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Ao tA

ANSTI, the African Network of Scientific and Technological Institutions, is an organ of cooperation that embraces African institutions engaged in University level training and research in the fields of science and technology. Founded in January 1980, through the financial support of United Nations Development Programme (UNDP), United Nations Educational, Scientific and Cultural Organization (UNESCO) and Federal Republic of Germany, the network has grown over the years to become an effective institution for the development of human resource capacity in the fields of Basic and Engineering Sciences.

To-date it has 105 member institutions in thirty-five (35) countries in sub-Saharan Africa. This puts ANSTI in a powerful position to advertise, coordinate and implement various programme activities for various international agencies.

The original aim of ANSTI, which has remained unchanged over the years, was to develop active collaboration among African scientific institutions so as to promote research and development in areas of relevance to the development of the region. ANSTI emphasizes the pooling of resources available in the region so as to provide quality training and research in various scientific disciplines. In order to achieve this objective, ANSTI is engaged in numerous activities which can be grouped into four programme areas:

- ❒ Training
- ❒ Seminars & Workshops
- ❒ Publications
- ❒ Promotion of Research

For further information on ANSTI programme and how you can benefit or cooperate with the network, please contact:

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sto A v to ns n A o ny s

Abbreviation	Meaning
ABU	Ahmadu Bello University
Addis, AAU	University of Addis Ababa
ANSTI	African Network for Scientific and Technological Institutions
BOTS	University of Botswana
Cape/UCC	University of Cape Coast
Dar	University of Dar-es-salaam
Ibadan	University of Ibadan
ICT	Information communication and Technology
JKUAT	Jomo Kenyatta University of Agriculture and Technology
Kwame Nkrumah/ KNUST	Kwame Nkrumah University of Science and Technology
Lagos/Lag	University of Lagos
Lome–Togo/Lome	Université de Lomé
Malawi/Mala	University of Malawi
MOU	Michael Okpara University of Agriculture, Umudike
Nsuka/Nigeria	University of Nigeria, Nsuka
S&E	Science and Engineering
S&T	Science and Technology
UNESCO	United Nations Educational Scientific and Cultural Organisation
UON/UoN/Nbi	University of Nairobi
UZ	University of Zimbabwe

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After two decades of neglect of all aspects of higher education in Africa, there are now signs that the situation is changing. In particular there is awareness that

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This study set out to assess the state of institutions offering training in Science and Technology. Specifically, the study was intended to determine the quality of the physical resources available in the various institutions, the nature of the human resource available both at the level of academic staff and the technical support staff, the financial support for the institutions, the major areas of constraints, which in the opinion of the institutional administrators, require urgent attention and the intervention strategies for the strengthening of S&T institutions in Africa. The study focused only on basic and engineering sciences. Hence the survey was conducted in faculties of Science and Engineering.

The survey tool used in the study was a structured questionnaire. The latter assessed staff, student population, library facilities, availability of textbooks/learning materials, infrastructure for information and Communications technology, laboratory facilities, teaching method/technology, relevance of syllabus and quality assurance. Participating institutions were selected from the membership of the African Network of Scientific and Technological Institutions (ANSTI). They were drawn from all the geographic and linguistic regions of the sub-Sahara Africa. The questionnaires were distributed throughout the year 2003 and the analysis carried out in the first half of 2004.

The analysis of the courses on offer gave us an insight about the S&T training programmes available in the region. All universities in the region offer degree level courses in all the traditional disciplines of basic and engineering sciences. Some universities also respond to local demand by offering courses in niche areas such as laboratory technology, petroleum engineering, textile technology and nutrition. However, the absence of strong research programmes may frustrate some staff who may decide to leave.

In general S&T training institutions have no problem in attracting students to their courses. The only constraint on students' enrollment is the lack of scholarships or the financial support. This finding confirms the widely held view that there is an explosion in the demand in higher education in Africa. There are however, subjects such as physics where enrolment is still low.

We can make conclusion about three important aspects pertaining to staff: availability and associated problems of recruitment; the quality of teaching staff and

the efficiency in the utilization of available staff. On average, across the region, about 40% of the established posts in science and technology training institutions are vacant. The main obstacle to recruitment of staff is the poor remuneration and other benefits. Brain drain and the inability of most institutions to train their own staff have compounded the problem of staff availability. A short-term solution would be dual degree programmes (or network degree programmes) in which staff of two neighboring institutions are pooled together to offer degrees in the two institutions. Staff quality, as indicated by the qualifications of its members, ranges from moderate to low. Across the region only about 50% of staff in S&T training institutions have Ph.Ds and hence the need for universities to put more effort in motivating staff to train for higher degree qualifications.

Except for a few institutions surveyed in this study, the problem of scarcity of relevant and current journals continues to be of concern in most institutions. The absence of journals and good library facilities means inability of staff to do research, publish and contribute to knowledge. As a way forward it is recommended that universities establish mechanisms of acquiring and sustaining subscriptions to journals (online and/or print) in at least all taught subject areas.

It was evident from the analysis that there is need to improve access to ICT facilities in most of the universities. There were also remarkable disparities in the number of computers in each university. On average there are about 6.5 computers per basic science course and about 9.1 computers per engineering science course. We also note that in general, very few departments provide computers to all their staff. In fact only 1 out of 3 departments across disciplines have more than half of their staff who have computers in their offices. These statistics point to a situation that require a substantial input of resources in order to achieve an efficient ICT infrastructure and access that will be supportive to the improvement of the teaching of Science and Engineering subjects.

In general, about 55% of laboratory equipment in most departments are not in a state in which they can be used to carryout experiments. The average age of equipment is too high; sometimes as high as 26 years. The net effect of this scenario is that only about half of the experiments are done.

Instructional methods vary from university to university and indeed from department to department as the need for their use more and more depends on individual departmental initiatives as opposed to specific policies. Most universities, though, encourage departments to improve their teaching approaches through the use of technology-mediated methods. But they do not necessarily provide the support to achieve this objective.

On the issue of the use of standard textbooks, printed notes and simulation, it was apparent that their use was not widespread due to their non-affordability. It is highly recommended that such modern teaching methods and aids be implemented in order to improve the overall quality of teaching.

The analysis in this study examined how funds are allocated in universities and has shown that there is no uniform way of distributing financial resources to departments across universities and even within universities. In some cases the allocation was equitably distributed across departments irrespective of the number of students. But in a few other cases, the allocations were in relative proportions to student enrollments. If quality is to be maintained in the provision of Engineering and Science Education, the universities and by extension governments must be ready to give reasonable financial support to help run the science and engineering departments.

On the question of relevance and quality assurance, the study found out that most universities frequently revised their syllabus. Some universities have an institution-wide policy to revise syllabus every 4-6 years. The frequent revision suggests an aspiration to be relevant and current with the trends and development in the disciplines. The use of external examiners as a means of ensuring that the quality of the programs is maintained is widely used. On the other hand, the accreditation model was also preferred in a few of the institutions. National bodies do the accreditation. There are no regional accreditation bodies.

This study has identified several major constraints that impact negatively on the smooth implementation of the academic programs. The prevalence of these constraints is widespread and affects both Basic and Engineering Sciences in relative equal proportions. The four main constraints frequently cited by respondents to the survey are, lack of equipment for conducting experiments, poor staff retention, lack of books, and poor physical facilities. These four constraints account for over 90% of those cited respectively by either basic or engineering sciences.

A few other constraints which were individually mentioned by one or two departments but which could be found in other institutions included poor management of the academic programs, poor student attitude, and disruption of the academic programs.

Overall, this study has brought out several issues that need to be resolved. Intervention strategies must be established at various levels in institutional hierarchies' right from the department, faculty up to the university level. Informed decision making process and prudent management of the resources already in the possession of individual universities is an important bold step.

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One of the reasons for the dismal economic performance of African Countries despite their large natural resource endowment is the inability to harness their resources for the benefit of their population. African countries lack the scientific and technological capacity to develop, process and utilize the resources with which they are endowed. There is need for scientific and technical manpower to maintain and operate industries, build infrastructure and provide services to agriculture, industry and other economic sectors. Governments and donors are encouraged to look at the development of science and technology capacity in Africa as an important route to sustainable development. Without a good Science and Technology (S&T) capacity, African governments and their donor partners will always be treating the symptoms of underdevelopment (famine, wars, disasters etc.) rather than its causes (i.e. lack of human, physical and financial capital).

The generation of S&T human resource capacity requires training institutions, which have the ability to provide quality training and education in all the relevant areas of science and technology.

