. This includes free housing and food; costs for books or travelling are to be borne by the students themselves.

number of applicants outstrips the number of vacancies by far[56].

Again, the causes of a student's low striving for excellence can be traced back to primary and secondary education, where the student's attitude with respect to enthusiasm and discovery has been tempered. With the subjects 'entrepreneurship', however, more emphasis will be put on the striving for excellence and consequently to change his or her attitude.

Teacher

The teachers at the technical colleges should hold a technical degree and are, therefore, either graduates from the University of Dar es Salaam (B.Sc.) or from the Dar es Salaam Technical College (holders of an Advanced Diploma in Engineering). For practicals the teacher's level may be lower. There is no teacher training programme for teachers at technical colleges and work experience is no condition either. Only on a college's initiative teachers can attend a methodology seminar, conducted by a private institute. The Ministry, however, does not provide funds for this and attendance of these courses is only possible with donor aid. This situation contributes to the 'chalk and talk' method of teaching, i.e. mainly expositive. However, many teachers have ample working experience in industry (which is reflected in the age composition of the teachers[57]) and a vast number of them is part-time teacher at technical college, part-time engineer in industry[58]. Their level of experience, therefore, might (partly) compensate the absence of a formal teacher training course. With respect to the teaching of modern metal working technologies this is especially the case for the teaching of theory; the teaching of these during practicals is limited by the present state and age of the machines, as is the emphasis on safety related aspects.

Finally the mastery of English by teachers is far better at technical colleges, compared with vocational training centres and technical secondary schools.

Management

The management's ability to directly influence institutional characteristics is very limited. It is hardly in a position to allocate means and also determining the curriculum's contents is largely out of reach. However, the management has taken the initiative to establish the new subject 'entrepreneurship' (although the influence on the development of the contents was limited) and therefore this is indicated with '(x)'.

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56 Although the system is designed to enable students from poor backgrounds to attend higher education, the burden of secondary education is so high that only students of a richer background are able to carry on studying after this level. It can, therefore, be argued that this system in fact shifts resources from the poor (at primary and, to a lesser extent, secondary level) to the rich (at tertiary level). In this way the system of fees works contra-egalitarian an and frustrates the underlying aim of selection on meritocratic reasons. In chapter 9 this will be discussed in more detail.

57 The age composition of the teachers at the Dar es Salaam Technical College:
22-30 years 8%
30-40 years 41%
40-55 years 51%
(Source: Dar es Salaam Technical College, 1995)

58 The relatively low salary levels and the limited promotion possibilities for teachers at technical colleges also contributes to the high level of part-time teachers.

CHAPTER 9 CONCLUSIONS

9.1 INTRODUCTION

In the previous chapter the shortcomings at the educational institutes were reviewed and analysed. From the review and analysis it became clear that there are two major issues underlying most bottlenecks:
- English as a medium of instruction;
- financial means of institutes.

These two issues are interrelated with other aspects, as is schematically presented in figure 14. The use of English as a medium of instruction affects teachers and influences the teaching methodology (directly as well as via the teaching material), which in turn has its effect on the level of the students. The financial means have three different sources (government, donor organizations and students' school fees) and influence the quality of the teachers and the availability and state of books and machines, of which the latter is directly related to the most appropriate teaching methodology.

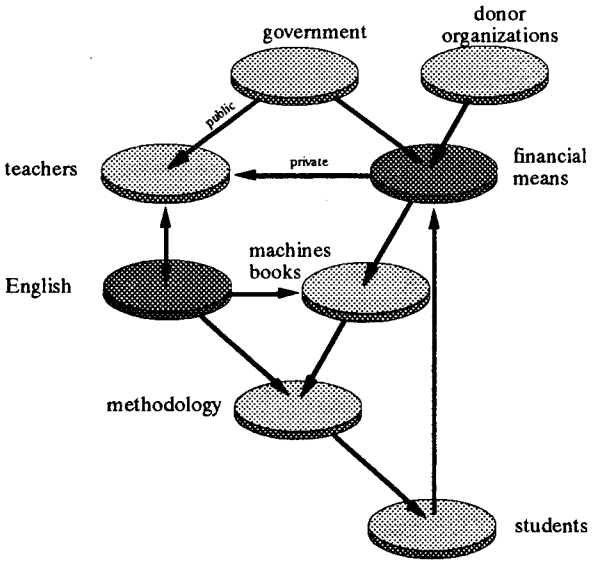

figure 14: interrelated issues and aspects in technical education

The role of English and of financial means will be discussed in paragraph 9.2 and 9.3 respectively.

9.2 ROLE OF ENGLISH

The use of English as the medium of instruction at all educational levels beyond primary school has been under discussion for many years and the effectivity of the language at schools has been questioned. Criper and Dodd[59], for example, state that:

- throughout their secondary school career little or no subject information is getting across to about 50% of the students; only about 10% of the Form IV students are at a level where one might expect English education to *begin*;
- the proportion of Form V students nearing but not at independent reading level is small - 17%;
- university students' levels of English are substantially below of what is required for university courses in the English language and the use of English text books and other materials;
- it is estimated that some 75% of the teaching, certainly in Form I, is done through Kiswahili.

This situation is a logical consequence of the limited use of English in Tanzanian society since independence. The language is no longer a second language but a foreign language - one which only a small proportion of the society uses in conversation with foreigners, in court and in classrooms (at secondary level and above). As soon as a student sets foot outside the classroom, the environment is predominantly Swahili. These conditions are certainly not conducive to attain the required level of proficiency in English.

In a way, it would seem to be a logical decision to make Kiswahili the medium of teaching at all educational levels. However, there are a number of arguments against such a step:

- especially at institutes of higher learning (colleges, universities) most (if not all) relevant literature is in English. Cooperation with foreign countries in research or production requires a mastery of English. Introducing Kiswahili would severely frustrate the cooperation and research;
- most literature at all levels (from secondary school onwards) is in English and changing this to Kiswahili would take a considerable time, not to mention the costs which would be immense, particularly for a developing country such as Tanzania;
- Kiswahili has an inadequately developed technical terminology. Developing a technical vocabulary for this language would take a considerable time (which, of course, is not to say that Kiswahili does not have the potential for such an adaption).

Against English, however, there are a number of arguments too:

- both teachers and students master the language insufficiently;
- as a result the teaching methodology has to remain mainly expositive, since any discussion or improvisation from the predetermined path of instruction is in danger of going astray.

Therefore, whichever way will be chosen, the society in general and the industry in particular will suffer a loss. Switching to Kiswahili would require considerable financial means, several generations of students (and graduates) who will be 'lost' between the two languages and

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59 Criper, C. and Dodd, W. *Report on the teaching of English language and its use as a medium in education in Tanzania* (Dar es Salaam: The British Council, 1984, page 14, 34)

difficulties in cooperating with foreign organizations. Maintaining English as the medium for instruction in the present way will mean that a large human potential of knowledge and skills cannot be tapped.

Still, if one has to make a choice, the choice should be to emphasize and strengthen the teaching of English. Considering the wide use of English in international science and technology and its importance with respect to industrial growth and the development of the economy and the society[60], the Tanzanian government should stimulate the use of English. Apart from fostering the development of profound basic knowledge of English, the government should stimulate the use of the language outside school in order to maintain this knowledge. In this way, English should be considered as a second language rather than a foreign language. Especially for teachers, trainers and managers the use of English is a must, since they find themselves in a continuous process of gaining knowledge. For recipients and students who (expect to) work at the lower levels in industry and who are not usually promoted to (higher) management levels the exclusive use of English is questionable. These are untrained workers and (ex-)VTC students at Trade Test 3 level. However, when applying for VTC Trade Test 2 and 1, the medium of instruction is mainly English[61], and the corresponding levels in industry will be at middle management level. Since these Trade Tests are an expansion of Trade Test 3 knowledge and skills, it can be argued that also at Trade Test 3 level, and thus at all levels at VTCs, English should be the medium of instruction.

9.3 ROLE OF FINANCIAL MEANS

9.3.1 THE IMPORTANCE OF AMPLE FINANCIAL MEANS

A second problem which is at the root of many indicated bottlenecks is the lack of financial means of many institutes. The research has shown that institutes which have ample financial means obtain better (examination) results: private vocational training centres are, in general, better equipped with respect to machines and books and consequently appear to show higher pass-rates. On the other hand, institutes which are clearly at a disadvantage with respect to financial means, i.e. private technical secondary schools, perform worse than their public counterparts: their examination results, both pass rates and average scores, are significantly lower than those of public technical secondary schools.

It may, therefore, be assumed that the provision of ample financial means, often in the form of close cooperation with foreign donor organizations, correlates positively with the students' examination achievements. In widening the financial means of the schools, the institutes will

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60 Lapperre, P. *Technologie, maatschappij en ontwikkeling - sociologische inleiding* (Eindhoven: Eindhoven University of Technology, 1996, lecture notes, page 4) and Szirmai, A. *Ontwikkelingslanden - dynamiek en stagnatie* (Groningen: Wolters-Noordhoff, 1994, page 9-11)

61 For *Trade Test 3*, the entrance condition is a minimum of Standard VII. In teaching as well as examination the medium is English. The minimum entrance conditions for a *Trade Test 2* course are graduation in Trade Test 3 and several years of working experience. The medium of instruction is mixed Kiswahili and English; the examinations, however, are in English. Students at a *Trade Test 1* course should hold Trade Test 2 and have additional work experience. Both teaching and examination at this level are in English. (Source: VETA)

be able to provide up-to-date literature in sufficient quantities, which will contribute to the raising of reproductive knowledge and skills, and perhaps also provide room for lifting the level of productive knowledge and skills, since less time would be needed to copy notes from the blackboard. Also machines can be repaired, replaced or modernized. This will contribute to the teaching of various skills and it will make it possible to raise knowledge of modern metal working technologies and safety and maintenance aspects.

9.3.2 IMPLICATIONS OF RAISING SOURCES OF FINANCE

From figure 14 it becomes clear that there are, in general, three potential sources of finance for schools:
- direct government contributions;
- donor contributions;
- student fees.

It would seem a logical suggestion to raise the schools' financial means by increasing one or more of these three sources. However, this will cause severe complications.

direct government contributions
Like in most developing countries, many sectors in the Tanzanian society which depend partly or fully on government contribution are underfinanced. Therefore, the government's ability to increase its contributions to the educational sector are hardly existent. Furthermore, it is beyond the scope of this research to suggest shifts in the national budget in favour of the educational sector. Within the educational sector, however, it would be interesting to gain more insight in the cost structure of overhead expenses and the efficiency of the various government bodies involved[62].

donor contributions
The second source of financial means is donor contributions. At present most of these are provided to vocational training centres - secondary and higher education appear to be less likely partners for donor cooperation. Foreign donor agencies traditionally focus on distinct, vocational courses rather than on academic education, despite the high degree of vocationalization of particularly the technical secondary schools[63,64]. From the research findings it has become clear that institutes which cooperate intensively with donor agencies (like private VTCs) appear to show higher pass rates for their students, while institutes which

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62 The urge for greater government efficiency with respect to the formulation and execution of educational policy is also stressed by Syrimis, S. in *Sector review: the financing of education in Tanzania* (Paris: Unesco Educational Financing Division, 1988, page 9-11)

63 King, K. *Aid and educational research in developing countries - the role of donor agencies in the analysis of education* (Edinburgh: Edinburgh University, Centre of African Studies, 1988, page 23-24)

64 As a result of the diversification process, secondary education is considered mainly as a source of trained middle level technician manpower and, in the absence of adequate manpower justification, external financing agencies are reluctant to finance its expansion - Syrimis, S. *Sector review: the financing of education in Tanzania* (Paris: Unesco Educational Financing Division, 1988, page 22)

lack substantial donor contribution (e.g. private technical secondary schools) perform significantly weaker with respect to examinations. Therefore, under the present circumstances, donor contributions in general contribute positively to a school's performance and both the Tanzanian government and the educational institutes themselves should be stimulated to stimulate donor financing.

This, however, should be accompanied by a more equal approach towards private secondary schools. With its regulations concerning fees, appointment and training of teachers and the selection of students, the government clearly favours its own public institutes. Private institutes in particular are handicapped by these government imposed burdens: apart from the difficulty in acquiring financial support from donor agencies (since, by nature, all institutes at this level are less likely partners for these organizations), donor agencies might question the efficiency of their contributions to private institutes under these circumstances.

student fees

In line with the suggestion to investigate the government's financial efficiency with respect to education, it can be argued to have student fees (either partly or totally) collected, allocated and spent by and at the level of individual schools. Only where spending at central level will lead to benefits of scale, the financial circle should be widened accordingly.

Apart from this, this financial source can be raised by increasing the student fees. Since, at all levels included in the research, the number of applicants outstrips the number of vacancies by far, it can be argued that raising school fees will not have negative consequences with respect to the number of students. In fact, it would widen the spending possibilities of the various institutes (both public and private) and consequently improve teaching. However, whereas low school fees are a determinant of a meritocratic and egalitarian educational system, raising fees would make the educational system more elitair: it would limit the access for students from poor backgrounds.

On the other hand it can be argued that the present structure of school fees in Tanzania, like that of many developing countries, is in essence inegalitarian and places students from a poor family background, apart from the higher opportunity costs[65], at a disadvantage. Compared with primary education[66], the fees for secondary education are relatively high (Tsh. 30,000/- to 60,000/- at vocational training centres and Tsh. 15,000/- to 90,000/- at secondary schools). In accordance with Lapperre[67], this amounts to a system of educational advancement and selection based on family income levels rather than merits. The situation is compounded even further at the higher levels, i.c. technical colleges, where school fees are limited to a

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65 Costs caused by the absence of labour and consequently loss of production and decrease of family income.

66 Although school fees at this level are officially non-existent, a Tanzanian family spends on average Tsh. 3,842/- per pupil in primary education - Duijsens, R. *Education in Tanzania - sector review* (Eindhoven: Eindhoven University of Technology, 1995, page 22)

67 Lapperre, P.E. *Problems of developing countries in institutional perspective* (Eindhoven: Eindhoven University of Technology, lecture notes, 1993, page 125-126)

maximum of Tsh. 15,000/-[68]. Since most students at this level already come from upper income brackets (and were so selected at the primary and secondary levels), subsidies at this educational level using public funds amount in fact to a transfer of payment from the poor to the wealthy[69]. Under the present circumstances an increase of school fees at the technical colleges is very well tenable.