These institutions must have important resources including staff, laboratory facilities, a good library and a collection of learning materials. Because of the dynamic nature of science, it is essential that these resources are regularly improved so as to be able to maintain the quality and relevance of the training they offer. Such frequent updates of resources require continuous financial investment in higher education institutions that offer scientific and technological training. Unfortunately this has not been the case in most sub-Saharan African countries. Since the mid 80s there has been serious under-funding of Higher Education Institutions (HEI). This was partly due to the widespread belief in donor organizations and development banks that the rate of return on investment in higher education in Africa was less than that for basic education, and that public subsidies for higher education tended to favor higher-income families from which majority of the university students came.

African governments under pressure from their development partners and the competing pressures for other demands for public resources also cut down on their support for higher education in favor of primary and secondary education.

This neglect of higher education manifested itself in many ways including poor remuneration for staff. Lecturers' salaries have declined substantially and many institutions find it difficult to retain staff. In some African universities, staff salary is usually about 20% of what it used to be ten years ago. And in other countries, the rapid devaluation of national currency without a matching rate of increase in salaries, have left staff with a salary which in hard-currency equivalence, is only 10% of what it was 5 years ago. As some staff leave for better-paying jobs, inadequacy in staffing becomes a major problem.

The increase in student population coupled with the decrease in resources has led to a huge drop in the expenditure per student. Institutions, which were designed for 5000 students now, enroll four times more with no increase in the resources allocated. In the scientific disciplines such a huge drop in resource allocation per student inevitably leads to poor practical training. Furthermore, lack of funding has made it difficult for several universities in the region to embrace the Information and Communication Technology (ICT) for learning, research and management of the institutions.

In the last few years there has been some re-assessment of the importance of higher education in socio-economic development and some countries and donor organizations are once again looking favorably to supporting higher education institutions.

Unfortunately, after several years of under-funding of higher education in Africa, most science and technology training institutions may not be in a position to deliver quality training and education. There are obvious weaknesses, which include the lack of staff, laboratory equipment and libraries without current journals. However the problem goes deeper. The interplay of the obvious factors mentioned here may even touch on other issues which are less obvious such as the relevance of the training and the system of quality assurance for the courses. Thus in order to encourage regional cooperation in scientific training and research and in particular, facilitate the exchange of staff and students, it is necessary to know the general state of the various training institutions. Furthermore, for the purpose of developing a collective approach to the resolution of the problems facing S&T institutions, it will be useful to provide information on the general areas of weakness and how such weaknesses affect the human resource capacity building process in S&T.

In analyzing the state of S&T institutions in Africa, the obvious problems of staff, laboratory, library and availability of learning materials are well recognized and there are frequent references to them in every forum. Unfortunately, even these references are in qualitative terms. No one doubts the existence and severity of

- The nature of the human resource available both at the level of academic staff and the technical support staff.
- The financial support for the institutions.
- The major areas of constraints, which in the opinion of the institutional administrators, require urgent attention.
- Intervention strategies for the strengthening of S&T institutions in Africa

The study focused only on basic and engineering sciences. Hence the survey was conducted in faculties of Science and Engineering.

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The study first undertook an analysis of the factors that influence the teaching and training of scientists and engineers in higher education institutions. The analysis identified the various resources and facilities that are essential for effective and quality training in the sciences. This was followed by a questionnaire survey among a few institutions to determine the quality and quantity of the resources identified. The survey, which covered only a small group of S&T training institutions in the region, was meant to illustrate the relative magnitude of the various constraints confronting institutions and also present views of all priority cases for intervention. The survey was carried out between January 2003 and August 2003. The information summarized in the report will help donors and governments to develop intervention strategies for capacity building in Science and Technology.

The report is structured to ensure that the findings from the survey and conclusions derived from them are presented together in a single chapter for each of the factors that constrain training and research in science and technology training institutions. Thus each of the chapters on the analysis of the results of the survey will give a picture on a particular issue.

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The study used the questionnaire approach complemented with physical verification of the information through a few field visits. This approach was economical and more effective. It enabled the project team to collect information from several institutions at a low cost because there was limited travel involved. The main disadvantage of the approach is in the reliability of the data submitted. However, this was addressed through visits to the institutions, where the data was considered to be too good or bad to be representative of the real situation. Another problem with this approach was that of getting responses from the institutions. Even when honorarium was offered some of the questionnaires were never returned. However, with perseverance this problem was overcome.

Finally it should be stated that a significant portion of the study and analysis has relied on the experience of the ANSTI secretariat particularly the Coordinator's knowledge of the physical state of the institutions.

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A structured questionnaire was the main survey tool and it was constituted in a manner to assess all the factors that influence the training, teaching and learning in science and technology institutions. These factors include the staff and student population, library facilities, availability of textbooks, information technology, laboratory facilities, financial input and relevance of the syllabus. All these factors affect the quality of the human resource generated by the institutions and each was thoroughly investigated in the questionnaire.

The following is a brief description of the various training resources that were assessed in the questionnaire:-

Staff: The questionnaire looked at both the size and quality of the available staff. Another staff-related factor is the ability to recruit and retain staff. This was also investigated directly through pointed questions as well as indirectly through the estimate of the level of staff vacancies.

Student Population: One of the contributing factors to the low quality of higher education is student overcrowding, which results in a thin spread of teaching resources. The questionnaire collected information on the student numbers in absolute terms as well as in relation to the staff available.

Library Facilities: The questionnaire did not look into the number of volumes in the library. Rather, it examined the number of current scientific journals available in libraries. The availability of the journals helps research and strengthens the capacity of the staff.

Textbooks/Learning Materials: The absence of teaching materials can be a major constraint in the delivery of quality education. Without these materials students will be forced to rely entirely on classroom discussions with no opportunity for referral to alternative interpretation or presentation of ideas. The questionnaire enquired only about the availability of these materials (i.e. textbooks) without getting into details of quality and quantity. The latter, while desirable, would have complicated the administration of the questionnaire.

Information and Communication Technology (I. C. T.):

Financial Input: The level of financial contribution to various teaching departments is a determining factor of the quality of the education they provide. Budgets for non-salary expenses are used to provide important resources such as laboratory consumables, photocopy materials and utilities. It will be useful to compute the non-salary expenses per student for each institution as an indication of the level and intensity of training (especially practical training). This survey has attempted to do this.

Relevance of Syllabus:The quality of any training is measured not only in terms of the level it attains but also its relevance. Training is considered to be of poor quality, in one sense, if it cannot be used for the intended application. Thus a highly trained medical doctor who cannot operate without the assistance of high-technology diagnostic tools will be considered to have poor quality education in a rural African community where he may even fail to diagnose any disease. Relevance of training is not determined only by location, logistics and infrastructure. It is also reflective of measures taken to address or respond to changes in society as well as developments in the subject discipline. The survey tool assessed the relevance of training courses in African universities by enquiry into dates of recent revisions for syllabi and curricula.

Quality Assurance: A good system of quality assurance sets standards and performance criteria that must be maintained. It is the guarantee that the products are reliable. It also puts staff under pressure to perform to a desired level. Without a system of quality assurance the whole training process will fall apart with no yardstick to keep errant staff in check. Thus the existence of a good system of quality assurance is indicative of the effort to attain high standard in the training process. The survey enquired into the existence of national or regional accreditation scheme as means of assessing quality. It also investigated the existence of other methods of quality assurance such as visitation by external examiners.

History/background of the Institution: The survey looked at the history and types of courses offered by the institution so as to put the cross-institutional analysis into perspective. The specific background information included the dates the courses were started, the range of courses and the types of degrees offered in the courses.

The data collection was disaggregated by the various scientific and engineering disciplines

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It was not possible to include all institutions in the region in the survey. The institutions, which participated in the survey, were selected in a manner to enable one to get a snapshot of the general state of the institutions in the region.

First, a few countries were selected to represent various regions: West Africa (2 countries), Eastern Africa (4 countries), Southern Africa (4 countries), and Francophone West Africa (2 countries). It was important to have a geographical distribution because most of the institutions are funded largely by governments whose commitments to higher education vary from country to country. Thus the wrong impression may be portrayed if for instance we were to concentrate only on countries where the governments are highly committed to higher education. In each country, if there was only one university, that university was selected. If there were several universities, the selected institutions were a combination of those perceived to be strong in Science and technology and those considered not very strong. The logic was to get a balanced picture of the state of the institutions. The selection was only from among members of ANSTI. Fortunately the network has membership in almost every sub-Saharan country. It has 98 member institutions in 33 countries.

The following institutions participated in the survey: **Kenya** (*University of Nairobi; Jomo Kenyatta University of Agriculture and Technology; Moi University*), **Uganda** (*Makerere University*), **Nigeria** (*University of Lagos, University of Ibadan, Obafemi Awolowo University Ile Ife, Ahmadou Bello University, Michael Okpara University of Agriculture, University of Nigeria, Lagos State University*), **Ethiopia** (*Addis Ababa University*), **Ghana** (*Kwame Nkrumah University of Science and Technology, University of Cape Coast*), **Malawi** (*University of Malawi*), **Zambia** (*University of Zambia*), **Botswana** (*University of Botswana*), **Tanzania** (*University of Dar es Salaam*), **Niger** (*Ecole des Mines*), **Togo** (*Université de Lomé*), **Zimbabwe** (*University of Zimbabwe*).