An increase of fees at private technical secondary schools and at private vocational training centres (the latter only if deemed necessary considering the present situation at these institutes), while leaving the fees at public institutes unchanged, would in theory leave entry to these public schools and centres meritocratic. However, regarding the very limited number of public technical secondary schools in Tanzania (eight) and their geographical location, this would limit access for a large group because of increased travel expenses. Considering the relatively large number of public VTCs (nineteen) and their geographic locations, this is less likely at this educational level.

To elevate the situation of budgetary constraints, the government could stimulate (an increase of) the investment of third parties in the educational institutes, as for example the Kenyan government does for its private educational institutes[70]. This, however, should be accompanied by a more equal approach towards private secondary schools, as discussed under the heading 'donor contributions'.

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68 In 1986 unit recurrent expenditures for secondary and tertiary (i.e. teacher training, technical colleges and university) expressed as multiples of that for primary education were 18 and 65 (weighted average) respectively (203 for university education alone). Corresponding figures for Sub-Saharan Africa as a whole are 5.5 and 29 - The WorldBank *Education in Sub-Saharan Africa - policies of adjustment, revitalization and expansion* (New York: WorldBank Publication, 1987, various pages)

69 The Tanzanian government allocates (including donor supplements) Tsh. 7,300/- per primary school student, Tsh. 75,000/- per secondary school student and Tsh. 1,575,000/- per student at higher levels of education - Duijsens, R. *Education in Tanzania - sector review* (Eindhoven: Eindhoven University of Technology, 1995, page 26)

70 Riddell, A. *The evidence on public/private educational trade-offs in developing countries*, published in *International Journal of Educational Development, Vol. 13 no. 4* (London: Pegamon Press, 1993, page 374-376)

LITERATURE

Baarda, D.B. and De Goede, M.P.M. *Methoden en technieken - praktische handleiding voor het opzetten en uitvoeren van onderzoek* (Leiden: Stenfert Kroese, 1990)

Biervliet, W. and King, K. *Trends in agency policies and support to basic education in Tanzania* in *NORRAG News No. 11* (The Hague: CESO, 1991)

Caroll, J. *Tanzania Economy* in *Africa South of the Sahara* (London: Europa Publications, 1991)

Coenegracht, A.M.M.A. and Kole, S.C.A. *Beroepskwalificaties in de metaalbewerking: een kwestie van ondernemen* (Rotterdam: OSAM, 1989)

Criper, C. and Dodd, W. *Report on the teaching of English language and its use as a medium in education in Tanzania* (Dar es Salaam: The British Council, 1984)

Deutsches Institut für Normung *DIN Taschenbuch 241 (allgemeine Begrifen)* (Berlin: Deutsches Institut für Normung, 1993)

Duijsens, R. *Education in Tanzania - sector review* (Eindhoven: Eindhoven University of Technology, 1995)

Emans, B. *Interviewen - theorie, techniek en training* (Groningen: Wolters-Noordhoff, 1986)

Gaillard, H. *Industrial organizations in developing countries - a measuring instrument for research and evaluation* (Eindhoven: Eindhoven University of Technology, 1991)

Gleeson, D. *Training and its alternatives* (Milton Keynes, 1990)

Goodlad, J. *What schools are for* (Bloomington: Peacock, 1979)

De Groot, A.D. *Begrip van evalueren* (Den Haag: VUGA, 1986)

Hammond, R.L. *Evaluation at the logical level* (Belmont: Wadsworth, 1973)

Kalpakjian, S. *Manufacturing, engineering and technology (second ed.)* (Illinois, 1992)

Kessels, J.W.M. and Smit, C.A. *Opleidingskunde - een bedrijfsgerichte benadering van leerprocessen* (Deventer: Kluwer Bedrijfswetenschappen)

Keuning, D. *Bedrijfskunde - bedrijfsontwikkeling en -beslissingsgebieden* (Houten: Stenfert Kroese/Educatieve Partners, 1989)

King, K. *Aid and educational research in developing countries - the role of donor agencies in the analysis of education* (Edinburgh: Edinburgh University, Centre of African Studies, 1988)

Lauglo, J. and Lillis, K. *Vocationalizing education - an international perpective* (Oxford: Pergamon Press, 1988)

Lapperre, P.E. *Man, technology, society and development: from the hunters and gatherers to the first industrial revolution 3.5 million years ago until 1760 BC* (Eindhoven: Eindhoven University of Technology, 1993)

Lapperre, P.E. *Problems of developing countries in institutional perspective* (Eindhoven: Eindhoven University of Technology, 1993)

Lapperre, P.E. *Technologie, maatschappij en ontwikkeling - sociologische inleiding* (Eindhoven: Eindhoven University of Technology, 1996)

Maliyamkono, T.L. and Bagachwa, M.S.D. *The second economy in Tanzania* (Nairobi: Heinemann Kenya: 1992)

Masuha, J., Mutagahywa, B. and Nyichomba, B. *Phase I of Development of Improveed Production Systems (DIPS) - the TDP Project* (Dar es Salaam: University of Dar es Salaam, 1992)

Mendenhall, W. and Sincich, T. *Statistics for engineering and the sciences* (New York: Collier McMillan, 1988)

Ministry of Science, Technology and Higher Education *Higher and technical education statistics in Tanzania* (Dar es Salaam: Ministry of Science, Technology and Higher Education, 1994)

Ministry of National Education *Basic facts about education in Tanzania* (Dar es Salaam: the Ministry of National Education, 1980)

Ministry of Education and Culture *Wizara ya elimu na utamaduni takwimu za schule za sekondari Tanzania* (Ministry of Education and Culture, 1995)

Riddell, A. *The evidence on public/private educational trade-offs in developing countries* in *International Journal of Educational Development, Vol. 13 No. 4* (London: Pegamon Press, 1993)

Romiszowski, A.J. *Designing Instructional Systems - decision making in course planning and curriculum design* (London: Kogan Page, 1981)

Romiszowski, A.J. *Designing Instructional Systems* (London: Kogan Page, 1984)

Syrimis, S. *Sector review: the financing of education in Tanzania* (Paris: Unesco Educational Financing Division, 1988)

Szirmai, A. *Ontwikkelingslanden - dynamiek en stagnatie* (Groningen: Wolters-Noordhoff, 1994)

Van Tilburg, P. and Bertholet, G. *Technology for developing countries* (Eindhoven: Eindhoven University of Technology, 1992)

Todaro, M. *Economic development in the third world* (New York: Longman, 1992)

Weisberg, H.F. and Bowen, B.D. *An introduction to survey research and data analysis* (San Francisco: Freeman, 1977)

WorldBank Education in Sub-Saharan Africa: policies of adjustment, revitalization and expansion (New York: WorldBank Publication, 1987)

Van der Wolff, A.C.H., Kals, J.A.G. and Hijink, J.A.W. *Orientatie productietechniek A en B* (Eindhoven: Eindhoven University of Technology, 1988)

Worthen, B.R. and Sanders, J.R. *Educational evaluation - alternative approaches and practical guidelines* (New York: Longman, 1987)

APPENDIX A

THE STRUCTURE AND ORGANIZATION OF EDUCATION IN TANZANIA[71]

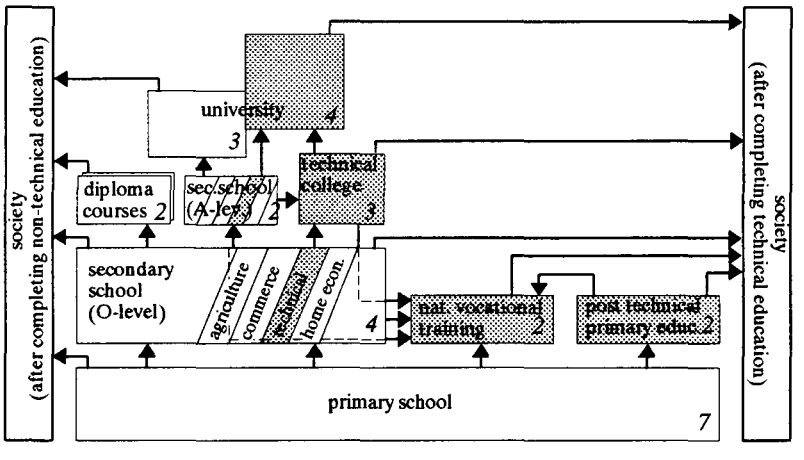
1 INTRODUCTION

The Tanzanian formal educational structure can, with respect to the duration of the various typres of schools, be characterized by *7-4-2-3+*. Pupils begin their enrolment with seven years of primary education (Standard I-VII). Secondary education consists of four years at Ordinary level (O-level, Form 1-4), followed by two years of Advanced level (A-level, Form 5-6). After this, students can enroll in various forms of higher education, whith a duration of at least 3 years.

Apart from the formal system, students can enroll in vocational education and training, which is closer associated with the acquisition of skills. Its admission requirements vary, but all take primary school as a minimum condition.

Based on this, the structure of the education system in Tanzania is schematically presented below.

figure 15: schematic review of the education system in Tanzania



Source: Ministry of Education and Culture, 1980, 1993; Van Dam, A., 1990; Duijsens, R., 1995
(Note: shaded areas refer to technical education)

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71 This appendix is a summary of chapter 2 of Duijsens, R. *Education in Tanzania - sector review* (Eindhoven: Eindhoven University of Technology, 1994, page 3-21)

In Tanzania, three ministries are responsible for educational matters:
- Ministry of Education and Culture (MEC), which supervises pre-primary, primary and secondary education, and teachers' training;
- Minstry of Science, Technology and Higher Education (MSTHE), responisble for higher education, both general and technical;
- Ministry of Labour and Youth Development (MLYD), under which supervision the National Vocational Training Centrers resort.

2 PRE-PRIMARY EDUCATION

This level of education is offered in kindergarten or nursery schools. Its aim is to provide education for children between 3 and 6 years, to promote cultural values in the traditional settings. To date pre-primary education is not institutionalized as there is no law or policy to guide it. However, this type of education is to be formally institutionalized, at least by the year 2000. At present, most fo the pre-primary schools are run by non-governmantal organizations (NGOs) and are mainly concentrated in urban areas. Parents pay for most of the costs and very few children of 3-6 year have access to this level of education.

3 THE ADMINISTRATIVE STRUCTURE OF PRIMARY AND SECONDARY EDUCATION (NATIONAL AND DISTRICT LEVEL)

3.1 MANAGEMENT AND ADMINISTRATION

The Minister for Education and Culture is the overall in-charge of the Ministry of Education and Culture. He is assisted by a Deputy Minister and has an advisory committee. The Minister's main responsibility is the promotion of the education of the people and and progressive development of institutions devoted to that purpose. He also is responsible for guiding the local authorities in the control, direction and effective implementation of the national education policy.

Down the line is the Principal Secretary who is the chief accounting officer and head of the civil service in the MEC. Under the Principal Secretary is the Commissioner for Education, who is the chief advisor on educational policy and practice. He coordinates all the academic departments of education and some parastatal organizations. Under him are also sections dealing with Media Education, Special Education, Guidance and Councelling, and Family Life Education. He is also responsible for the general management and administration of all government owned and aided schools.

The Ministry of Education and Culture has, with respect to education, several departments responsible for primary, secondary and adult education, teacher training, planning, and finance and administration. Its former departments of Higher Education and Technical Education have been transferred to the new Ministry of Science, Technology and Higher Education. Each department is headed by a Director, except for the Inspectorate which is headed by the Chief Inspector of Schools.

In the regions and districts there are Regional Education Officers (REOs) and District Education Officers (DEOs) who are the chief administrators and managers of education at regional and district levels respectively. They are professionally accountable to the Ministry of Education whereas administratively they are accountable to Regional Development Directors (in case of REOs) and District Executive Directors (for the DEOs).

The Ministry of Education and Culture is responsible for both pre-primary and primary education for policy formulation, curriculum and training of teachers. The Local Education Authorities are responsible for administration and management. The Central Goverment is responsible for the management of public secondary schools, teacher training as well as the universities. Private education institutes are run and managed by the owners, according to guidelines and regulations issued by the MEC.

The management and administration of primary education is partially decentralized. The Ministry of Education and Culture (MEC) is responsible for curricula, training of teachers (pre-service and in-service) and liasses with the Ministry of Finance and the Planning Commission for budgetary purposes, and Regional Administration and Local Governments in the Prime Minister's Office for administrative matters and resource mobilization.

The Regional Education Officers (REOs) and the District Education Officers (DEOs) are professionally responsible to the MEC while administratively they belong to decentralized structure. They are key figures in the primary education management. They are administratively responsible for the schools in their respective areas, in seeing to it that the schools are well staffed and all educational matters are being implemented as directed by the Ministry. In practice, however, the REOs and DEOs are not very effective managers, due to lack of superior support and lack of personal committment. As for the primary sector the inspectorate for the secondary education is centralized at the headquarters of the seven zones . Like their collegues at primary level, they evaluate the teaching of the various subjects, general administration of the educational institutions, financial management, and other matters relating to the institutions' organization.

An important parastatal under the MEC is the Tanzania Institute of Education (TIE), formerly known as the Institute for Curriculum Development (TIE). The TIE is responsible for developing curricula used in pre-primary and primary education, as well as in secondary education, teacher training colleges and technical colleges. (Institutions of higher learning are autonomous in curricula and examinations.) To fulfill this role the TIE operates through panels comprising teachers from the field, Ministry experts and specialists from the University of Dar es Salaam. The panel discusses and divises sylabi, curricula, textbooks and teachers' guides, which subsequently are being submitted for approval by the MEC.

Finally, to evaluate the teaching of the various subjects, general administration of the educational institutions, financial management, and other matters relating to the institutions' organization, the Ministry has employed 'school inspectors', who function at district level. They report to assistant chief inspectors at zonal level, where secondary and teacher education are centered. There are seven educational zones (Eastern, Southern, Westrn, Northern, Highland, Lake, and Central), each of them consisting of two (Central) or three (rest) districts. The zonal chief inspectors report to the Chief Inspector of Schools at MEC.