The survey questionnaires were also sent to Cote d'Ivoire and Cameroon but they were not returned to the ANSTI secretariat. A list of institutions which participated in the survey is given in the Appendix. The questionnaires were sent out in January 2003 and the last completed one was returned in August 2003.

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In most "state of entity" reports, the data corresponding to the various parameters are simply reported for each entity. The report therefore becomes a huge database from which individual users can extract and manipulate all kinds of

information and conclusions. Analyses across entities are left to individual assessment. Such a report would usually have data on a very large fraction of all the existing entities under study. In this report however the objective is not to present a database but to paint a picture of the situation. Therefore, analysis using cross-country, cross-disciplinary comparison have been carried out. The survey has relied on various types of descriptive statistical parameters to undertake the analysis. The report has presented in most cases the percentages, maximum, average and minimum level of the resource factors that were assessed. Where the information is not quantitative, the study resorted to the use of frequency counts.

A consultant was engaged to develop small software for the analysis of the data. Each questionnaires data were entered into the computer from which various queries were developed.

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The state of the institutions will be viewed against the background of the country and courses offered by those participating in the survey. It will help explain discrepancies, strengths and weaknesses observed. The target universities surveyed include some of the oldest and largest science and engineering institutions in sub-Saharan Africa. For instance in Nigeria the report has covered universities such as University of Ibadan, University of Nigeria (Nsukka), Ahmadu Bello University, Obafemi Awolowo University Ile Ife and University of Lagos. They are the first generation universities, which are supported by the federal government and expected to be most resourceful for the purpose of science and technology training. Outside Nigeria, historically strong national universities such as the University of Addis Ababa, University of Nairobi and University of Zimbabwe have been included in the study.

The report has also has covered institutions, which were established for the specific purpose of training in Science and Technology. Among them are the Kwame Nkrumah University of Science and Technology (Ghana), Federal University of Technology at Akure (Nigeria), Moi University (Kenya), and Jomo Kenyatta University of Agriculture and Technology (Kenya).

Relatively new universities such as the Lagos State University, Michael Okpara University of Agriculture and University of Botswana have also been included in the study. Sometimes new universities tend to have more or less resources depending on whether they are pioneers or additional institutions. This combination of institutions enabled the analysis to present a realistic picture of the situation in science and technology training institutions. The report simultaneously examined those institutions, which by their history, mandate and sources of funds were expected to be resourceful, and those who for similar reasons were expected to be weak. Also included in the study were universities from small and large countries, and institutions, which are the sole national degree-granting colleges.

Thus the average of the ranges that were obtained was expected to be realistic. In **Table 3.1** a summary of the background of the institutions is presented: -

Table 3.1: Summary of Universities' Background

Universities Under Analysis			
No.	University Name	Country	Year Established
1	Addis Ababa University	Ethiopia	1950
2	Obafemi Awolowo University Ile Ife	Nigeria	N/A
3	Makerere University	Uganda	N/A
4	Moi University Eldoret	Kenya	N/A
5	University of Zambia	Zambia	N/A
6	Michael Okpara University of Agriculture, Umudike	Nigeria	1993
7			

Cape Coast has only one diploma course and that is in Laboratory Technology. On the other hand the University of Botswana which recently merged with the Botswana Polytechnic offered diploma courses in all the traditional engineering disciplines (civil, electrical, mechanical and agricultural engineering).

In most countries, like Nigeria, Ghana and Zimbabwe, there is obviously a clear definition of the services expected from universities and polytechnics. The award of diploma has been assigned to the latter. This rationalization may help each institution to use efficiently the resources at its disposal. This trend is now appearing in most countries in the region.

The duration of the diploma courses range from one year to four years. The latter is available to part time (evening class) students in the University of Addis Ababa. In general diploma courses are for two years except it is offered on a part time basis when it can then be expected to take a little longer. A university that offers long duration diploma courses along side undergraduate and postgraduate degrees is expected to require a lot more resources than others. The demand for staff will be high and classroom availability may be a problem.

At the undergraduate degree level the courses in basic science, which are offered in almost every university, are: Math, Physics, Chemistry, Computer Science, Biology, Botany, and Zoology. Degrees are offered in these courses by almost all the universities surveyed. The duration of undergraduate degree courses range from 3 to 4 years. In the engineering sciences the courses offered by most universities are civil, electrical and mechanical engineering. Some of the institutions surveyed (e.g. Michael Okpara University) do not offer engineering courses at all. At the postgraduate level most of the universities surveyed claimed to be offering courses at masters and doctorate levels in the four basic sciences (Math, Physics, Chemistry and Biological Science) and for engineering disciplines (civil, electrical, mechanical and agricultural).

There are also some who have postgraduate programmes in specialized areas such as surveying, materials engineering, and chemical/biochemical engineering. The duration of the postgraduate programmes are typically 1-2 years for the MSc. and 3 - 4 years for the Ph.D.

Although several institutions have postgraduate training programmes only few of them are really running the courses. This can be observed from the student population information collected in the survey. For instance, The University of Botswana has MSc. and Ph.D. programmes in all areas of basic science and none in engineering science. However, only the Physics and Biology programmes have students. Similarly, Michael Okpara University of Agriculture has a postgradu-

Name of University		Dipl (Number of Students pursuing course)				BSc courses (Number of Students pursuing course				MSc courses (Number of Students pursuing course)				PhD courses (Number of Students pursuing course			
		Min	Avg	Max	Tot	Min	Avg	Max	Tot	Min	Avg	Max	Tot	Min	Avg	Max	Tot
Addis Ababa University	Sc	99	165	256	660	32	337	645	2026	22	39	98	195	2	4	5	7
	Eng	243	343	504	1370	73	250	563	1748	25	37	58	111	-	-	-	-
Michael Okpara	Sc	-	-	-	-	24	48	102	428	1	3	10	20	1	3	5	17
	Eng	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
University of Malawi	Sc	-	-	-	-	201	359	721	1434	22	22	22	22	1	1	1	1
	Eng	-	-	-	-	81	119	142	474	32	32	32	32	-	-	-	-
Ahmadu Bello University	Sc	-	-	-	-	75	188	342	1688	4	23	34	203	3	12	24	105
	Eng	-	-	-	-	148	286	387	2290	5	34	156	241	1	20	115	143
University of Lagos	Sc	-	-	-	-	200	364	502	2908	11	29	56	234	3	11	20	90

ate programme in Physics and Computer Science but has no students. In University of Malawi only the departments of biology and agricultural engineering have postgraduate students even though a programme exists for chemistry also.

In older and larger institutions like the University of Nairobi, University of Ibadan and University of Lagos, all the postgraduate programmes on offer are utilized.

However, Table 3.2 shows that only 5 - 10 % of the student population are in the postgraduate programme. The lower percentages tend to be mainly in the engineering sciences. The popular post-graduate courses are in the biological sciences and chemistry. It would appear that African Science and Technology institutions are still undergraduate colleges with limited research activity. Therefore, staff are spending large amounts of time teaching.

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Analysis of the various courses on offer and student population across the survey sample, leads to several conclusions about the S&T training programme available in the region. All universities in the region offer degree level courses in all the traditional disciplines of basic science. Those with faculties/schools of engineering also offer all the traditional engineering courses. Some universities also respond to local demand by offering courses in niche areas such as laboratory technology, petroleum engineering, textile technology and nutrition. In each country there is a range of science and engineering courses on offer to address relevant scientific and technical issues.

Several postgraduate programmes exist but are not being run. The reasons for this were not readily available. However, judging from the background (especially size of the target population) one could conclude that in most cases the demand for courses may not exist because the potential clients are few. However, this is not a very strong reason in view of the fact that courses are usually developed in response to demand. A more acceptable reason is that the weak state of the research facilities have made it impossible to run the courses or attract students. Such weaknesses in state of resource may include the lack of staff to teach the courses.

The small fraction of postgraduate students means that most academic staff are only engaged in teaching. The absence of strong research programmes may frustrate some staff who may decide to leave. It will also make it difficult to recruit new staff especially those with Ph.Ds.

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Academic staff is vital resource in training and therefore the availability of staff can affect the quality of the training. In this report the issue of staffing in S&T training institutions has been analyzed from the point of view of the availability of staff, the efficiency and effectiveness of the use of the available staff, the quality of the staff and the ability to recruit academic staff members. The various indices such as the student-staff ratio, the number of vacant posts and the percentage of staff with doctorate degrees are considered.