3.2 STRUCTURES AND METHODS OF EDUCATIONAL PLANNING

The Ministry of Education and Planning incorporates a planning directorate, which is responsible for the preparation, implementation and evaluation of short, medium and long term plans. To discharge these functions the department is divided into six sections: Sectoral Planning, Projects Implementation, Statistics, Policy Analysis and Review, Coordinating Unit for Research and Evaluation (CURE) and Book Management Unit.

Once a policy has been made, then projections need to be made of the number of education recipients at various levels and of the resources needed to meet the corresponding requirements. Data on a number of variables are collected from school level, either via theREOs and the DEOs (pre-primary and primary schools) or direct (secondary schools).

Once all the necessary data have been collected, the Planning Department liases with the Planning Commission of the President's Office and with the Ministry of Finance for financial implications. With respect to manpower allocation and training purposes, the Planning Department cooperates with Civil Service. Finally, for administrative matters and resource mobilization, it is in close contact with the Prime Minister's Office which houses regional administration and local governments.

Until recently, educational planning was guided largely by manpower requirements in the various (economic) sectors, known as a system of rationing. In paragraph 2.6.7, the results of this system will be discussed in more detail. Due to pressure of parents for more schooling for their children, social demand has to be taken into account. Educational planning has been inhibited by unreliable data, lack of qualified personnel and other factors beyond the planners' control (cultural inhibitions and a general lack of interest for education amoung some groups in society, changing population growth trends and the rapid changing global economic, technological and political climate).

4 PRIMARY EDUCATION

4.1 CURRICULUM AND EXAMS

Primary education starts at the age of 7 for a period of seven years, i.e. Standard I to Standard VII, and enrolment is (officially) compulsory for every child between 7 and 13. Its curriculum is centralized, and it comprises 13 different subjects, which, per week, have the following allocation:

table 1: primary school subjects and allocation of periods per week

subject	allocation of subjects per standard						
	I	II	III	IV	V	VI	VII
mathematics	9	9	7	7	7	7	8
science	-	-	2	3	3	3	3

subject	allocation of subjects per standard						
	I	II	III	IV	V	VI	VII
agricultural science	-	-	-	-	2	2	2
home economics	1	1	2	2	2	2	2
georaphy	-	-	2	2	2	2	2
history	-	-	-	-	2	2	2
political education	-	-	1	1	2	2	2
English	-	-	6	6	6	6	6
Kiswahili	12	12	8	8	7	7	7
religion	2	2	2	2	2	2	2
music	2	2	1	1	1	1	1
arts and craft	2	2	2	2	2	2	2
physical education	2	2	2	2	2	2	2
total periods per week	30	30	35	35	40	40	40

Source: Ministry of Education and Culture, 1983

For all subjects, except English, the medium of instruction is Kiswahili.

For Standard I-III, annual promotion to the next grade does not depend on scholastic achievement. From Standard III-IV onward, a teacher may recommend repetition. At transition from Standard IV-V an examination (measuring the mastery of mathematics, reading and writing) may compel one to repeat. In all cases, the District Education Officer should permit such repetition. At the end of Standard VII pupils sit for a Primary School Leaving Examination (PSLE). Although supposedly evaluative of the curriculum, the test items are mainly cognitive in mathematics, general knowledge and the languages; affective and psychomotor domain variables are left out.

The differences between these types of teacher will be discussed in paragraph 2.9. The MEC is committed to staff all primary schools with Grade A and Diploma teachers in order to improve the quality of teaching at these schools.

4.2 Management and Administration (Local Level) of Primary Education

At a school level, a primary school is headed by a headteacher, who reports to the DEO on all academic and professional matters and to the local school education committee for issues like management problems, classrooms, teachers' houses and disciplinary problems. By and large the communities are made to be involved in school matters. Their involvement, however, is marginal as they do not have control over the teachers and the curriculum. Each school is supposed to have at least some Grade A teachers to teach in the upper classes,

although at some rural schools this intention cannot be met.

5 POST PRIMARY TECHNICAL EDUCATION AND NATIONAL VOCATIONAL TRAINING

At post primary technical education, pupils are trained for artisans during a two year course. After this, they may decide to work in society, or to enter National Vocational Training (NVT). A course at one of the NVT centres lasts for two years. Some courses take two years at a voactional training centre, whereas other courses may take one year at a vocational training centre and one year in industry. After finishing NVT succesfully, pupils will have completed Trade Test 3. After several years of working experience, they may return to NVT to pass their Trade Test 2 and subsequently Trade Test 1, each with a duration of one year.

6 SECONDARY EDUCATION

6.1 CURRICULUM AND EXAMS

According to the aim to equip students with skills and knowledge, especially scientific and technical, the curriculum is diversified so that they are voactionally oriented. For this, there are four biases: *agiricultural, commercial, technical* and *home economics.* Most secondary schools focus on one of the four biases, and therefore there are for example technical secondary schools or agricultural secondary schools. The purpose of having the various biases is to help students learn some useful knowledge and skills, reduce school costs, develop positive attitudes towards manual labour and to participate in productive activities such as emphasized in Education for Self-reliance. Most of the students take agriculture, followed by commerce. Fewer students take the technical bias, since equipment required in technical schools is very costly and (therefore) scarce. Home economics is sex-biased: it is 100% female.

The subjects that are offered in the different biases are shown below:

table 15: secondary school subjects and allocation of periods per week (Form I-IV)

subject	Form 1 & 2	Form 3 & 4			
		agriculture	home econom.	commerce	technical
Kiswahili	3	3	3	3	3
English	5	5	5	5	5
mathematicas	6	6	6	6	6
biology	3	4	4	4	-
geography	3	-	-	3	-
history	2	-	-	-	-

subject	Form 1 & 2	Form 3 & 4			
		agriculture	home econom.	commerce	technical
chemistry	3	4	4	-	4
physics	3	-	-	-	4
political education	2	2	2	2	2
religion	2	2	2	2	2
agricultural science	8	10	-	-	-
home economics	8	-	10	-	-
commerce*	8	-	-	14	-
technical subjects	12	-	-	-	19
self -reliance	10	10	10	10	10
sports and games	2	2	2	2	2

* Commerce subjects are *commerce, book-keeping* and *typing*. A student selects two subjects from these (2 x 4 hours at Form 1 & 2 and 2 x 7 hours at Form 3 & 4).

Note: each period is 40 minutes long except in self-reliance and in sports, where duration is in hours. Home economics is compulsory to girls in Form 1 & 2 but optional to boys.

The above mentioned subjects are compulsory. Optional subjects are listed below:

subject	Form 1 & 2	Form 3 & 4			
		agriculture	home econom.	commerce	technical
physical education	3	3	-	3	3
physics*	-	4	4	4	-
chemistry*	-	-	4	4	-
foreign languages	3	3	3	3	-
music	3	3	3	3	3
woodwork/metal work	3	-	-	-	-
home economics	3	3	-	3	-
additional mathematics	-	4	4	4	-
geograpghy	-	3	3	-	-
history	-	3	3	3	-
biology	-	-	-	-	4
art	3	3	3	3	3

* At least 70% of the students taking agriculture, commerce or home economics biases must take physics. Also at least 70% of the students taking commerce must take chemistry.

Source: Ministry of Education, 1986; Van Dam, A., 1990

At the end of Form 4, nine subjects are being examined, depending on the student's chosen bias: Kiswahili, English, political education, mathematics, biology, geography, history, chemistry, physics, literature, French, home economics (craft and kooking), and commerce. Exams are in English.

Students who pass their Form 4 exams and who continu secondary education will pass to Form 5, i.e. A-level. Since the exams are in November and the results are publiced in March or April, there is a gap of six months: primary schools and secondary schools (O-level) follow 'calendar years', while from secondary schools (A-level) onwards, a school year lasts from July until May.

At A-level, education is primarily aimed at preparation for university courses. Students have to follow combinations of both social and exact subjects, which are indicated in table 4.

The language of instruction at secondary school is English, with the exeption of Kiswahili and Political Education, where Kiswahili is used. Given the fact that Kiswahili is used as a medium of instruction at the primary level, and English being a foreign language to the majority of the Tanzanians, the use of English as a medium of instruction at secondary schools is often discussed. Most of the students find it difficult to follow instructions given in English, and even some of the teachers have problems in using the language while teaching. However, the government has decided to continue the use of English, becasue of its international usefulness and due to the fact that most of the leading scientific and technological literature is in English.

table 16: subjects in the different biases of secondary education (Form 5 & 6)

subject	Form 5 & 6		subject	Form 5 & 6	
	social	exact		social	exact
Kiswahili	8	-	mathematics	10	10
English	8	-	physics	-	10
French	8	-	chemistry	-	10
geography	8	8	biology	-	10
history	8	-	agricultural science	-	10
economics	8	-	textile	-	10
book-keeping	8	-	nutrition	-	10
commerce	8	-	political education	4	4
educational science	8	8	applied mathematics	4	4

Source: Ministry of Education, 1986; Van Dam, A., 1990

6.2 MANAGEMENT AND ADMINISTRATION (LOCAL LEVEL) OF SECONDARY EDUCATION

The public schools are managed by the Commissioner for education from MEC. The heads of schools deal directly with the Ministry, bypassing DEOs and REOs who are in charge only of basic (i.e. primary) education. For both public and private schools, each school has its own manager. The head of each school will report directly to the manager/owner. The owner may issue directions as he deems benefitting to the school(s). The two managements (private and public) do not have a formal structure (e.g. at MEC) through which they can meet.

Each school is supposed to have a School Board which has advisory functions with particular aspects relating to the management and conduct of the school. They are mainly active when a school is facing some crisis, e.g. shortage of classrooms.

7 TECHNICAL COLLEGES

Pupils who, after following the technical bias of secondary education, pass Form 4 may enter a technical college, whith a duration of three years. After successfully passing their exams, these students are given a Full Technician Certificate. Technical colleges are in Dar es Salaam, Arusha and Mbeya. Apart from these FTC-courses, the Dar es Salaam Technical College also offers an Advanced Diploma in Engineering (ADE)- course, the level of which is fairly equal to B.Sc. (albeit more practically oriented). The FTC-courses at these three colleges are presented in table 17.

table 17: courses at technical colleges

course	Dar es Salaam	Arusha	Mbeya
civil engineering	x	x	x
architectural engineering			x
electrical engineering	x	x	x
automation engineering		x	
telecommunication eng.	x		
laboratory engineering	x		
mechanical engineering	x	x	x

Source: Bureau of Statistics, 1992

8 TEACHERS' EDUCATION

There are several categories of teachers at the primary, secondary, college and university level, who should meet the following qualifications:

table 18: teacher training programmes

entry qualification	period of professional training	level of teaching and professional qualification
primary school leaving certificate	-3 years on-the-job training -Distance Teacher Training Progr.	Primary education teacher - Grade C
primary school leaving certificate	-4 years full-time courses at a residential teacher training college	Primary education teacher - Grade B
certificate of secondary education	-2 years residential course	Primary education teacher - Grade C
advanced certificate of secondary education (A-level)	-2 years residential course	secondary and college teacher - Diploma in Education
certificate of secondary education with good passes for entry into Form V	-3 years taken currently with A-level studies	secondary and college teacher - Advance Certificate of Sec. Educ. and Diploma in Education
Grade A certificate, 3 years of working experience, A-level passes	-2 years upgrading course	secondary and college teacher - Diploma in Education
A-level passes for entry into university	-3 years university course with education	secondary and college teacher - BA or BSc degree with education
General BA or BSc degree	-1 year university postgraduate diploma in education	secondary and college teacher - Post-graduate diploma in education
Ba or BSc with education, or B.Ed.	-2 years MA/MSc or Med. degree course	second., college, university teacher - Ma/MSc or MEd degree in educ.

Source: Van Dam, A., 1990

The MEC has developed correspondence courses for Grade B and Grade C teachers, in order to upgrade their academic and professional level of teaching at primary schools.These courses are are part of the Distance Teacher Training Programme (DTTP). These courses bring the teacher to the level of Form 2 education (called Stage 1). Those who complete this stage go to college for one year and sit for the Ordinary level exams. After this second phase those who qualify go back to college for one year professional training to qualify as Grade A teacher. Other teachers from the Grade B and Grade C category go straight to college for a one year Grade A course, after having passed the ordinary level (Form 4) examination as private candidates.

In primary education, about 30% of the school teachers have the Grade A qualification, and about 60% have the Grade C qualification. The Grade B qualification teachers form a minority, and the pre-service training of this type of teachers is planned to be phased-out. To meet the growing demand for Grade C teachers, the MEC has introduced the non-residential training, where trainees spend six weeks in residential colleges and the rest of the time attend on-the-job training.

With respect to secondary education, university graduates teach the upper classes of the system while diploma holders should teach O-level classes. However, due to a sharp increase in the number of secondary schools and a limited number of qualified teachers, the demand for teachers is very high. Consequently, the majority of the teachers in public schools are professionally ranging from degree holders to a few exceptionally good Grade A teachers who teach at Form 1 and Form 2 level. Especially private schools are affected by the shortage of qualified teachers, and they are compelled to recruit less qualified and often uncertified teachers. Also in-service training to teach and update necessary teaching knowledge and and skills is irregular.

9 UNIVERSITY EDUCATION

Tanzania has three academic centres: the University of Dar es Salaam, the Muhimbili College of Health Science (Dar es Salaam) and Sokoine University of Agriculture (Morogoro), the latter named after the late Tanzania Prime Minister, Edward Sokoine. A non-technical course at university last for three years, wheras a technical course has a duration of four years.

table 19: courses at universities

University of Dar es Salaam		Sokoine University of Agriculture	Muhimbili College of Health Science
Bach. of Arts (general)	Bach. of Science (with education)	Bach. of Sc. in Agriculture	Doctor of Medicine
Bach. of Arts (with education)	Bach. of Sc. in Geology	Bach. of Sc. in Forestry	Doctor of Dental Surgery
Bach. of Education	Bach. of Sc. in Engineering	Bach. of Sc. in Home Econom. and Human Nutr.	Bach. of Sc. in Pharmacy
Bach. of Commerce	Bach. of Laws	Bach. of Sc. in Vetrinary Medicine	Bach. of Sc. in Nursing
Bach. of Computer Sciences		Bach. of Sc. in Food Science and Technology	
Bach. of Science (general)		Bach. of Sc. in Agric. Engin.	

Source: Ministry of Science, Technology and Higher Education, Tanzania, 1995

APPENDIX B

SELECTED METAL WORKING PROCESSES

The selected metal working processes can be classified as follows:

table 20: metal working processes according to DIN 8580

group 2	**group 3**				**group 4**			**group 5**
forming	removing				joining			coating
	chipping mechanical	chipping non-mechanical	non-chipping cutting mechanical	chemical	reversible	semi-reversible	non-reversible	
forging rolling pressing extruding bending forcing	milling sawing boring planing grinding	spark-erosion fire-cutting jet-cutting plasma- and laser cutting	cutting punching shortening	etching electrolitical polishing	clasping screwing	riveting (stapeling) winding soldering	welding	laqcuering vulcanising carbonizing galvanising pack-coating enameling

source: 'DIN Pocketbook 241', 1993

APPENDIX C

DETERMINING THE SAMPLE SIZE

For determining the sample size (n) for each combination of company size, metal working proces and level of education, two aspects are important[72]:

- the confidence interval, which determines the probability that the random interval will contain the estimated value; if repeatedly a sample size n from the population is collected with an x% confidence interval for each sample, then it can be expected that x% of the intervals will enclose the true value. In case the population has a normal distribution (which can be assumed when $n \geq 30$), with a mean μ and a standard deviation σ, the confidence interval is determained by a z-value. The normal distribution can be translated to a standard normal distribution by translating the population mean to $\mu=0$ and the standard deviation to $\sigma=1$. In that case, 50% of the population is situated below 0, and 50% above 0, and the z-value indicates the value at both sides of 0 where the bottom and top x% is situated. In case the confidence interval should be 10% (i.e. 5% at each side) these values are +1.96 and -1.96, and therefore $z=1.96$.
- the proportion p, which indicates the proportion of the population with a specific characteristic (the population proportion that is attempted to be estimated), and the proportion q, which indicates the remaining part of the population. By definition $p+q=100\%$, or as a proportion of 1: $p+q=1$, and thus q equals $1-p$.

By definition, a confidence interval for a population proportion p can be determined by the formula

$$p=p_s \pm z\sqrt{\frac{p_s q_s}{n}}$$

in which p_s is the sample proportion of observations with the characteristic of interest, and $q_s=1-p_s$. Since n is then determined by the desired confidence-interval (i.e. z), and by p_s and q_s, the desired confidence interval is the main determinant of n. In a formula, in which x represents the desired fraction of the confidence-interval (e.g. a confidence interval of 95% means $x=0.05$), this is presented below:

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72 Mendenhall, W. and Sincich, T. *Statistics for engineering and the sciences (3rd ed.)*(New York: Collier McMillan, 1988, page 299-300)

$$x=z\sqrt{\frac{p_s q_s}{n}}$$

From this formula, n can be determined by transforming n into the dependent variable:

$$n=\frac{p_s q_s}{(x/z)^2}$$

Since both p_s and q_s are to be determined by the survey and therefore beforehand unknown, the most conservative value for $p_s q_s$ is when $p_s=q_s=0.5$, and consequently $p_s q_s=0.25$. The information to be measured will be of qualitative origine, mostly on a nominal or ordinal scale[73], and therefore the confidence interval does not need to be very large. A 80% confidence interval (which means that the estimates for a population fraction p are $p_s \pm 10\%$) will fit for this purpose. The corresponding z-value for a 80% confidence interval is 1.28, resulting in a sample size of at least 11 for each combination of educational level, metal working process and company size.

[73] Data on a nominal scale have no (numeric) order and are mutally exclusive. Variables on a ordinal scale are categories with intrinsic order but without intrinsic numerical properties. Adapted from: Weisberg, H.F. and Bowen, B.D. *An introduction to survey research and data analysis* (San Fransisco: Freeman, 1977, page 125-126)

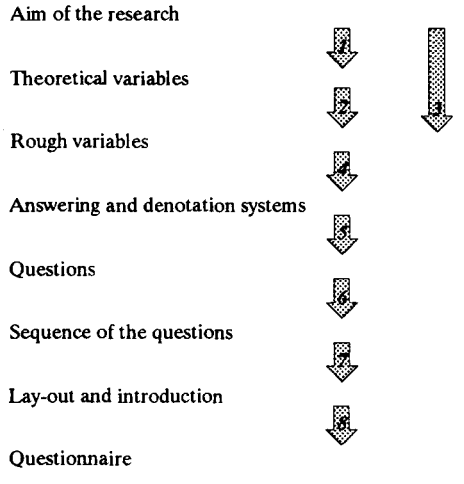
APPENDIX D

DESIGN OF THE SURVEY

1 INTRODUCTION

In order to be comprehensive, the survey will be drawn up according to the following scheme[74]:

figure 16: sequence in drawing-up the survey



Source: Emans, B. (1986)

2 DEFINITION OF THE THEORETICAL VARIABLES

The aim of this particular part of the research is to determine the presence and level of skills of workers in the metal working industry in Tanzania.

The research questions for this are:
1 What is the level of skills amoung workers in the metal working sector?
2 Does the presence of these skills depend on the size of the company in which the worker is employed?

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74 Emans, B. *Interviewen - theorie, techniek en training* (Groningen: Wolters-Noordhoff, 1986, page 95-130)

3 Does the presence of these skills depend on the level of education of the worker?
4 Does the presence of these skills depend on the sort of metal working process in which the worker is employed?

The population that will be investigated is: technically educated employees in the metal working sector (ISIC 3.8) in Tanzania. On basis of availability of companies and of the preference of the commissioner of this research, the population will be restricted to metal working companies in the Dar es Salaam region which recently have contributed to the DIPS-research of the University of Dar es Salaam.

On basis of the above, the following variables and their possible values can be listed:

table 21: theoretical variables and their possible values

theoretical variable		possible values
1	skills	fully present to fully absent, with all intermediate values
2	company size	from smallest to largest present
3	educational level	all levels of technical education in Tanzania
4	metal working process	all metal working processes in ISIC 3.8

3 FROM THEORETICAL VARIABLES TO ROUGH VARIABLES

The theoretical variables in their present form cannot be adequately measured. They need to be translated into rough variables, which represent the theoretical variable and which can be measured.

3.1 SKILLS

In the main text, the different skills have been listed and defined. For reason of completeness, these skills are listed here again:
1.1 cognitive skills (reproductive);
1.2 cognitive skills (productive);
1.3 psychomotor skills (reproductive);
1.4 psychomotor skills (productive);
1.5 reactive skills (reproductive);
1.6 reactive skills (productive);
1.7 interactive skills (reproductive);
1.8 interactive skills (productive).

A more extensive discussion of the various skills can be found in paragraph 4.3 of the main text.

In order to measure skills, the representing variables should refer to either 'actual behaviour' or 'intended behaviour'. The reason for this is to present well known situations in which the respective skills are applied: examples of situations in which the use of skills is necessary. Practical, well-known situations are easy imaginable and subsequently demand less explanation, thus reducing the risk of mis-interpretations and of non-valid answers.

The situation should refer to all metal working processes within ISIC 3.8 and should, therefore, be stated in general terms, independent of the respective processes. For this a flow chart is constructed in which the different (general) phases of a metal working process can be determined. Subsequently, the general process can be divided into several phases, all of them consisting of several interrelated activities. Schematically, the flow chart can be presented as follows:

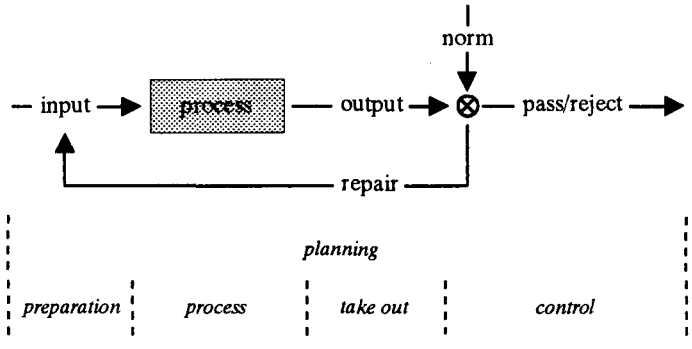

figure 17: flow chart of a metal working process

The activities of the different phases are listed below:

table 22: phases and activities of a metal working process

phase	activity	cognitive skills	psycho-m. skills	interactive skills	reactive skills
planning	determine production characteristics	x		x	
preparation	making drawing	x			
	reading drawing	x			
	chosing process (sequence)	x		x	
	chosing material	x			
	adjusting machine/tools	x	x		
	placing material		x		x
process	operating machine/tools		x	x	
	supervising process	x			

phase	activity	cognitive skills	psycho-m. skills	interactive skills	reactive skills
take out	switching off machine and taking out product		x	x	
control	judging product	x		x	
(additional)	providing power supply		x	x	
	maintenance and repair	x	x	x	

Note: several cells, representing interactive skills and reactive skills, cover two or more activities (e.g. interactive skills during the preperation phase cover all activities of this phase)

With respect to this listing, several remarks can be made:
- 'providing power supply' and 'maintenance and repair' have been added to the list of activities for reasons stated in paragraph 3.3.3;
- since the scope of the research is limited to metal working processes, the design phase of a product is summarized under the activity 'making drawing';
- the occurance of the different skills (either 'reproductive' or 'productive') during the different phases has been indicated by a cross. The necessity for using cognitive or psychomotor skills may occur at activity level, while the interactive skills are not directly linked to activities and, therefore, occur per phase. The use of reactive skills surpasses the phase-level and is constantly present during the execution of the metal working process.

3.2 COMPANY SIZE

To indicate the company size, the representitative variable is the number of employees. This indicator is both easy to determine and has in other researches proved to be significant.

3.3 EDUCATION LEVEL

To indicate the educational level of the employee, the highest finished technical course should be listed. In order to determine the possible technical courses, the following scheme can be drawn up (see next page). Based on this scheme, a technically skilled worker working in 'production' can have completed one or more of the following forms of technical education:

1 post technical primary school;
2 national vocational training (resulting in 'Trade Test 1, 2 or 3' - TT 1, 2 or 3);
3 technical secondary school;
4 technical college (resulting in 'Full Technician Certificate' - FTC);
5 university (technically biased).

Since both national vocational training and technical college are also well-known by their diploma/ certificate, these should be mentioned as well.

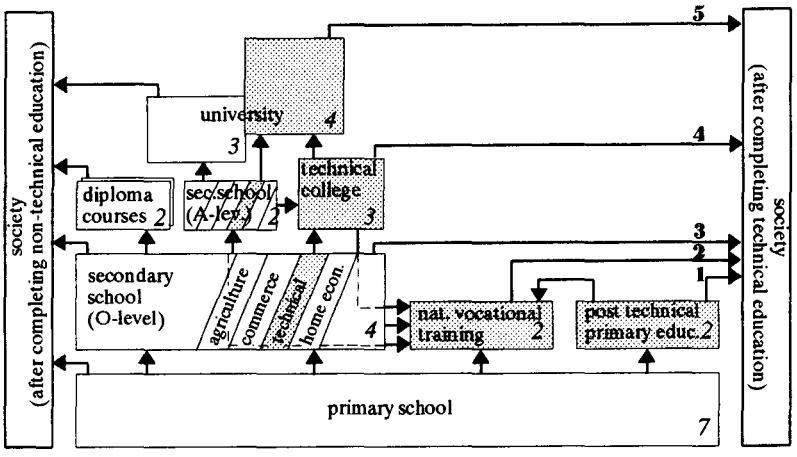

figure 18: technical courses in formal technical education
Source: Ministry of Education and Culture, 1986, Van Dam, A., 1990, Duijsens, R., 1995

3.4 METAL WORKING PROCESS

To indicate the metal working process in which the employee is mainly working, a distinct series of categories, based on DIN[75] norm 8580, can be listed, all of them existing within ISIC 3.8:

- table 23: metal working processes according to DIN 8580

group 2 forming	**group 3** removing				**group 4** joining			**group 5** coating
	chipping mechanical	chipping non-mechanical	non-chipping cutting mechanical	chemical	reversible	semi-reversible	non-reversible	
forging rolling pressing extruding bending forcing	milling sawing boring planing grinding	spark-erosion fire-cutting jet-cutting plasma- and laser cutting	cutting punching shortening	etching electrolitical polishing	clasping screwing	riveting (stapeling) winding soldering	welding	laqcuering vulcanising carbonizing galvanising pack-coating enameling

75 DIN - Deutsche Industrie Normen; Deutsches Institut für Normung e.V. *Genormte Begriffe Maschinenbau, DIN-Taschenbuch 241 (allgemeine Begriffen)* (Berlin: Beuth, 1993, page 100-103)

Based on this extensive overview, there are four distinct groups of metal working processes:
- forming;
- removing;
- joining;
- coating.

3.5 OVERVIEW

All variables, both theoretical and rough, can be listed as follows:

table 24: theoretical and rough variables and their possible values

theoretical variable	rough variable	possible values
1 skills	1.1 cognitive skills (reproductive)	fully present to fully absent, with all intermediate values
	1.2 cognitive skills (productive)	fully present to fully absent, with all intermediate values
	1.3 psycho-motorskills (reproductive)	fully present to fully absent, with all intermediate values
	1.4 psychomotor skills (productive)	fully present to fully absent, with all intermediate values
	1.5 reactive skills (reproductive)	fully present to fully absent, with all intermediate values
	1.6 reactive skills (productive)	fully present to fully absent, with all intermediate values
	1.7 interactive skills (reproductive)	fully present to fully absent, with all intermediate values
	1.8 interactive skills (productive)	fully present to fully absent, with all intermediate values
2 company size	2.1 number of employees	from smallest to largest number
3 educational level	3.1 highest level of technical education	post technical primary education, national vocational training (TT1,2or3), technical secondary school, technical college (FTC), university (technically biased)
4 metal working process	4.1 metal working process in ISIC 3.8	forming, removing, joining, coating

4 FROM AIM OF THE RESEARCH TO ROUGH VARIABLES

In order to process the data of the research, the list of variables should be extended with several 'technical variables'. With respect to the research entities (i.e. the metal working employees), it is decided not to question them personally, but to submit the questions to their direct superior. The reason for this is that the objectivity of the answers, and therefore the

validity of the results, will increase. Also it is expected that interpretation of the questions will cause less difficulty for these superiors, for it may be expected that their level of education surpasses the lowest ones. By doing so, it is also possible to question the presence of the skills of more than one employee per supervisor (more than one interview for one supervisor). Furthermore, since the interviewee's position (function) may very well depend on the company's size, both his name and his function will be asked for. Apart from the supervisor, the name of the company and of the employee(s) will be asked for, as well as the date of the interview. (Note: not all variables will be enclosed as questions in the survey, they may very well be determined by the interviewer).