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One of the major problems confronting higher education institutions in general is the inefficient use of even the meager resources available. The student-staff ratio is an important index for assessing the efficiency and effectiveness of staff utilization. A very low student-staff ratio may indicate *inefficiency* in resource utilization. It means staff are teaching fewer students. On the other hand a very

In Table 4.1 the computed student-staff ratio for several universities are presented for courses on offer in basic and engineering science. It is difficult to decide on a cut-off figure for student-staff ratio for efficient staff utilization. This is because it depends on the cost of staff as well as the fees paid by the students (or income of the institution). Where the students pay high fees or staff are poorly paid, a low student-staff ratio may be more acceptable than if the reverse were the case. These are factors that vary from country to country. In this study we have assumed that, based on the salaries and fees structures prevailing in most countries in Africa, a student-staff ratio of 10 or higher is a more efficient way of staff utilization (assuming average cost of staff of $5000/year and a total tuition and subvention per student at $600/year). Using 10 as the minimum student-staff ratio for efficiency, then one can conclude from the data given in Table 4.1 that most of the courses are using their staff efficiently. Only a few universities like the University of Nairobi, Jomo Kenyatta University of Agriculture and Technology, Michael Okpara University and University of Botswana has more than 30% of their courses with student-staff ratio less than 10.

In Table 4.1 the average student-staff ratio across all science and engineering disciplines, are very high for all the institutions under survey. Only one university has an average below 10. In general one could conclude that over 90% of all courses in African Science and Technology training institutions are making efficient use of staff. This may well have been forced on them by the difficulty in recruiting staff. This issue is analyzed in the next section.

Tale 4.1: Student – Staff Ratio

Analysis of Student-Staff Ratio Within a Specific University - Basic & Engineering Sciences
(Number of students to one staff member)

Subject	**Universities**													
	AAU	JKUAT	MOU	Lagos	KNUST	Nsukka	UZ	ABU	Nairobi	Cape Coast	Malawi	Ibada	Botswana	Dar es Salaam
Physics	17.40	12.62	8.25	12.59	20.42	16.75	16.00	6.78	11.48	133.40	56.25	8.39	23.50	22.75
Chemistry	19.86	11.71	13.50	22.11	38.00	32.53	31.27	10.36	26.61		25.13	14.50		
Math	34.33		7.75	25.76	41.00	9.21	47.33	9.54	5.13	80.86	120.17	11.62		29.09
Biology	23.21	14.38		35.63	33.30		46.83	9.73			44.29		30.19	
Biochem			12.50	34.09	25.45	31.40	13.50	18.42	4.94			25.38		
Botany			6.75	13.78		16.46			16.82	70.73		34.41		
Geology	13.88	9.65				35.82	15.90	9.25	9.33			21.25	4.55	
Computer		5.13	18.00	46.50	71.33	93.43	40.38		17.15			37.17	22.50	
Industrial		6.83	13.80	20.65	22.61	22.56	47.13	14.00	24.00			9.80		4.28
Production			36.00	47.53	15.50	14.00	14.00	27.29	1.18	92.50		10.06	28.63	
Agricultural		6.48	6.00	52.92	42.56	21.63	22.22	14.17				40.31	11.24	
Architecture	8.56	6.86		49.89		19.71		31.36	14.12			38.60	16.88	
Building	56.30	6.57			30.00	25.17		34.70	12.96			21.70		
Pre-Eng				44.22		56.31		34.25			6.00	15.76		
Civil	38.20					64.29	37.50				8.35	38.71		
Mechanical	22.05					76.71		28.69			10.13			
Electrical	26.70										30.25			
Electronic							20.60	41.90				22.30		
Chem/Biochem				10.43	23.33		25.00	26.90					1.50	
Comp Eng		6.00		38.00	27.10		8.14	29.14	13.89			22.22	15.29	
Mining				39.44	19.17			23.54	9.29			12.75		
Average	***26.05***	***8.62***	***13.62***	***32.90***	***31.52***	***35.73***	***27.56***	***20.75***	***13.14***	***94.37***	***37.57***	***23.33***	***17.14***	***18.71***

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The number of vacant posts in an academic department is a reflection of the difficulty of recruiting staff which itself can say a lot about the financial and other resource endowments of the institution. In Table 4.2, the percentage of staff at post for the basic sciences is presented. It is observed that with the exception of University of Botswana where there are several departments with a full complement of staff, most other universities have only 60 - 80 % of the staff they need for training in science and engineering. On average, across the region and across disciplines, only about 70% of the required staff are at post. In some universities there are departments with only 30 - 40 % of total staff requirement.

Table 4.2: Percentage of Staff at Post

Analysis of Staff Levels Across All Universities - Basic Sciences

Subject	No of Universities Analysed	Min % Staff at Post	Avg % Staff at Post	Max % Staff at Post	Min % PhD Staff at Post	Avg % PhD Staff at Post	Max % PhD Staff at Post
Archeology	1	65.38	65.38	65.38	58.82	58.82	58.82
Biochem	7	56.25	61.95	76.47	25.00	67.10	100.00
Biology	6	40.00	72.58	120.00*	28.57	69.24	87.50
Botany	5	50.00	70.03	90.91	14.29	46.59	84.62
Chemistry	8	54.24	75.17	93.33	31.25	64.28	100.00
Comp Tech	0						
Computer	7	28.57	58.86	75.00	0.00	27.77	66.67
Environ	0						
Geography	2	40.00	52.35	64.71	54.55	60.61	66.67
Geology	5	66.67	89.29	133.33	30.00	66.97	93.75
Lab Tech	0						
Math	9	33.33	62.74	86.36	14.29	49.16	100
MetLogy	1	80.00	80.00	80.00	100.00	100.00	100.00
MicroBio	2	71.43	73.21	75.00	46.67	54.31	60.00
Nutrition	0						
Physics	9	44.44	82.03	150.00	23.53	54.78	95.83
Statistics	2	42.86	50.00	57.14	31.25	38.19	50.00
Textile	1	77.78	77.78	77.78	35.71	35.71	35.71
Zoology	5	56.25	65.15	71.43	40.00	67.90	100.00
Average	***4***	***54***	***69***	***88***	***36***	***57***	***80***

(*Overstaff)

There are several possible reasons for this large amount of vacant posts. One is the obvious poor remuneration for academic staff in the region. In this connection, it is instructive to note that the University of Botswana, which pays relatively high salaries to staff, has the lowest vacancy rate.

Other reasons for low staff levels are presented in Table 4.3. The respondents were asked to give any reason which in their opinion, influenced the availability

of staff in their institutions. The many different reasons and the frequency with which they were listed are given in Table 4.3. The results confirm that poor remuneration is the major cause of the low level of staff. With the exception of University of Botswana, every other institution, which responded to this part of the survey, cited poor remuneration. Among the non-economic issues, the most significant is the absence of staff development programme (no training of new staff), brain drain (staff sent abroad do not return), and the inability of the institution themselves to train/develop their own staff. These factors clearly show that institutions have problems in training staff and retaining them. Staff retention is therefore a key issue.

The low level of staff at post suggests that the high student-staff ratio observed earlier in Table 4.1 might not really reflect efficiency in staff utilization but rather an indirect indication of the difficulty in recruiting staff. Indeed when the *planned* student-staff ratio data are presented side-by-side with those of the *actual* percentage of staff at post it is observed that a number of courses with satisfactory planned staff-student ratio is low (see Table 4.4). Most of the engineering departments planned very low student numbers per staff which may not be very efficient. .

Tale 4.3: Frequency of reasons advanced for low staff levels

REASON	UNIVERSITIES	FREQUENCY
Low Remuneration	Ahmadu, JKUAT, Dar es Salam, Ibadan, Lagos, Nairobi,Nsukka,Zimbabwe, Malawi	9
Poor Benefit Scheme	Addis Ababa,Malawi	2
More Gainful Employment Elsewhere	Michael Okpara, Dar es Salam, Nsukka, Malawi	4
Limited Prospects for Promotion	Nairobi	1
Recruitment Problem to Senior Level Staff	Botswana	1
Large Numbers of Students in Lower Level Degrees	Addis Ababa, Botswana	2
High Work Load	Nairobi	1
Slow and Bureaucratic Administration	Addis Ababa, Nairobi	2
Unbalanced Staff Distribution	Nairobi	1
No Training of new Staff Locally/Abroad	Addis Ababa,JKUAT,Dar es Salaam	3
Weak Research and Postgraduate Training Program	JKUAT	1
Lack of Lecturing interest in Young Professionals	Kwame Nkrumah†	1
Poor General Economic Situation	Addis Ababa	1
Staff sent for Further Studies Do Not Return	Nairobi, Malawi†	2
Large Number of Employed Staff on Study Leave	Botswana	1
Lack of Qualified Personnel to Train Locally/Abroad	Addis Ababa, Michael Okpara, Dar es Salaam	3

In Table 4.4 we present the planned student-staff ratio (using all the established staff posts) in five universities. Using the latter index it is observed that several of the institutions are only barely efficient in the use of staff.

Table 4.4: Planned Student-staff ratio vs. actual staff-student ratio

University		Total Stud Population	Planned no of staff	Actual no of staff	% of filled positions	Planned Stud-staff ratio	Actual student-staff ratio
UZ	Basic	2722	129	85	65.9	21.1	32.0
	Eng	955	95	49	51.6	10.1	19.5
Malawi	Basic	1457	50	25	50.0	29.1	58.3
	Eng	474	69	56	81.2	6.9	8.5
Ahmadu	Basic	1996	190	162	85.3	10.5	12.3
	Eng	2287	161	86	53.4	14.2	26.6
Lagos	Basic	3232	201	143	71.1	16.1	22.6
	Eng	4063	142	88	62.0	28.6	46.2
JKUAT	Basic	935	206	117	56.8	4.5	8.0
	Eng	794	149	90	60.4	5.3	8.8
			Average		63.8		

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The indicators normally used for assessing staff quality are the percentage of staff with doctorate degrees and fraction of staff in the senior rank. The former indicates the level of knowledge embodied in the staff while the latter suggests the amount of teaching and research experience possessed by the staff. The desirable staff will be one with all members having doctorate degrees and at least 30 - 40% in their senior rank. It was not possible to assess the "fraction of staff in senior rank" as an indicator because of difficulty in defining senior ranks for all universities and also the requirements for entering the rank may vary with institutions. For most universities in the region, senior academic staff is anywhere from senior lecturer upwards. However, the entry requirements into the senior lecturer vary. Some universities insist on a Ph.D. qualification for staff wishing to become senior lecturers. However, several universities would allow a staff member with masters to compensate for his/her lack of Ph.D. with two or more years teaching/research experience. The result from this disparity in promotion criteria is that a senior staff in one institution may only be a junior staff in another.

Consequently a high percentage of senior staff in a particular university may not really mean the same in terms of staff quality, when compared to another with a

different standard. Hence the survey did not use "percentage of senior staff" as an indicator.

In Table 4.5 the percentage of staff with Ph.D. are presented for various disciplines and across universities. These percentages range from 25% - 90%. Across all science and engineering disciplines we find from Table 4.5 that University of Nairobi, for instance, has on average 58.28% of staff with PhD. While the figure for Jomo Kenyatta University of Agriculture is 33.7%. Among the institutions listed in table 4.5 University of Zimbabwe has a very high average percentage of staff with PhD (i.e. 60.4%). On average the percentage of staff with Ph.D. in the science and engineering faculties in the institutions surveyed is just about 50%.

Table 4.5: Percentage of staff with PhD at post

	Percentage PhD Staff At Post							
	UON	Addis	MOU	UZ	JKUAT	Bots	Malawi	ABU
Subject								
Physics	66.67	45.00		69.23	38.46	95.83	25.00	38.89
Chemistry	67.74	64.29	50.00	100.00	14.29		62.50	53.57
Math	44.74	40.74	50.00	53.33			50.00	53.85
Biology		79.31	50.00	83.33	0.00	85.19	28.57	70.00
Biochem	94.44		100.00	80.00	55.56			25.00
Botany	50.00		50.00					
Geology	58.33	93.75		60.00	23.53	90.91		30.00
Computer	30.77			37.50	31.25	31.25		
Zoology	100.00		60.00	50.00	25.00			46.67
Geography	54.55		33.33	33.33		37.50		35.71
MetLogy	100.00		40.00	33.33	40.00	52.94		66.67
Civil	28.00	18.75			27.27	56.25		36.36
Mechanical	52.17	20.00			30.43			20.00
Electrical	46.67						77.78	41.67
Electronic		60.00		50.00			5.88	
Chem/Biochem	38.10					12.50	30.77	
Comp Eng		60.00						
Mining				60.00				
Industrial		42.86		75.00		50.00		
Production					85.00	14.29		
Agricultural	44.44							40.00
Survey	35.71							50.00
Average	***58.28***	***51.16***	***54.17***	***60.39***	***33.71***	***57.13***	***37.46***	*42.61*

This suggests that majority of staff are at the level of lecturer, assistant lecturer or of research assistant since staff without Ph.D. in most universities cannot proceed beyond these levels. Secondly it indicates overall weakness of staff since most of them have not acquired enough research experience. Thirdly it confirms the difficulty earlier expressed about recruiting staff. Because of the low remuneration,

staff members with Ph.D. are likely to join the brain drain or seek opportunities in other sectors in the country. Although the average age of the Ph.D. holders was not assessed in the survey, knowledge about staff mobility suggests that it is the older generation of Ph.D. holders who will stay behind. Thus one is left to wonder what happens in a few years from now when the present group of Ph.D. holders on the staff retires.

Science and Technology training institutions from all indications are experiencing problems recruiting staff especially high-level staff. Unless something is done, there is a possibility that staff will progressively become less qualified to teach courses in these fields.

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In general S&T training institutions have no problem in attracting students to their courses. The only constraint on students' enrollment is the lack of scholarships or the financial support. This finding confirms the widely held view that there is an explosion in the demand in higher education in Africa. There are however subjects (e.g. physics) where enrolment is still low.

We can make conclusion about three important aspects pertaining to staff: availability and associated problems of recruitment; the quality of teaching staff and the efficiency in the utilization of available staff.

The analysis of the survey results show that the percentage of vacant posts is well over 25% in most departments in all universities. In some cases it is as high as 75%. **On average, across the region about 40% of the established posts in science and technology training institutions are vacant. The main obstacle to recruitment of staff is the poor remuneration and other benefits. Brain drain and the inability of most institutions to train their own staff have compounded the problem of staff availability.**

A short-term solution would be dual degree programmes (or network degree programmes) in which staff of two neighboring institutions are pooled together to offer degrees in the two institutions. This is already happening in some of the urban universities in Nigeria and Kenya.

Staff quality, as indicated by the qualifications of its members, ranges from moderate to low. **Across the region only about half of the staff in S&T training institutions have Ph.Ds. The ability of the staff to undertake research is therefore questionable.** There is also the possibility that most of the Ph.D. holders are due for retirement. This raised serious concern for the future of staff in science

and technology training institutions. African institutions and governments must start looking seriously at staff development programmes in science and technology.

The efficiency in the use of available staff (as measured by the student-staff ratio) is good. However, this is an enforced efficiency because if the staff positions were all filled the efficiency of the use of the human resource will not be good. The moderate sizes of the student-staff ratio also suggest that if the staff has the resources they can be very effective. Several universities need to examine some of their courses and staff compliments with a view of effectively and efficiently using what is available (i.e. students and staff). Extremely low student-staff ratio in some cases require a rationalization of the staff (e.g. staff teaching in several departments) and possible restructuring process of courses. The need for this type of action exists in virtually every institution in the region.

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Availability of Library facilities is a basic requirement of any university. A university with a well stocked library with relevant books and current journals reflects a strong academic institution. An ideal assessment of library facilities should obviously include statistics on the number of volumes in the library. In particular, since this is a study on Science and Technology training facilities, it would be useful to determine the number of Science and Engineering books in the library. Aware that such a request for the institutions would be difficult to fulfill, and because some indication of library strength can be derived from the number of science and engineering journals, the survey decided to use the number of current journals as an indicator of quality of library facilities. Thus data was collected on the number of journals in the various subjects in each university. In this report we present findings on the status of library facilities and give insights within and across universities.

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A survey on individual universities reveals a shortage of current journals in almost all subjects. Engineering courses have fewer journals than in basic Sciences as shown in table 5.1 below. For instance, at JKUAT, 7 departments in basic sciences have a total of 47 current journal titles, while engineering has a total of 2 current titles. This trend is observed in several other universities; giving rise to an average of 90 Journal titles in Basic Sciences per university compared with only 53 journals per university in engineering subjects.

The average number of current journal titles per department in the Science faculty across all universities surveyed, is approximately 11 as shown in table 5.2. This is low and is inadequate to cover all the sub-disciplines of the subject.

Table 5.1: Number of Journal titles per University

	No of Journals in each University				
University	**No of Journal titles (Basic Sc)**	No of Depts Considered (Basic)	**No of Journal titles (Engineering)**	No of Depts analysed (Eng)	**Ratio (Basic:Eng)**
JKUAT	47	11	2	13	23.50
U of Malawi	51	9	0	11	
Addis	152	9	48	13	3.17
MOU	231	13	78	11	2.96
Ahmadu Bello	34	12	19	13	1.79
U of Lagos	127	10	110	13	1.15
Kwame	0	9	0	13	
U of Nigeria	0	12	0	11	
Dar	4	10	0	11	
Bot	273	10	289	10	0.94
Ibadan	51	13	39	13	1.31
Cape Coast	112	11	0	11	
Lome-Togo	7	7	0	3	-
Ecole des Mines	38	11	24	8	1.59
Average per University	**80.5**	***10.5***	***43.5***	***11***	

The ratio of Journals in basic Sciences to that in Engineering is more than 1 in almost all universities. This is an indication that there are more journals in Basic sciences than there are in Engineering.