These extra technical variables are listed as follows:

table 25: technical variables (theoretical and rough) and their possible values

theoretical variable	rough variable	possible values
5 company name	5.1 company name	-
6 supervisor	6.1 supervisor's name	-
	6.2 supervisor's function	-
7 employee	7.1 employee	-
8 date	8.1 date	-

5 FROM ROUGH VARIABLES TO ANSWERING AND DENOTATION SYSTEMS

5.1 SCALE

For the skill variables (1.1-1.8) as well as for the variables 'educational level' (2.1) and 'company size' (3.1) it is decided to chose *ordinal* variables. The remaining variables 'metal working process' (4.1), 'company name' (5.1), 'supervisor' (6.1-6.2), 'employee' (7.1) and 'date' (8.1) will be measured on a *nominal* scale[76].

5.2 ANSWERING CATEGORIES

It is decided to present the interviewee a fixed set of possible answers to chose from. There are several considerations to support this decision:
- the information does not need to be very specific;
- the information should be equal for all employees;
- the information has to be gathered within a short period;
- the interviewer and interviewee do not necessarily speak the same laguage.

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[76] Data on a nominal scale have no (numeric) order and are mutally exclusive. Variables on an ordinal scale are categories with intrinsic order but without intrinsic numerical properties - Weisberg, H.F. and Bowen, B.D. *An introduction to survey research and data analysis* (San Fransisco: Freeman, 1977, page 125-126)

Although a system of 'open questions' undoubtly has advantages, they do not outweigh the benefits of a system of fixed answer possibilities to chose from. It should be noted, however, that the technical variables (5.1, 6.1-6.2, 7.1 and 8.1) are open questions and, therefore, have no fixed answers.

For measuring the skill variables (1.1-1.8), the answers will range from 'fully present to fully absent, with all intermediate values', as indicated in the earlier tables. With respect to the different answering categories, it is decided to expose only the extremes. Since measuring skills (and with this also knowledge, as is described in paragraph 4.3) is the prime aim of this questionnaire, it is important to leave room for the interviewee to express his personal view on shortcomings in skills and knowledge. This will be done by means of an open question. For the variables (2.1), (3.1) and (4.1) all answering possibilities will be listed. Since these do not depend on the question's formulation, the answering categories can already be named:

2.1	educational level	- post technical primary education; - national vocational training (TT 1, 2 or 3); - technical secondary education; - technical college (FTC); - university (technically biased);
3.1	company size	- ≤10 employees; - 11-99 employees; - ≥100 employees[77a];
4.1	metal working process	- metal forming; - metal removing; - metal joining; - metal coating.

The answering possibilities for the skill variables (1.1-1.8) very much depend on the formulation of the question and will, therefore, be drawn-up simultaneously. (The reason for this will be discussed in paragraph 6.2 of this appendix.) For the remaining variables, which will be measured on basis of 'open questions', the possible answers will by definition not be presented.

The fixed answering categories (for the variables 1.x, 2.1 and 4.1) will be complemented by two other, distinct categories. The first will be the category 'no meaning', the second will be 'not applicable'. The latter referring to possible situations in which, for any reason, measuring of the variable will not possible. With respect to measuring the skill variables, apart from these last two categories, the range from 'fully present' to 'fully absent' will comprise four alternatives. The reasons to chose this even number is twofold. Firstly, the interviewee will be forced to chose between 'present' or 'absent', for it will now be impossible to chose a safe middle category. (It can be argued that, at a 5-point scale, the choice for the middle category is socially determined[4b]. For this reason no pre-test has been conducted with respect to the number of answering categories.) Secondly, the chance of confusing an intermediary category

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77 Gaillard, H. *Industrial organizations in developing countries - a measuring instrument for research and evaluation* (Eindhoven: Eindhoven University of Technology, lecture notes, 1991, page 9[a], and lectures[b])

with 'no meaning' (although the risk for this to occur is small, since this category has already been attended to).

The remaining variables will be measured with the use of open questions. In order to avoid resemblance with a job evaluation or rating, the variable 'employee' will be noted as a number, rather than a name, since the intention of the variable 'name' is merely to make each respective questionnaire distinct - 'employee' will serve as a unique number for each questionnaire. For the variable 'supervisor', however, a name will be asked for, in order to be able to trace the respective person within the respective company in case of indistinctness in retrospect.

On basis of these considerations, the following table can be constructed:

table 26: variables, scales, types of question and answering categories

variable	scale	type of question	answering categories
1.x skills	ordinal	closed	4, from fully present to fully absent, plus 2
	nominal	open	-
2.1 educational level	ordinal	closed	5 (post technical primary education, national vocational training, technical secondary school, technical college, university (technically biased)), plus 2
3.1 company size	ordinal	closed	3 (≤10, 11-99, ≥100 employees)
4.1 metal working process	nominal	closed	4 (forming, removing, joining, coating), plus 2
5.1 company name	nominal	open	-
6.1 supervisor's name	nominal	open	-
6.2 supervisor's function	nominal	open	-
7.1 employee	nominal	open	- (unique number)
8.1 date	nominal	open	-

Before the respective answers will be crossed or filled in, the interviewee should be instructed on the way this should be done. For all closed questions, one (and no more than one) answer should be crossed. For the open questions, the answer should be either a name or description (for the company and for the supervisor), a date, or a unique number (for the employee).

6 FORMULATION OF THE QUESTIONS

6.1 LANGUAGE

In the foregowing paragraph it has already been mentioned that the interviewer and the

interviewee do not necessarily speak the same language. It is tried to hold the survey in English, in order to enable the interviewer to assist with answering the questions. However, if the interviewee is unable to understand and/or to correctly interprete the questions, a Swahili formulated questionnaire will be necessary (although this will reduce the possibility of assistance further).

6.2 MEASURING SKILLS

For each activity, combined with one of the listed skills, two questions will be paired, one referring to 'productive skills' and one to 'reproductive skills'. In principle, there are two measuring points (situations) of interest for this. The first is when the worker is entering the firm after finishing education, the second is at present. This leads to a two by two combination model, presented below.

table 27: measuring points for skills

		measure point / situation	
		entering the present firm	at present, facing a new situation
type of skill	reproductive	a	c
	productive	b	d

Situation *a* refers to the ability to work with an existing process, for which a certain amount of basic knowledge is needed, but which largely consists of applying a known procedure which will lead to a known 'solution'. Situation *b* is rather difficult to measure, since a person, when entering a firm, usually is placed in a position where he can master the details of his new job, which in most cases will hardly include practising productive skills. Situation *c* refers to a situation where known procedures should be used to master an unknown situation (of which neither the process nor the outcome is known beforehand). This combination of situation and skill is not likely to occur or even to imagine. Situation *d* could very well indicate a worker's ability to adapt to a changing (new) situation of which the process or even the outcome is not beforehand known. Based on these considerations, situations *a* and *d* are most likely to indicate the worker's level of (re)productive skills and these two situations will be referred to for each question.

6.3 QUESTIONS

With respect to the skill variables, each question will refer to either a known situation or an imaginable ('new') situation - the former measuring a 'reproductive' skill, the latter measuring a 'productive' skill. It is decided to ask for a person's *ability* to perform in the respective situations, for this term is broad enough to appeal to the interviewee's understanding, but at the same time specific enough for the purpose. Furthermore, a question will be asked in

which the interviewee can express his personal view on shortcomings in skills and knowledge. To avoid interpretation problems, the question will ask after 'shortcomings of the educational institute'.

	very capable			not capable	no meaning	not applicable
- *How would you judge the person's capability to plan production characteristics..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the product is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to cooperate with other people (collegues, customers) in planning the production characteristics..*	very capable			not capable	no meaning	not applicable
..at the time he was entering your firm?	□	□	□	□	□	□
..at present?	□	□	□	□	□	□
- *How would you judge the person's capability to make a technical drawing of a new product, when all characteristics are given..*	very capable			not capable	no meaning	not applicable
..at the time he was entering your firm?	□	□	□	□	□	□
..at present?	□	□	□	□	□	□
- *How would you judge the person's capability to correctly interprete a technical drawing..*	very capable			not capable	no meaning	not applicable
..at the time he was enetering your firm?	□	□	□	□	□	□
..at present, given the product is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to correctly chose a proper sequence of production processes to produce a product..*	very capable			not capable	no meaning	not applicable
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the product is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to correctly chose the proper material to produce a product..*	very capable			not capable	no meaning	not applicable
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the product is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to correctly chose the proper machines or tools and processes to produce a product..*	very capable			not capable	no meaning	not applicable
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the product is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to correctly adjust a machine to produce a product..*	very capable			not capable	no meaning	not applicable
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the machine is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to correctly place material in a machine..*	very capable			not capable	no meaning	not applicable
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the machine is new to the person?	□	□	□	□	□	□

	very capable			not capable	no meaning	not applicable
- *How would you judge the person's capability to cooperate with other people (collegues) in reading a technical drawing, selecting machines and material and adjusting the machine..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present?	□	□	□	□	□	□
- *How would you judge the person's capability to correctly operate a machine/tool..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the machine/tool is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to supervise a working machine and possibly to decide that intervention and correction is needed..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the machine is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to cooperate with other people (collegues) in operating a machine and in supervising its working..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present?	□	□	□	□	□	□
- *How would you judge the person's capability to switch off the machine and to take out the finished product..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the machine is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to cooperate with other people (collegues) in switching off the machine and taking out the finished product..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present?	□	□	□	□	□	□
- *How would you judge the person's capability to judge the quality of the finished product, and eventually to decide to correct or reject it..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the product is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability to cooperate with other people (collegues) in judging the quality of the finished product, and eventually to decide to correct or reject it..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present?	□	□	□	□	□	□
- *How would you judge the person's capability to take the necessary action with respect to power supply for a machine or process..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the machine is new to the person?	□	□	□	□	□	□
- *How would you judge the person's capability in cooperating with other people (collegues) in taking the necessary action with respect to power supply for a machine or process..*						
..at the time he was entering your firm?	□	□	□	□	□	□
..at present, given the machine is new to the person?	□	□	□	□	□	□

- *How would you judge the person's capability to judge whether or not a machine needs maintenance..*	*very capable*				*not capable*	*no meaning*	*not applicable*
..at the time he was entering your firm?	□	□	□	□		□	□
.at present, given the machine is new to the person?	□	□	□	□		□	□
- *How would you judge the person's capability to carry out maintenance of the machine?*	*very capable*				*not capable*	*no meaning*	*not applicable*
..at the time he was entering your firm?	□	□	□	□		□	□
.at present, given the machine is new to the person?	□	□	□	□		□	□
- *How do you judge the person's capability in cooperating with other people (collegues) in judging whether or not a machine needs maintenance, and in the maintenance-process itself..*	*very capable*				*not capable*	*no meaning*	*not applicable*
..at the time he was entering your firm?	□	□	□	□		□	□
..at present, given the machine is new to the person?	□	□	□	□		□	□
- *How would you judge the person's attitude towards working in a metal working process at the time he was entering your firm?*	*very positive*				*very negative*	*no meaning*	*not applicable*
	□	□	□	□		□	□
- *How would you judge the person's attitude towards cooperating with other people (collegues) at the time he was entering your firm?*	*very positive*				*very negative*	*no meaning*	*not applicable*
	□	□	□	□		□	□
- *How would you judge the person's attitude towards safety measures at the workplace at the time he was entering your firm?*	*very positive*				*very negative*	*no meaning*	*not applicable*
	□	□	□	□		□	□

(With respect to the last two questions (aimed at measuring 'reactive' skills), these will be investigated by the employee's attitude towards working in a metal working process and towards cooperating with other people (collegues) and by enquiring about the employee's attitude towards safety measures at the workplace (the latter being empirically determined as being an important factor in carrying out a task succesfully and satisfactory[78]). Since both attitudes can be learned at the workplace over a period of time, the questions refer only to the moment the person was entering the firm.).

- *What are, to your opinion, the major shortcomings in the person's education?*

With respect to the variables 'educational level', 'company size', 'main metal working process', as well as the technical variable 'supervisor', the questions are listed below:

- *What is the person's highest completed level of technical education?*	*post primary technical education*	*national vocational training (Trade Test 1,2,3)*	*secondary school*	*technical college (Full Technician Certificate)*	*university*	*other*
	□	□	□	□	□	□

[78] Kraus, A *Development of a finance strategy for low cost housing in Tanzania with special emphasis on bamboo housing* (Eindhoven: Eindhoven University of Technology, 1995)

- *How many people work in this company?* ≤10 □ 11-99 □ ≥100 □

- *What is the main metal working process at which the person usually works?*

metal forming	*metal removing*	*metal joining*	*metal coating*	*no meaning*	*not applicable*
□	□	□	□	□	□

- *What is your name and function?*

The technical variable 'company name' and 'date' will be filled in beforehand or afterwards by the interviewer.

7 ARRANGING THE SEQUENCE OF THE QUESTIONS

In order to keep the worker's background in mind while answering the questions, the interviewee will be asked for this first. Therefore, the variables 3.1 (education) and 4.1 (metal working process) will be listed first. After this, the skill variables (1.1-1.8) will be measured. For reasons of clearliness, the order of the activities of the different phases, as well as the order of the phases themselves, will not be altered. Finally, the remaining variables will be measured in the sequence 2.1, 5.1, 6.1, 8.1. Variable 7.1 (the employee's 'number') will be filled in afterwards by the interviewer.