One aspect of the information on journals which was not adequately captured in the questionnaire was quality of the journals. However, during visits by the ANSTI coordinator to verify the responses in the questionnaire, he was able to establish that most of the journals in the libraries in the institutions in the region fall into two categories: those produced locally by scientists of the institution and invariably circulated only among themselves; and those sent to the library free of cost. In effect most universities no longer subscribe to international scientific journals. The library for the faculty of Technology in Blantyre had only the African Journal for Science and Technology. Unfortunately, staff were not even aware of its availability suggesting that no one now checks the library for journals.

The local publication of journals is not a bad idea in countries with several universities and a large scientific community (e.g. Nigeria and Kenya). However, in other countries where such a population of scientists does not exist, dissemination of scientific information through locally produced journals will only mean that the scientist is sharing his knowledge with himself. He would not benefit from any peer review.

It is interesting to examine the variation in the availability across a university. It can reveal subject areas in which some research is taking place. In the same university one will find departments with no current journals at all while there are others with several journals. It suggests that some universities have identified niche areas in which they successfully apply for a significant amount of research funds. A case in point is Michael Okpara University in Nigeria as shown in table 5.2. This university, which is dedicated to Agricultural Technology, has a large number of current journals on Nutrition.

Table 5.2: Maximum and Minimum Number of Journals Per University

Name of University	Number of Depts Analyzed	Minimum Library Journal title (Quantity)	Dept with Lowest number Journal titles (Quantity)	Average Library Journal Quantity	Maximum Library Journal Quantity	Dept with Highest Journal Quantity
Addis Ababa University	14	3	Computer	14.29	39	Biology
Michael Okpara University of Agriculture, Umudike	10	3	Botany	30.90	102	Nutrition
University of Malawi	6	3	Biology	8.50	20	Math
Ahmadu Bello University	15	1	Botany	3.53	7	Chemistry
University of Lagos	17	0	Mining	14.53	25	Chemistry
JKUAT	16	0	Agricultural	3.06	12	Computer
University of Dar es Salaam	1	4	Zoology	4.00	4	Zoology
University of Botswana	16	7	Design Tech	35.13	97	Electrical
University of Ibadan	18	2	Archeology	5.00	17	Agricultural
University of Cape Coast	9	1	Biochem	12.44	35	Biology
Lome-Togo	7	0	Math, Biochem, Geology	1	3	Biology
Ecole des Mines - Niger	16	1	Agricultural	3.19	12	Mining
Average	***12.08***			***11.3***		

Among the Universities that responded to the survey, the University of Botswana records the highest number of current Journal titles in Engineering with Electrical Engineering topping the list. It also tops as the university with the highest number of journals in both Basic science subjects while JKUAT has the least numbers in both areas. University of Nigeria, Kwame Nkrumah University and University of Nairobi were excluded from this analysis as they either did not provide any data or the data was perceived to be erroneous.

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Some universities like Kwame Nkruma University identify Books and Journals as one of the major constraints that face the institution. All other universities except Botswana and Ibadan generally identify the unavailability of relevant course text books as a major constraint. Available information indicates that some of these universities are also engaged in projects aimed at utilizing the modern technologies for accessing online journals and books. The universities of Nairobi and Dar-es-salaam, for instance have subscribed to several databases and sites where abstracts and other research findings are published.

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The primary function of S&T training institutions such as faculties of Science and Engineering is to transfer knowledge to students. To be able to do that, staff should at least be at the frontiers of scientific knowledge and at best contribute to the advancement of the frontier. Hence there is need for staff to not only be able to do research but also stay abreast with developments in one's area of specialization.

Except for a few institutions surveyed in this study, the problem of scarcity of relevant and current journals continues to be of concern in most institutions. Ideally we would expect that each subject area in both Science and Engineering, subscribe to at least one journal. This will promote research and scholarly excellence by staff in these universities. **However, only a few universities in the region are in a position to boast of quality scientific journals in their libraries**.

Four out of the thirteen respondents offer training in some subjects for which they do not stock any journals - three of these subject areas being in Agricultural Engineering.

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The availability of journals also has profound influence on the motivation of staff and their career progression. The absence of journals and good library facilities means inability to do research, publish and contribute to knowledge. The staff will not be aware of current trends in his/her field and over some time his/ her knowledge becomes obsolete and career prospects dim. Since most scientists will not be able to fund their own research or journals, there is the tendency to leave the institution once they find that the library facilities are not very good. **Thus, the observation made in this study on the state of libraries, may also be one of the contributing factors to the brain-drain from African institutions.**

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As a way forward it is recommended that universities establish mechanisms of acquiring and sustaining subscriptions to journals in at least all taught subject areas. This will improve scholarly activities and teaching in general.

Most of the print-based journals are also available online over the Internet and subscription to such databases is affordable. Where the technology permits, it is highly recommended that such online databases be made available to staff.

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A technology whose time has come; a technology that makes teaching, learning and research exciting; a technology that we may not do without - these are some of the phrases that have been used to describe the Internet, email, e-learning and other ICTs' used for teaching and learning. The prevalence, application, and the need to use these ICTs' is bound to vary from region to region and from country to country. The factors that will dictate the use of these ICTs' include the ability to create an infrastructure that will support their implementation; budgetary allocations that will help sustain them; availability of the necessary manpower and also inculcating the required attitude towards their use.

Universities, the world over have recognized the need to embrace modern technologies at least for administrative purposes and to varying degrees of success, for teaching and learning functions. In this chapter we take a close look at the situation in some of the universities across the African region. At least all the universities which responded to this part of the questionnaire indicated that they have some computers in one department or the other.

This chapter is divided into four parts. The first part outlines issues related to staff access to Computers in Basic Sciences. Part II outlines the situation in Engineering Sciences while Part III looks at the situation of ICT in individual universities. It is instructive to note that the quality of the ICT laboratory facilities can suggest the level of access to ICTs' by students. Part Iudeniversities.

Table 6.1 shows the percentage of staff with access to computers in some of the universities surveyed. The information is categorized by departments. There is a marked variation on the number of staff with computers in various departments across universities.

ber in the Basic Sciences courses has a computer in his/her office. None of the departments in Botswana reported that they have staff retention problems.

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A total of 25 engineering departments were considered. The number of staff with computers in their offices in these departments is quite low. This is obvious from Table 6.2. There are many possible interpretations of the data in table 6.2. However if you look at the statistically-significant data (i.e. those of agricultural engineering, civil engineering and mechanical engineering) we note that on average less than half of the staff have access to computers. Agricultural Engineering is the department which presents the lowest minimum average number of staff with computers - recorded as being 2% in one of the universities.

Table 6.2: Percentage of Staff with Computers in Engineering Sciences

Percentage of Staff With Computers (Engineering Sciences)				
Subject	No of Universities Analysed	Minimum % Staff With Computers	Average % Staff With Computers	Max % Staff With Computers
Agricultural	8	2.00	50.45	100.00
Architecture	1	50.00	50.00	50.00
Building	1	50.00	50.00	50.00
Chem/Biochem	2	38.46	47.49	56.52
Civil	10	4.17	37.39	100.00
Design Tech	1	100.00	100.00	100.00
Electrical	9	9.09	50.41	100.00
Electronic	1	28.57	28.57	28.57
Environ	1	14.29	14.29	14.29
Geoinfo	1	8.33	8.33	8.33
Industrial	1	30.00	30.00	30.00
Mechanical	10	0.00	42.51	100.00
Metallurgical	2	20.00	32.22	44.44
Mining	1	100.00	100.00	100.00
Petroleum	1	80.00	80.00	80.00
Survey	1	0.00	0.00	0.00
Surveying	2	23.08	47.26	71.43
Wood	1	50.00	50.00	50.00

From the same table, we note that there is a big disparity among the various departments in terms of the number of staff with computers in their offices. Some departments have the ideal staff-computer ratio of 1:1 while in others, the percentage of staff with computers in their offices is quite low.

. s t n v nv st s

The effective use of ICTs' for teaching will depend on levels of access by staff engaged in the teaching of various subjects. Pre-lecture preparation work, delivery of the content and getting feedback from students is greatly enhanced when computer access is made possible.

A look at individual universities, without regard to subject area, shows that except for Botswana where each member of staff has a computer, all other universities have departments that have no computers for staff or with very low ratios of less than 1:11. However, table 6.3 shows that some other universities in the region are gradually moving towards the ratio 1:1 for computer: staff. In university of Addis Ababa even in the least –endowed department (i.e. Department of Physics) a quarter of the staff have access to computers. This represents a ratio 1:4.

Table 6.3: Percentage of Staff with Computers (By University)

Percentage of Staff with Computers (By University)

University	Country	Number of depts Analysed	Minimum Percentage Staff With Computers	Dept with Min. %	Average Percentage Staff With Computers	Maximum Percentage Staff With Computers	Dept with Min. %
Addis	Ethiopia	10	25.00	Physics	60.88	100.00	Geology
Michael Okpara	Nigeria	0					
Zimbabwe	Zimbabwe	10	10.00	Geology	49.20	83.30	Mechanical
Malawi	Malawi	8	0.00	Biology	31.65	100.00	Agricultural
Ahmadu Bello	Nigeria	17	6.67	Biology	22.40	50	Electrical
Lagos	Nigeria	14	0.00	Biology	30.40	100.00	Computer
Nigeria - Nsukka	Nigeria	15	0.00	Botany	23.46	100.00	Computer
JKUAT	Kenya	11	3.30	Chemistry	21.84	55.56	Mechanical
Dar-es-salaam	Tanzania	4	2.00	Zoology	45.20	100.00	Civil
Nairobi	Kenya	14	0.00	Survey	27.65	100.00	Computer
Botswana	Botswana	13	100.00	Agricultural	100.00	100.00	Agricultural
Ibadan	Nigeria	17	5.88	Archeology	22.92	80.00	Petroleum
Cape Coast	Ghana	4	11.11	Physics	19.41	30.00	Chemistry
Lome	Togo	9	30	Civil	50	70	Geology

In Kenya, two universities were considered. There is no strong basis for comparison of the ICT situation in these universities since each of them lays emphasis in different areas of the programs that they offer. Whereas JKUAT is basically an engineering-oriented university, established purposely to develop capacity in engineering disciplines, the University of Nairobi, on the other hand is an established university which seeks to wholesomely develop all faculties equitably. The department of Survey at the University of Nairobi has no computers for

staff, while in JKUAT only 3.3% of the staff have access to computers. The latter represents a ratio of 1:30. It is only in the department of mechanical engineering that about half the staff (55%) have access to computers. By way of comparison, in the University of Nairobi, all staff in the department of mechanical engineering have access to computers.

While it is clear that due to the oil industry situation in Nigeria, the department of Petroleum at the University of Ibadan will inevitably be well equipped with ICT facilities (at 80% staff have access to computers) we can only speculate that there could be special reasons why for instance, the University of Malawi enjoys a 1:1 staff-computer ratio in Agriculture.

. o t o ý y t s

The number of Computer laboratories is largely determined by the student population in a department. However, there are other extenuating factors, such as space and ability to equip these laboratories that need to be considered. Take for instance Addis Ababa University where the total student population for Science and Engineering is 3000. Assuming that all these students need access to computer facilities, the student-computer ratio would be 1:24. This is quite low.

From the survey we find that, on average, there are 67 computers per university for teaching first degree basic science courses. Table 6.4 below gives a summary for both engineering and basic sciences.

Table 6.4: Course-Computer ratio per University

Area	Average No of Computers/ university for teaching all courses in basic sciences and Engineering	Total No. of Computers reported from all Universities in the survey	Total No of undergraduate Courses	Course-Computer ratio
Basic Sciences	67.0	670	103	6.5
Engineering	62.6	625	69	9.1

This table paints a general picture of the computer situation across all universities. It does not show the weak or strong institutions. There are several institutions (e.g. University of Nairobi and University of Botswana) with the number of computers considerably higher than the averages mentioned in table 6.4.

Table 6.6: Analysis of First Degree Course - Student Populations (Engineering Sciences)

Subject	Number of Universities Analysed	Average First Degree Population	Total Population
Agricultural	8	112.25	898
Architecture	1	137.00	137
Biomech	1	30.00	30
Building	1	563.00	563
Chem/Biochem	4	406.75	1627
Civil	11	308.27	3391
Comp Eng	2	57.50	115
Design Tech	1	107.00	107
Electrical	10	313.70	3137
Electronic	1	515.00	515
Environ	1	182.00	182
Geodetic	1	238.00	238
Geoinfo	1	310.00	310
Geological	1	115.00	115
Geomatic	1	60.00	60
Industrial	1	160.00	160
Materials	1	119.00	119
Mechanical	11	277.45	3052
Mechatronic	1	60.00	60
Metallurgical	2	288.00	576
Metalurgy	1	100.00	100
Mining	1	150.00	150
Petroleum	1	171.00	171
Pre-Eng	1	204.00	204
Survey	1	130.00	130
Surveying	2	179.00	358
Wood	1	40.00	40
Total	**69**		**16,545**

Average population per course	240
Total student population in surveyed institutions	16,545
No. of computers needed to satisfy a 1: 5 stud ratio	3,309
No. of computers in Engineering Sciences in surveyed institutions	625
Deficit between needed and current no.	2,684
Additional no of computers needed per course (69 courses)	38.90

Tables 6.5 and 6.6 show the average population of students enrolled for various courses in Basic and Engineering Sciences respectively. For each table, the first column indicates the subjects considered while the number of universities where each subject in question is established is indicated in the second column. The

average enrollment for each subject is indicated in column 4. The total population (Average multiplied by the number of Universities analysed) for each subject across universities is given in the last column. At the bottom of the table is a summary of averages and projections.

These tables give us a snapshot of the situation in terms of enrollments in order for us to make a statement on the adequacy of the facilities. The summaries at the end of each of the two tables indicate that in order to attain a reasonable student-computer ratio of about 1 to 5, it is necessary to purchase about 55.1 and 38.9 computers for each Basic and Engineering Science course respectively.

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Although the figures in the tables given above are quite averaged, it is clear that there is need to improve access to computers in most of the universities. Access to computers by students is very limited. There are also remarkable disparities in the number of computers in each university. On average there are 6.5 computers available to students per basic science course as shown in table 6.4. This means that in order to achieve a fair ratio of 1 computer for 5 students, the enrolment level should not be more than 33 students per basic science course. However, we notice from table 6.5 that except for the Lab Technologists course, the lowest average student population in a course is 89.5 (in geography) while the overall average number of students in each course is 308. In order to maintain the current enrolment levels of 308 students then more computers per course must be bought. This averages to 55 additional computers per course: a figure that is eight times more than the current average level.

The situation is somewhat similar in Engineering where the average number of computers per course is 9.1 (see table 6.4) for an average student population of 240 (16545 students for 69 courses) per course. **This averages to about 26 students per computer**. In order to maintain an overall ratio of 1 computer for 5 students, each department shall need to purchase an additional 38.9 computers - which is about 4.3 times more than the current level.

We also note that in general, only 10 out of the 30 departments surveyed across disciplines have more than half of their staff who have computers in their offices. Even in Computer Science departments where it would be expected that each staff member has a computer in the office, we find that this is not the case. In some situations, the percentage of staff with office computers in a few of these departments is as low as 12.5%.

These statistics point to a situation which requires a substantial input of resources in order to achieve a realistic ICT infrastructure and access that will be supportive to the improvement of the teaching of Science and Engineering subjects. Lack of books is one big problem that is experienced in most African universities. It is instructive for universities to develop policies that will address the creation of sound ICT infrastructures that will allow the innovative use of ICTs' in e-learning, e-books and resource sharing.

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Two issues stand out as far as laboratory facilities are concerned: the working condition of the equipment and the availability of competent staff to facilitate its correct use and maintenance. The quality of a laboratory is determined by both the equipment it carries and the quality of staff
that operate them. Furthermore, the stock of working equipment can increase considerably as a result of good maintenance by a well trained staff. Their state notwithstanding, access to these facilities and the physical laboratory space are also equally important.

There are two factors about stock of equipment which is important in relation to availability. These are the average age of equipment and whether it is in working order. Both were examined.

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Quality training is not guaranteed if students do not actively engage in laboratory exercises during the training period. Basic science subjects such as Physics, Chemistry and Biology are not complete without practical sessions. Neither is computer Science which requires rigorous training in software development and digital signaling. Engineering subjects also require laboratory sessions which sometimes demands highly specialized equipment to complete the training.

Moreover, in most cases, laboratory resources are shared among many students. If the sharing is not well coordinated, we end up with a situation where only a few students learn while others are spectators. This is not good if we are to ensure that quality graduates come out of the system.

Table 7.1 below paints a picture of the situation at the various universities in as far as the state of equipment is concerned. It shows the minimum, maximum and averages of the percentages of the equipment that are in working order condition in both basic and engineering sciences. The departments which registered the minimum and maximum are also shown.