A critical remark should be made with respect to the distinct order of questions when measuring the skills variables. Placing the questions in the above mentioned order increases the risk of 'responce set': the series of questions has identical answering possibilities, which may lead the interviewee to tend to answer all questions by crossing more or less the same possibilities. After a series of 'positive' answers, the interviewee will be less inclined to cross a 'negative' answer. Although this may cause a real risk, the uniformity and the distinct sequence of questions prevail. It should be noted that changing the answering categories may have a negative impact, since the possibility of overseeing this by the interviewee is very likely to occur. Also it is believed that the contents of the questions rather differ, in which case the interviewee will be forced to concentrate on each distinct question. Furthermore, the different skills are spread over the different questions, which also causes the questions' contents to be rather different.

8 LAY-OUT AND INTRODUCTION

With respect to the lay-out, the survey will be divided into three parts:
a questions referring to the employee and the main metal working process;
b questions referring to the skills applied during the different activities and phases of the metal working process;
c questions referring to the company and the interviewed supervisor.

The notation of the questions, as well as the style, will be equal to paragraph 6.3.

The introduction should preferably be of limited length. It should, however, adress the following items:

- introduction of the interviewer and of the submitter;
- explanation of the aim of the interview and expected interview time;
- construction of the survey, criteria for the employee who should be taken as an example;
- empasizing the importance of 'unbiased' answering and the guarantee of confidentiality.

9 THE QUESTIONNAIRE

On basis of the foregoing paragraphs, the questionnaire can be drawn up in its final form.

Introduction

Two years ago, the Faculty of Engineering of the University of Dar es Salaam started a project called 'Development of Improved Production Systems' (DIPS), in which your company was one of the participants. Since our previous cooperation with your company has been very pleasant and useful, we would kindly like to ask for your cooperation again. In collaboration with the University of Technology of Eindhoven, the Netherlands, we are pleased to introduce Mr. Raimond Duijsens B.Sc. to you, who is currently working with us in the DIPS-project.

With this research, we are investigating the apperent misfit between technical education and metal working companies in Tanzania. We would kindly like to ask you to fill in the attached questionnaire, which will take no more than approxi-mately **ten minutes**. Throughout this questionnaire, you are requested to focus on one of your employees who has recently (until approx. 3 years ago) finished formal technical education, and who has since then worked for your company. He/she should be regarded as an example for artisans or technicians with the same educational background.

The questionnaire consists of three parts:
part 1: questions referring to the status of the employee,
part 2: questions referring to his functioning in a metal working process,
part 3: questions referring to characteristics of your company.

Most of the questions of part 2 consist of two parts. The first part refers to the time when the employee started working in your firm - how capable was he at that time? The second part is an imaginative situation: suppose the employee, at present, would be asked to produce a product which is new to him, or to operate a machine with which he has not worked before - how do you expect he would function in that situation?

We would like to stress that all answers will be kept in strict confidence, and will not be used for any other purpose than that stated above. It will not be given to any other person, University or Government official.

Thanking you in advance for your kind cooperation,

Prof. J.R. Masuha,
head of DIPS

part 1: status of the employee

1	*What is the person's highest completed level of technical education?*	*post primary technical education* ☐	*national vocational training (Trade Test 1,2,3)* ☐	*technical secondary school* ☐	*technical college (Full Technician Certificate)* ☐	*university* ☐	*other* ☐
2	*What is the main metal working process at which the person usually works?*	*metal forming* ☐	*metal removing* ☐	*metal joining* ☐	*metal coating* ☐	*no meaning* ☐	*not applicable* ☐

part 2: functioning of the employee

3	*How would you judge the person's capability to plan production characteristics..*	*very capable*			*not capable*	*no meaning*	*not applicable*
	..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
	..at present, given the product is new to the person?	☐	☐	☐	☐	☐	☐
4	*How would you judge the person's capability to cooperate with other people (collegues, customers) in planning production characteristics..*	*very capable*			*not capable*	*no meaning*	*not applicable*
	..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
	..at present?	☐	☐	☐	☐	☐	☐
5	*How would you judge the person's capability to make a technical drawing of a new product, when all characteristics are given..*	*very capable*			*not capable*	*no meaning*	*not applicable*
	..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
	..at present?	☐	☐	☐	☐	☐	☐
6	*How would you judge the person's capability to correctly interprete a technical drawing..*	*very capable*			*not capable*	*no meaning*	*not applicable*
	..at the time he was enetering your firm?	☐	☐	☐	☐	☐	☐
	..at present, given the product is new to the person?	☐	☐	☐	☐	☐	☐
7	*How would you judge the person's capability to correctly chose a proper sequence of production processes to produce a product..*	*very capable*			*not capable*	*no meaning*	*not applicable*
	..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
	..at present, given the product is new to the person?	☐	☐	☐	☐	☐	☐
8	*How would you judge the person's capability to correctly chose the proper material to produce a product..*	*very capable*			*not capable*	*no meaning*	*not applicable*
	..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
	..at present, given the product is new to the person?	☐	☐	☐	☐	☐	☐
9	*How would you judge the person's capability to correctly chose the proper machines or tools and processes to produce a product..*	*very capable*			*not capable*	*no meaning*	*not applicable*
	..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
	..at present, given the product is new to the person?	☐	☐	☐	☐	☐	☐

	very capable			not capable	no meaning	not applicable
10 *How would you judge the person's capability to correctly adjust a machine to produce a product..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
11 *How would you judge the person's capability to correctly place material in a machine..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
12 *How would you judge the person's capability to cooperate with other people (collegues) in preparing the production of a product, like for example reading a technical drawing together, selecting machines and material, and adjusting the machine(s)..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present?	☐	☐	☐	☐	☐	☐
13 *How would you judge the person's capability to correctly operate a machine/tool..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine/tool is new to the person?	☐	☐	☐	☐	☐	☐
14 *How would you judge the person's capability to supervise a working machine and possibly to decide that intervention and correction is needed..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
15 *How would you judge the person's capability to cooperate with other people (collegues) in operating a machine and in supervising its working..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present?	☐	☐	☐	☐	☐	☐
16 *How would you judge the person's capability to switch off the machine and to take out the finished product..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
17 *How would you judge the person's capability to cooperate with other people (collegues) in switching off the machine and taking out the finished product..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present?	☐	☐	☐	☐	☐	☐
18 *How would you judge the person's capability to judge the quality of the finished product, and eventually to decide to correct or reject it..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the product is new to the person?	☐	☐	☐	☐	☐	☐

	very capable			not capable	no meaning	not applicable
19 *How would you judge the person's capability to cooperate with other people (colleagues) in judging the quality of the finished product, and eventually to decide to correct or reject it..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present?	☐	☐	☐	☐	☐	☐
20 *How would you judge the person's capability to take the necessary action with respect to power supply for a machine or process..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
21 *How would you judge the person's capability in cooperating with other people (collegues) in taking the necessary action with respect to power supply for a machine or process..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
22 *How would you judge the person's capability to judge whether or not a machine needs maintenance..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
.at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
23 *How would you judge the person's capability to carry out maintenance of the machine?*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
.at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐
24 *How do you judge the person's capability in cooperating with other people (collegues) in judging whether or not a machine needs maintenance, and in the maintenance-process itself..*						
..at the time he started working in this firm?	☐	☐	☐	☐	☐	☐
..at present, given the machine is new to the person?	☐	☐	☐	☐	☐	☐

	very positive			very negative	no meaning	not applicable
25 *How would you judge the person's attitude towards working in a metal working process at the time he started working in this firm?*	☐	☐	☐	☐	☐	☐
26 *How would you judge the person's attitude towards cooperating with other people (collegues) at the time he started working in this firm?*	☐	☐	☐	☐	☐	☐
27 *How would you judge the person's attitude towards safety measures at the workplace at the time he started working in this firm?*	☐	☐	☐	☐	☐	☐

28 *What are, to your opinion, the major shortcomings in the person's education?*

_____

_____

_____

part 3: characteristics of the company

29 How many people work in this company?

≤10	11-99	≥100
☐	☐	☐

30 What is your name and function?

10 OVERVIEW

In the following table, the questions (with their number as they appear in the questionnaire) are listed in combination with the respective skills they intend to measure.

table 28: questions for phases and activities of a metal working process

phase	activity	cognitive skills	psycho-m. skills	interactive skills	reactive skills
planning	determine production time, material use and price)	3		4	25, 26, 27
preparation	making drawing	5		12	
	reading drawing	6			
	chosing process (sequence)	7			
	chosing material	8			
	adjusting machine/tools	9	10		
	placing material		11		
process	operating machine/tools		13	15	
	supervising process	14			
take out	switching off machine and taking out product		16	17	
control	judging product	18		19	
(additional)	providing power supply		20	21	
	maintenance and repair	22	23	24	

APPENDIX E SURVEY OUTCOMES

1 ALL EDUCATIONAL LEVELS

table 29: survey outcomes for all educational levels

	all educational levels N=30								National Vocational Training N=12								Technical Secondary Schools N=8								Technical Colleges N=10							
	reproductive				productive				reproductive				productive				reproductive				productive				reproductive				productive			
	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x
cognitive skills	627	250	2.51	**2.49**	465	245	1.90	**3.10**	2.39	96	2.49	**2.51**	176	93	1.89	**3.11**	185	71	2.61	**2.39**	143	71	2.01	**2.99**	203	83	2.45	**2.55**	146	81	1.80	**3.20**
psychomotor skills	401	176	2.28	**2.72**	302	176	1.72	**3.28**	157	70	2.24	**2.76**	115	70	1.64	**3.36**	116	48	2.42	**2.58**	85	48	1.77	**3.23**	128	58	2.21	**2.79**	102	58	1.76	**3.24**
interactive skills	480	196	2.45	**2.55**	341	197	1.73	**3.27**	184	76	2.42	**2.58**	134	77	1.74	**3.26**	135	56	2.41	**2.59**	100	56	1.79	**3.21**	161	64	2.52	**2.48**	107	64	1.67	**3.33**
reactive skills	181	90	2.01	**2.99**	-	-	-	-	72	36	2.00	**3.00**	-	-	-	-	48	24	2.00	**3.00**	-	-	-	-	61	30	2.03	**2.97**	-	-	-	-
all skills	*1689*	*712*	*2.37*	***2.43***	*1108*	*618*	*1.79*	***3.21***	*652*	*278*	*2.35*	***2.65***	*425*	*240*	*1.77*	***3.23***	*484*	*199*	*2.43*	***2.57***	*328*	*175*	*1.87*	***3.13***	*553*	*235*	*2.35*	***2.65***	*355*	*203*	*1.74*	***3.24***

Note: a_i answer ranging from 1 (very capable) to 4 (not capable)
n number of answers depends on the number of questions w.r.t. the specific skills and the number of complete answers
$\bar{a}$ average answer ranging from 1 (very capable) to 4 (not capable); median score is 2.5
x adjusted average answer ranging from 1 (not capable) to 4 (very capable); x=5-$\bar{a}$; median score is 2.5
N number of questionnaires

table 30: survey outcomes per educational level

	metal forming								metal removing								metal joining								metal coating							
	reproductive				productive				reproductive				productive				reproductive				productive				reproductive				productive			
	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x	$\sum a_i$	n	$\bar{a}$	x
National Vocational Training																																
questionnaires	N=0								N=5								N=6								N=2							
cognitive skills	-	-	-	-	-	-	-	-	117	41	2.85	**2.15**	82	41	2.00	**3.00**	113	48	2.35	**2.65**	73	48	1.52	**3.48**	39	13	3.00	**2.00**	22	15	1.47	**3.53**
psychomotor skills	-	-	-	-	-	-	-	-	74	28	2.64	**2.36**	56	28	2.00	**3.00**	68	35	1.94	**3.06**	57	35	1.63	**3.37**	29	12	2.42	**2.58**	19	12	1.58	**3.42**
interactive skills	-	-	-	-	-	-	-	-	87	30	2.90	**2.10**	58	30	1.93	**3.07**	86	41	2.10	**2.90**	65	41	1.59	**3.41**	30	12	2.50	**2.50**	21	13	1.62	**3.38**
reactive skills	-	-	-	-	-	-	-	-	35	15	2.33	**2.67**	-	-	-	-	32	18	1.78	**3.22**	-	-	-	-	13	6	2.17	**2.83**	-	-	-	-
all skills	-	-	-	-	-	-	-	-	*313*	*114*	*2.75*	***2.25***	*196*	*99*	*1.98*	***3.02***	*299*	*142*	*2.11*	***2.89***	*195*	*124*	*1.57*	***3.43***	*111*	*43*	*2.58*	***2.42***	*62*	*40*	*1.55*	***3.45***
Technical Secondary School																																
questionnaires	N=5								N=6								N=4								N=0							
cognitive skills	119	44	2.70	**2.30**	83	44	1.89	**3.11**	136	54	2.51	**2.49**	108	54	2.00	**3.00**	99	36	2.75	**2.25**	72	36	2.00	**3.00**	-	-	-	-	-	-	-	-
psychomotor skills	77	30	2.57	**2.43**	54	30	1.80	**3.20**	82	36	2.28	**2.78**	67	36	1.86	**3.14**	63	24	2.63	**2.37**	45	24	1.88	**3.12**	-	-	-	-	-	-	-	-
interactive skills	84	35	2.40	**2.60**	53	35	1.51	**3.49**	102	42	2.43	**2.53**	73	41	1.78	**3.22**	69	28	2.46	**2.54**	49	28	1.75	**3.25**	-	-	-	-	-	-	-	-
reactive skills	24	12	2.00	**3.00**	-	-	-	-	36	18	2.00	**3.00**	-	-	-	-	22	12	1.83	**3.17**	-	-	-	-	-	-	-	-	-	-	-	-
all skills	*304*	*121*	*2.51*	***2.49***	*190*	*109*	*1.74*	***3.24***	*356*	*150*	*2.37*	***2.63***	*248*	*131*	*1.89*	***3.11***	*253*	*100*	*2.53*	***2.47***	*166*	*88*	*1.89*	***3.11***	-	-	-	-	-	-	-	-
Technical College																																
questionnaires	N=6								N=2								N=4								N=2							
cognitive skills	131	49	2.67	**2.33**	85	47	1.81	**3.19**	48	18	2.67	**2.33**	29	18	1.61	**3.39**	90	35	2.57	**2.43**	62	34	1.82	**3.18**	42	17	2.47	**2.53**	36	17	2.12	**2.88**
psychomotor skills	81	34	2.38	**2.62**	55	34	1.62	**3.38**	30	12	2.50	**2.50**	24	12	2.00	**3.00**	60	24	2.50	**2.50**	54	24	2.25	**2.75**	28	12	2.33	**2.67**	27	14	2.35	**2.65**
interactive skills	95	36	2.64	**2.36**	66	36	1.83	**3.17**	42	14	3.00	**2.00**	28	14	2.00	**3.00**	65	28	2.32	**2.68**	43	28	1.54	**3.46**	39	14	2.79	**2.21**	24	14	1.71	**3.29**
reactive skills	42	18	2.33	**2.67**	-	-	-	-	15	6	2.50	**2.50**	-	-	-	-	23	12	1.92	**3.08**	-	-	-	-	10	6	1.67	**3.33**	-	-	-	-
all skills	*349*	*137*	*2.55*	***2.45***	*206*	*117*	*1.76*	***3.24***	*135*	*50*	*2.70*	***2.30***	*81*	*44*	*1.84*	***3.16***	*238*	*99*	*2.40*	***2.60***	*159*	*86*	*1.85*	***3.15***	*119*	*49*	*2.43*	***2.57***	*87*	*4m3*	*2.02*	***2.98***

APPENDIX F

GOAL AREAS

Acording to Goodlad[79] there are twelve goals for schooling. '...Broadly representative of interests, these twelve goals constitute a sociopolitical expression of external expectations to which school personnel are to pay attention and for which they might expect to be held accountable'.

1 Mastery of basic skills or fundamental processes:

1.1 develop the ability to acquire ideas through reading and listening;
1.2 develop the ability to communicate ideas through writing and speaking;
1.3 develop the ability to understand and utilize mathematical concepts;
1.4 develop the ability to utilize available sources of information;
1.5 develop the ability to read, write, and handle basic arithmetical operations.

2 Career education - vocational education:

2.1 develop the ability to select an occupation that will be personally satisfying and suitable to one's skills and interests;
2.2 develop salable skills and specialized knowledge that will prepare one to become econo-mically independent;
2.3 develop attitudes and habits (e.g. pride in good workmanship) that will make the worker a productive participant in economic life;
2.4 develop positive attitudes toward work, including acceptance of the necessity of making a living and an appreciation of the social value and dignity of work.

3 Intellectual development:

3.1 develop the ability to think rationally; i.e. thinking and problem-solving skills, use of reasoning and the application of principles of logic, and skill in using different modes of inquiry;
3.2 develop the ability to use and evaluate knowledge; i.e. ritical and independent thinking that enables one to make judgements and decisions in a wide variety of life roles (e.g. citizen, consumer, worker, etc.) as well as in intellectual activities;
3.3 accumulate a general fund of knowledge including information and concepts in mathematics, literature, natural science and social science;
3.4 develop the ability to make use of knowledge sources, utilizing technology to gain access to needed information;

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79 Goodlad, J. *What schools are for* (Bloomington: Peackock, 1979, page 34-57)

3.5 develop positive attitudes toward intellectual activity, including intellectual curiosity and a desire for further learning.

4 Enculturation:

4.1 develop insight into the values and characteristics of the civilization of which one is a member;

4.2 develop awareness of one's cultural and historical heritages - the literacy, aesthetic and scientific traditions of the past - and familiarity with the ideas that have inspired and influenced mankind;

4.3 develop understanding of the manner in which heritages and traditions of the past are operative today and influence the direction and values of society;

4.4 acquire and accept the norms, values, standards and traditions of the groups of which one is a member;

4.5 examine the norms, values, standards and traditions of the groups of which one is a member.

5 Interpersonal relations:

5.1 develop a knowledge of opposing value systems and their influence on the individual and society;

5.2 develop an understanding of how members of a family function under different family patterns;

5.3 develop skill in communicating effectively in groups;

5.4 develop the ability to identify with and advance the goals and concerns of others;

5.5 develop an understanding of the factors that affect social behaviour.

6 Autonomy:

6.1 develop a positive attitude toward learning;

6.2 develop skill in selecting personal learning goals;

6.3 develop skill in coping with and accepting continuing change;

6.4 develop skill in making decisions with purpose;

6.5 develop the ability to plan and organize the environment in order to realize one's goals;

6.6 develop the willingness to accept responsibility for and the consequences of one's own decisions.

7 Citizenship:

7.1 develop a sense of historical perspective;

7.2 develop knowledge of the basic workings of the government;

7.3 develop a commitment to the values of liberty, government by consent of the governed, representational government and responsibility to the welfare of all;

7.4 develop an attitude of inquiry in order to examine societal values;

7.5 develop the ability to think productively about the improvement of society (refer to 7.3);

7.6 develop skill in democratic action in large and small groups (refer to no. 7.5);

7.7 develop a willingness to participate in the political life of the nation and community;

7.8 develop a commitment to the fulfillment of humanitarian ideas everywhere;

7.9 develop a commitment to involve oneself in resolving social issues.

8 Creativity and aesthetic perception:

8.1 develop the ability to motivate oneself, to deal with new problems in original ways;

8.2 develop the ability to be sensitive to problems and tolerant of new ideas;

8.3 develop the ability to be flexible, to rededine skills and to see an object from different points of view;

8.4 develop the ability to enjoy ad be willing to experience the act of creation;

8.5 develop the ability to understand creative contributions of others and evaluate them;

8.6 develop the ability to communicate through creative work in an active way (as a creator) or in a perceptive way (as a consumer);

8.7 develop the commitment to enrich cultural and social life.

9 Self-concept:

9.1 develop the ability to search for meaning in one's activities;

9.2 develop the self-confidence needed for confronting one's self;

9.3 develop the ability to live with one's limitations and strengths;

9.4 develop both general knowledge and interest in other human beings as a means of knowing oneself;

9.5 develop an internal framework by which an individul can organize his concept of 'self';

9.6 develop a knowledge of one's own body and a positive attitude towards one's own physical appearance.

10 Emotinal and physical well-being:

10.1 develop the willingness to recieve new impressions and to expand affective sensibility;

10.2 develop the competence and skills for continuous adjustment and emotional stability;

10.3 develop the ability to control or release the emotions according to one's values;

10.4 develop the ability to use leisure time effectively;

10.5 develop positive attitudes and habits toward health and physical fitness;

10.6 develop physical fitness and psychomotor skills.

11 Moral and ethical character:

11.1 develop the judgement to evaluate events and phenomena as good or evil;

11.2 develop a commitment to truth and values;

11.3 develop the ability to utilize values in determining choices;

11.4 develop moral integrity;

11.5 develop an understanding of the necessity for moral conduct;

11.6 develop a desire to strengthen the moral fabric of society.

12 Self-realization.

APPENDIX G EDUCATIONAL INSTITUTES

The various educational institutes, and the grouping of these according to their special field, are listed below.

table 31: selected educational institutes

educational level	name of institute	size	location	ownership
Vocational Training	NVTC (Dar es Salaam)	large	urban	public
	NVTC (Moshi)	large	urban	public
	Ndanda Trade School	small	rural	private
	Voc. Educ. Training Authority (Dar es Salaam)	not applicable		
	Voc. Teacher Training College (Morogoro)	not applicable		
Secondary Education	Technical Secondary School (Moshi)	large	urban	public
	Technical Secondary School (Mtwara)	large	rural	public
	Minja Technical Secondary School (Ugweno)	small	rural	private
	Tanzania Institute for Education (Dar es Salaam)	not applicable		
	National Examination Council (Dar es Salaam)	not applicable		
	Klerruu Teachers Training College (Iringa)	not applicable		
Higher Technical Education	Technical College (Dar es Salaam)	large	urban	public
	Technical College (Arusha)	large	urban	public
	National Examination Council (Dar es Salaam)	not applicable		
	Merit Int. Consultancy (Dar es Salaam)*	not applicable		

* Although there is no teacher training college for higher technical education, the mentioned consultancy company has provided the technical college with assistance in this field.

The location of the institutes is indicated below.

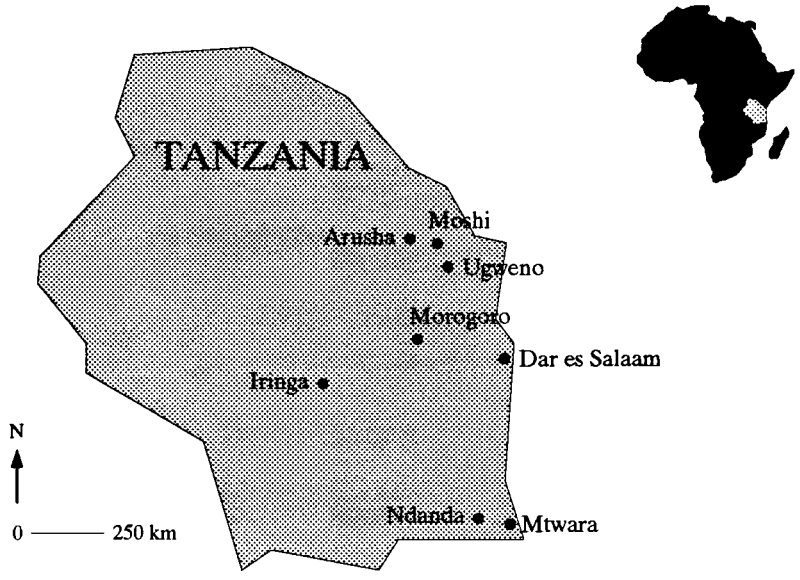

figure 19: geographic location of selected educational institutes

APPENDIX H

VOCATIONAL TRAINING CENTRES - ANALYSIS OF EXAMINATION RESULTS (1993)

1 INTRODUCTION

To compare the examination results of public vocational training centres and private vocational training centres the outcomes for the 1994 examination, drawn up and corrected by the Vocational Education and Training Authority (VETA), are listed below[80].

To determine whether or not the examination outcomes of public VTCs and private VTCs differ significantly for public schools and private schools are significant, a test on equal proportions will be carried out[81]. In this test, the 'pass rate' (proportion of students which pass either theory, practical or both vs. the total number of examinations applicants) of the two types of school will be compared. For this, the average pass rate for each type of VTC will be determined: p_{Public} and $p_{Private}$.

For certain combinations of examination results (e.g. pass theory, fail practical) the listed outcomes suggest $p_{Public} > p_{Private}$, whereas for other cases the opposite might be the case ($p_{Public} < p_{Private}$). In this case the procedure to follow is that the testing will be uniform, i.c. $p_{Public} \neq p_{Private}$ for all cases and consequently, according to the test outcome, it can be concluded whether $p_{Public} > p_{Private}$ or $p_{Public} < p_{Private}$ (or even that $p_{Public} = p_{Private}$). Therefore, the hypothesis to test (H_0) and the hypothesis to accept when H_0 is rejected (H_A) are

H_0 $p_{Public} = p_{Private}$;
H_A $p_{Public} \neq p_{Private}$.

Since the number of students at the two types of VTC (n_{Public} and $n_{Private}$) exceeds 30, it can be assumed that both samples are from a normal distribution. The test statistic z_t is

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80 This only includes Trade Test 3 examination results of metal working courses and not the Trade Test 2 and Trade Test 1 examination results, since outcomes of these examinations may be influenced by the fact that applicants have several years of working experience.

81 Mendenhall, W. and Sincich, T. *Statistics for engineering and the sciences (3rd ed.)* (New York: Collier McMillan, 1988, page ..)

$$z_t = \frac{p_{Publ} - p_{Priv}}{\sqrt{\frac{p_{Publ}q_{Publ}}{n_{Publ}} + \frac{p_{Priv}q_{Priv}}{n_{Priv}}}}$$

with $q_{Public}=1-p_{Public}$ and $q_{Private}=1-p_{Private}$.

With 95% reliability (i.e. there is a 5% chance that the outcome will be false while considered correct) the corresponding tabled z-value for two-sided testing is 1.96. The dicision criteria to accept or reject H_0 are

$z_t < -z$ or $z_t > +z$ H_0 should be rejected and consequently H_A should be accepted, or

$-z < z_t < +z$ H_0 should be accepted.

2 POPULATION AND SAMPLE CHARACTERISTICS

In this test all outcomes of Trade Test 3 examinations in metal working courses (i.e. the whole population) will be included: 494 applicants at 19 public VTCs and 209 applicants at 26 private VTCs. Since the data refer to 1993 only they should be regarded as a sample of the data over a longer period.

3 TRADE TEST 3 EXAMINATION RESULTS

The outcomes of the Trade Test 3 examinations for 1993 are listed below. For reasons of clearliness, only the institutes with 10 or more applicants in metal working courses are mentioned. The VTCs with less than 10 applicants are grouped under 'rest (≤9)'.

table 32: 1993 Trade Test 3 examination results for public VTCs and private VTCs

public vocational training centres+						private vocational training centres[1]					
VTC	#	p/p	p/f	f/p	f/f	VTC	#	p/p	p/f	f/p	f/f
Dar es Salaam	142	50	14	54	24	Langas	31	19	3	5	4
Dar es Salaam	128	66	3	55	4	Ifunda	23	13	1	7	2
Tanga	48	31	3	8	6	Ifunda	19	10	0	7	2
Moshi	31	14	9	6	2	Mikumi	15	14	1	0	0
Dodoma	30	22	3	5	0	Kidatu	12	3	0	5	4
Mwanza	24	12	8	2	2	Dar es Salaam	12	0	9	1	2
Arusha	23	21	0	2	0	Usangi	12	1	0	9	2
Morogoro	14	8	0	6	0	Dar es Salaam	11	7	1	3	0
Arusha	11	3	2	6	0	Iringa	10	5	0	5	0
rest (≤9)[2]	43	16	3	23	1	rest (≤9)[3]	64	43	2	17	2

public vocational training centres+					
VTC	#	p/p	p/f	f/p	f/f
total	494	243	45	167	39
	%	49.0	9.1	33.7	8.2

private vocational training centres[1]					
VTC	#	p/p	p/f	f/p	f/f
total	209	115	17	59	18
	%	55.0	8.1	28.2	8.6

Note: # number of examination applicants
1 includes mission VTCs and private non-mission VTCs
2 public VTCs with less than 10 applicants in examination of (a) metal working course(s): Shinyanga, Kigoma, Bukoba, Kidatu, Mpanda, Mtwara, Mbeya, Lindi, Songea and Mpanda
3 private VTCs with less than 10 applicants in examination of (a) metal working course(s): Ifakara, Ndanda, Tabora, Bukoba, Mangula, Singida, Mahenge, Kidatu, Sumbawanga, Mbeya, Mgololo, Mtera, Mufindi, Njombe
p/p: pass theory/pass practical p/f: pass theory/fail pract. f/p: fail theory/fail pract., f/f fail theory/fail practical
source: VETA, 1994

3 CONCLUSIONS

On basis of the listing of the pass/fail combinations the following table can be drawn:

table 33: proportions and test statistics of 1993 Trade Test 3 examination results for public VTCs and private VTCs

pass/fail-combination	public VTCs			private VTCs			z_i
	p	q	n	p	q	n	
pass theory, pass practical	0.490	0.510	243	0.550	0.450	115	-1.064
pass theory, fail practical	0.091	0.909	45	0.081	0.919	17	0.047
fail theory, pass practical	0.337	0.663	167	0.282	0.718	59	0.796
fail theory, fail practical	0.082	0.918	39	0.086	0.914	18	-0.050

Since $-z_{95\%} < z_i < +z_{95\%}$ for all pass/fail combinations, non of the decision criteria to reject H_0 have been met. Therefore the conclusion is that there are no significant differences in examination results between public and private VTCs.

APPENDIX I

TECHNICAL SECONDARY SCHOOLS - ANALYSIS OF EXAMINATION RESULTS (1993 AND 1994)

1 INTRODUCTION

To determine whether or not the differences with respect to the examination results for public and private technical secondary schools are significant, a test on equal proportions and a test on difference in means will be carried out. These tests are based on the examination results of 1993 and 1994 and include the subjects basic mathematics, English and technical subjects.

1.1 TEST ON DIFFERENCE IN PROPORTIONS (P_{PUBLIC} AND $P_{PRIVATE}$)

In the test on equal proportions[82] the 'pass rate' (proportion of students which pass their examination - Grade A-D - vs. the total number of examination applicants) of the two types of school will be compared. These pass rates are p_{Public} and $p_{Private}$.

On basis of the qualitative results of the research in technical secondary schools (paragraph 8.3) it is expected that public technical secondary schools perform better than private ones. Therefore it is tried to reject the hypothesis H_0 ($p_{Public} = p_{Private}$) in favour of H_A ($p_{Public} > p_{Private}$). For both types of schools the number of students (n_{Public} and $n_{Private}$) exceeds 30 and, therefore, it can be assumed that both samples are from a normal distribution. The test statistic z_t is

$$z_t = \frac{p_{Publ} - p_{Priv}}{\sqrt{\frac{p_{Publ}q_{Publ}}{n_{Publ}} + \frac{p_{Priv}q_{Priv}}{n_{Priv}}}}$$

with $q_{Public}=1-p_{Public}$ and $q_{Private}=1-p_{Private}$.

When accepting a 5% chance that a false outcome will be considered correct (i.e. testing with 95% reliability) the corresponding tabled z-value for one-sided testing is 1.645. The dicision criteria to accept or reject H_0 are

$z_t > z$ H_0 should be rejected and consequently H_A should be accepted, or

$0 < z_t < z$ H_0 should be accepted.

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82 Mendenhall, W. and Sincich, T. *Statistics for engineering and the sciences (3rd ed.)*(New York: Collier McMillan, 1988, page ..)

1.2 TEST ON DIFFERENCE OF AVERAGE CSSE-SCORES (μ_{PUBLIC} AND $\mu_{PRIVATE}$)

In order to compare the CSSE-scores (Certificate of Secondary School Examination, O-level) of public and private technical secondary schools the outcomes are listed below. On basis of these, a comparison is made by multiplying the various grades: Grade A x 1, Grade B x 2, Grade C x 3, Grade D x 4 and Grade E x 5. (Grade A represents the best result and Grade E the worst; Grade A-D represent a 'pass', Grade E represents 'failure'.) The sum of these values is then divided by the number of applicants. The resulting value 'y' ($1 \leq y \leq 5$) represents the average score of the group of schools. The closer this value is to 1, the better the average score is.

An example to illustrate this:

Grade A:	3	students	→ score:	3 x 1 =	3
Grade B:	5	students	→ score:	5 x 2 =	10
Grade C:	5	students	→ score:	5 x 3 =	15
Grade D:	6	students	→ score:	6 x 4 =	24
Grade E:	9	students	→ score:	9 x 5 =	45
Total:	28	students			97

On basis of this, the total score is 97 ÷ 28 = 3.464 (=y)

The mean scores μ_{Public} and $\mu_{Private}$ of the populations will be compared by testing their estimators, based on the sample of the two populations: $\bar{x}_{Public}$ and $\bar{x}_{Private}$[83].

The qualitative research findings (paragraph 8.3) suggest that public technical secondary schools perform better than private ones. Therefore it is tried to reject the hypothesis H_0 ($\mu_{Public} = \mu_{Private}$) in favour of H_A ($\mu_{Public} > \mu_{Private}$, or $\mu_{Public} - \mu_{Private} < 0$). For both types of schools the number of students (n_{Public} and $n_{Private}$) exceeds 30 and, therefore, it can be assumed that both samples are from a normal distribution. The test statistic z_t is

$$z_t = \frac{\bar{x}_{Publ} - \bar{x}_{Priv}}{\sqrt{\frac{s^2_{Publ}}{n_{Publ}} + \frac{s^2_{Priv}}{n_{Priv}}}}$$

in which the estimators for the population's standard deviations σ^2_{Public} and $\sigma^2_{Private}$ are estimated on basis of the sample data as s^2_{Public} and $s^2_{Private}$. These estimators should be accounted according to the formula

$$s^2 = \frac{\sum (\bar{x} - x_i)^2}{n-1}$$

The testing procedure is analogue to the testing of the pass proportions: when testing with 95% reliability, the tabled z-value for one-sided testing is 1.645. The dicision criteria to accept or reject H_0 are

$z_t > z$ H_0 should be rejected and consequently H_A should be accepted, or

$0 < z_t < z$ H_0 should be accepted.

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83 Mendenhall, W. and Sincich, T. *Statistics for engineering and the sciences (3rd ed.)*(New York: Collier McMillan, 1988, page ..)

2 POPULATION AND SAMPLE CHARACTERISTICS

In both tests all outcomes of the CSSE examinations (1993 and 1994) for basic mathematics, English and technical subjects[84] will be included. All technical secondary schools are included (8 public and 4 private) and all applicants. The data refer to 1993 and 1994 and, therefore, they should be regarded as a sample of the data covering a longer period. (In all tests, the data for 1993 and 1994 will be combined, in order to raise the significance level.)

3 CSSE EXAMINATION RESULTS

table 34: CSSE results for basic mathematics, 1993 and 1994

School	Grade A (pass)		Grade B (pass)		Grade C (pass)		Grade D (pass)		Grade E (fail)	
	'93	'94	'93	'94	'93	'94	'93	'94	'93	'94
Public Technical Secondary Schools										
Mazengo Secondary School	7	48	7	30	38	20	29	16	46	19
Ifunda Secondary School	11	16	21	15	42	31	51	50	57	39
Bwiru Boys School	3	3	2	8	6	13	15	30	54	24
Iyunga Secondary School	5	8	12	16	40	29	55	45	62	71
Tanga Secondary School	12	7	13	14	36	16	38	57	50	77
Mtwara Technical Secondary School	1	4	4	4	19	21	39	32	52	63
Moshi Technical Secondary School	17	2	11	14	39	20	41	61	80	111
Mikunguni Secondary School	0	0	1	0	4	1	15	10	19	14
Total public technical sec. schools	56	88	71	101	224	151	283	306	420	423
Private Technical Secondary School										
Milala Secondary School	0	2	2	1	5	2	1	6	50	40
Minja Secondary School	0	0	0	1	4	2	6	9	70	91
Ihanja Secondary School	0	0	0	0	2	0	3	5	25	29
Dodeani Technical Secondary School*	-	0	-	0	-	0	-	1	-	25
Total private technical sec. schools	0	2	2	2	11	4	10	21	145	185

*Dodeani Technical Secondary School was established in 1991 and conducted its first CSSE-examinations in 1994
Source: National Examination Council, 1994, 1995

[84] Technical subjects are: building construction, architectural draughting, carpentry & joinery, brickwork & masonry, painting & sign writing, surveying, plumbing, electrical installation, electricity & radio repair, technical draughting, workshop technology, motor vehicle mechanics, welding & metal fabrication, fitting & turning, auto electrics, mechanical draughting.

table 35: CSSE results for English, 1993 and 1994

School	Grade A (pass)		Grade B (pass)		Grade C (pass)		Grade D (pass)		Grade E (fail)	
	'93	'94	93	'94	'93	'94	'93	'94	'93	'94
Public Technical Secondary Schools										
Mazengo Secondary School	3	3	13	10	46	63	36	40	29	17
Ifunda Secondary School	1	4	11	15	68	69	59	45	43	18
Bwiru Boys School	0	4	1	19	16	32	22	16	41	7
Iyunga Secondary School	0	1	2	12	43	52	62	69	67	33
Tanga Secondary School	2	5	9	19	36	54	48	63	54	30
Mtwara Technical Sec. School	1	0	3	9	40	45	49	49	22	20
Moshi Technical Sec. School	4	10	20	25	59	65	68	70	37	37
Mikunguni Secondary School	0	0	0	3	4	4	8	12	17	16
Total public technical sec. schools	11	26	59	112	312	384	352	364	310	178
Private Technical Secondary School										
Milala Secondary School	0	0	0	1	4	9	11	31	43	10
Minja Secondary School	0	0	1	0	6	5	15	35	58	61
Ihanja Secondary School	0	0	0	0	12	7	11	21	7	6
Dodeani Technical Sec. School*	-	0	-	1	-	0	-	8	-	17
Total private technical sec. schools	0	0	1	2	22	21	37	95	108	94

*Dodeani Technical Secondary School was established in 1991 and conducted its first CSSE-examinations in 1994
Source: National Examination Council, 1994, 1995

table 37: CSSE results for technical subjects, 1993 and 1994

School	Grade A (pass)		Grade B (pass)		Grade C (pass)		Grade D (pass)		Grade E (fail)	
	'93	'94	'93	'94	'93	'94	'93	'94	'93	'94
Public Technical Secondary Schools										
Mazengo Secondary School	33	18	55	38	52	74	112	100	111	139
Ifunda Secondary School	27	49	52	66	65	98	107	134	209	179
Bwiru Boys School	25	4	30	16	48	33	62	54	58	129
Iyunga Secondary School	30	13	64	49	122	71	122	93	125	88
Tanga Secondary School	38	73	50	58	97	68	151	73	143	173
Mtwara Technical Secondary School	9	22	26	30	52	62	108	95	148	136
Moshi Technical Secondary School	39	39	46	62	86	101	134	135	253	200
Mikunguni Secondary School	0	9	4	4	21	12	40	22	29	40
Total public technical sec. school	201	227	327	323	543	519	836	706	1076	1084
Private Technical Secondary School										
Milala Secondary School	0	2	2	3	5	14	16	23	42	35
Minja Secondary School	1	11	7	19	23	31	88	57	186	122
Ihanja Secondary School	3	7	7	10	20	26	34	26	35	37
Dodeani Technical Secondary School	-	0	-	6	-	20	-	34	-	35
Total private technical sec. school	4	20	16	38	48	91	138	140	263	229

*Dodeani Technical Secondary School was established in 1991 and conducted its first CSSE-examinations in 1994
Source: National Examination Council, 1994, 1995

4 CONCLUSIONS

4.1 OUTCOME OF THE TEST ON DIFFERENCE IN PROPORTIONS (P_{PUBLIC} AND $P_{PRIVATE}$)

On basis of the listed data the z_t for pass proportions can be accounted. The results are:

table 38: test statistics for test on difference in proportions

subject	public techn. sec. school			private techn. sec. school			test
	p	q	n	p	q	n	z_t
basic mathematics	0.603	0.397	2123	0.136	0.864	382	22.777
English	0.769	0.231	2108	0.468	0.532	380	11.685
technical subjects	0.630	0.370	5842[1]	0.502	0.498	987[1]	7.485

1 the number for technical subjects is higher than for basic mathematics or English, since students sit for examinations of at least two technical subjects

With $z_{95\%}$=1.645 all listed subjects show $z_t > z_{95\%}$. Therefore H_0 should be rejected for all listed subjects and it should be concluded that, on basis of statistical tests for the subjects basic mathematics, English and technical subjects, public technical secondary schools perform significantly better than private ones.

4.2 OUTCOME OF THE TEST ON DIFFERENCE OF AVERAGE CSSE-SCORE (μ_{PUBLIC} AND $\mu_{PRIVATE}$)

On basis of the listed data the s_i and z_t for the average CSSE examination scores can be accounted. The results are:

table 39: test statistics for test on difference in average CSSE-score

subject	public techn. sec. school			private techn. sec. school			test
	$\bar{x}$	s^2	n	$\bar{x}$	s^2	n	z_t
basic mathematics	3.855	1.488	2123	4.788	0.372	382	-22.798
English	3.686	0.946	2108	4.403	0.516	380	-16.869
technical subjects	3.746	1.592	5842[1]	4.175	0.788	987[1]	-6.393

1 the number for technical subjects is higher than for basic mathematics or English, since students sit for examinations of at least two technical subjects

For each of the listed subjects $z_t < -z_{95\%}$ and therefore H_0 should be rejected. The conclusion is that public technical secondary schools obtain significantly higher average CSSE scores than private ones.