Table 7.1: Laboratory Facilities at individual Universities

Equipment Working Order Analysis (By University - Basic & Engineering Sciences)						
University	No of Depts Analysed	Min % in Good Order	Dept With Min %	Average % in Good Order	Max % in Good Order	Dept With Max %
Addis Ababa	9	70.00	Geology	80.00	90.00	Chem/ Biochem
Michael Okpara	11	0.00	Agricultural	37.27	60.00	Biochem
University of Zimbabwe	14	10.00	Biology	53.93	100.00	Computer
University of Malawi	8	40.00	Biology	58.75	80.00	Mechanical
Ahmadu Bello	16	20.00	Agricultural	32.50	40.00	Biochem
University of Lagos	12	10.00	Geoinfo	38.00	60.00	Biology
Kwame Nkrumah	12	60.00	Agricultural	70.80	90.00	Materials
University of Nigeria, Nsukka	12	55.00	Electrical	62.90	70.00	Biochem
JKUAT	11	50.00	Chemistry	75.90	90.00	Botany
University of Nairobi	14	20.00	Civil	56.79	90.00	Computer
University of Botswana	7	80.00	Agricultural	87.86	95.00	Civil
University of Ibadan	17	5.00	Geology	35.71	60.00	Computer
University of Cape Coast	4	60.00	Physics	78.75	90.00	Chemistry
Université De Lomé–Togo	7	10.00	Geology	30.00	60.00	Civil
Ecole des Mines	3	89.00	Electrical	93.33	97.00	Mining

The table shows that laboratory facilities in most African Universities are generally not well maintained. On average half of the universities that responded indicated that not more than 60% of their equipment was in working order. About a third of them have more than half of their equipment out of order. In some cases only 5% of the equipment was in good working state. There are only a few cases where nearly all the equipment is in good working order. There is need therefore to address the state of equipment in most of these universities through adequate maintenance programme. However, maintenance in some cases may be difficult because, as we shall see later, some of the equipment are quite old and therefore may not have spare parts on the market.

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Table 7.2 below shows details on minimum and maximum percentages of equipment in working order for various subjects across universities. This table gives an indication of the relative state of the equipment in various subject disciplines in the basic sciences. It is noted that the average percentage of equipment that is in good working condition in various departments vary quite significantly.

Table 7.2: Equipment Working order analysis (Basic Sciences)

Subject	Number of Universities Analysed	Min % in Good Order	Average % in Good Order	Max % in Good Order
Archeology	1	35.00	35.00	35.00
Biochem	9	30.00	54.44	80.00
Biology	7	10.00	48.57	80.00
Botany	6	35.00	64.17	90.00
Chemistry	12	15.00	58.75	90.00
Comp Tech	0			
Computer	8	0.00	71.38	100.00
Environ	0			
Geography	2	30.00	45.00	60.00
Geology	7	5.00	52.14	90.00
Lab Tech	0			
Math	6	0.00	62.50	100.00
MetLogy	1	50.00	50.00	50.00
MicroBio	3	30.00	50.00	70.00
Nutrition	0			
Physics	13	20.00	58.46	90.00
Statistics	2	0.00	2.50	5.00
Textile	1	40.00	40.00	40.00
Zoology	6	30.00	55.83	90.00

Chemistry, Physics and Biochemistry are the three most common departments established at the various universities. The percentage of equipment in working order in laboratories in these important subject disciplines is as low as 15% in some universities. In others, it is as high as 90%. On average 58.8% of the chemistry laboratory equipment in the region are in working order. This implies that there are chemistry departments within these universities where about half of the equipment are unused as they are not in good working condition. This consequently means that students do not carry out their experiments effectively and this can have a negative effect on the quality of education provided. One wonders what happens with the equipment since over time they may not be serviceable due to the unavailability of spare parts, rusting or even lack of appropriate software in case of the computers.

There are cases of departments such as Computer Science, Statistics and Mathematics in which no equipment is in working order. However, there are also instances in both Computer Science and Mathematics departments where all equipment were in good working condition.

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The situation of the state of equipment in Engineering sciences is as shown in tables 7.3. In the case of engineering sciences, the statistically meaningful data in table 7.3 are those of mechanical, civil and electrical engineering where the number of respondents is significant. On average only about 55% of the equipment in those departments are in working order. The situation here is comparatively fairer than it is in basic sciences; with only 5 departments out of a total of 63 recording an average of 70% or above of equipment in working-order condition. Perhaps these favourable figures for Engineering are due to the fact that Engineering faculties or schools usually have workshops for repair of equipment which facilitates the maintenance process.

Table 7.3: Equipment Working order analysis (Engineering Sciences)

Equipment Working-Order Analysis (Engineering Sciences)				
Subject	Number of Universities Analysed	Min % in Good Order	Average % in Good Order	Max % in Good Order
Agricultural	10	0.00	54.00	80.00
Building	1	80.00	80.00	80.00
Chem/Biochem	4	30.00	55.00	90.00
Civil	11	20.00	61.82	95.00
Comp Eng	1	80.00	80.00	80.00
Design Tech	1	80.00	80.00	80.00
Electrical	11	30.00	57.27	85.00
Electronic	1	55.00	55.00	55.00
Environ	1	30.00	30.00	30.00
Geoinfo	1	10.00	10.00	10.00
Geological	1	60.00	60.00	60.00
Industrial	1	50.00	50.00	50.00
Materials	1	90.00	90.00	90.00
Mechanical	9	10.00	51.67	80.00
Metallurgical	2	10.00	17.50	25.00
Metalurgy	1	20.00	20.00	20.00
Mining	1	70.00	70.00	70.00
Petroleum	1	42.00	42.00	42.00
Survey	1	50.00	50.00	50.00
Surveying	2	30.00	35.00	40.00
Wood	1	50.00	50.00	50.00

The table further shows that there are engineering departments in some universities where the percentage of equipment in working order condition is as low as 10% while in others it is as high as 95%.

Average age of Equipment in both Science and Engineering Faculties

Table 7.4 given below shows the average age of equipment in basic and engineering sciences respectively. The table also shows the number of years since the establishment of the science and technology faculties in various universities.

We note that in some cases the age of the equipment is about a quarter of a century old. It is in those universities where such old equipment exists that most of the experiments are not done. A case in point is the University of Lagos where only half of the experiments are done with equipment which are as old as 26 years and in poor state of maintenance (see table 7.5). Recently established universities such as JKUAT and Botswana have engineering equipment that are generally well maintained and in good working-order condition. For instance, over 90% of the engineering experiments at the University of Botswana and Jomo Kenyatta are carried out. The average age of the equipment at JKUAT is 9 years (with the last purchase of new equipment having been made in the year 2000) while in the University of Botswana, the average age of equipment is about 4 years (with the latest equipment having been bought in the year 2002). However, this situation cannot be generalized for the basic sciences situation in JKUAT where the equipment were recorded as being in poor state.

In general the reported average age of laboratory equipment is too high (11.6 years for basic sciences and 15.8 years for engineering sciences). Significant changes in laboratory technology have occurred in the last 10 years. Hence African institutions are clearly lagging behind their counterparts in other continents in the area of experimental science.

Table 7.4: Average age of equipment

University	Age of equipment in Basic Sciences	Age of equipment in Engineering Sciences	Age of Sc. and Tech departments (years since courses were first started)
Addis Ababa University	10	10	52
Michael Okpara University of Agriculture, Umudike	5	-	8
University of Zimbabwe	11.3	-	45
University of Malawi	14.5	23	35
Ahmadu Bello University	-	-	
University of Lagos	14.8	26	38
Kwame Nkrumah University of Science and Technology	14.6	12.6	51
University of Nigeria, Nsukka	25	30	42
JKUAT	5.4	9	12
University of Dar es Salaam	-	-	
University of Nairobi	17	14.5	43
University of Botswana	5	4	20
University of Ibadan	13.4	11	27
University of Cape Coast	12	-	40
Université De Lomé–Togo	17.5	18	30
Ecole des Mines	-	-	-
Average	11.6	15.8	

Apart from the most fundamental experiments whose requirements for successful execution do not change over a long period of time, there are many categories of experiments that require kits that are compatible with modern scientific inventions such as in microprocessor electronics. We therefore note that with most of the equipment in both science and engineering faculties averaging about 11.6 and 15.8 years old, some of the experiments may not be done. Table 7.5, which shows that on average, over 70% of the experiments in either basic or engineering sciences are not done, tends to confirm this fact. And in over half of the universities surveyed, the equipment used in both faculties of science and engineering are more than half the age of those faculties: with three quarters of these equipment being over three decades old.

Table 7.5: Percentage of Experiments not done

University	Basic Sciences (%)	Engineering Sciences (%)	Average state of equipment
Addis Ababa University	20	14.8	Average
Michael Okpara University of Agriculture, Umudike	60	5.3	Poor
University of Zimbabwe	33	35.7	Average
University of Malawi	42	23.8	Average
University of Lagos	22.5	58.3	Poor
Kwame Nkrumah University of Science and Technology	11	16.4	Average
University of Nigeria, Nsukka	12	30	Avg – basic & poor for Eng.
JKUAT	32	10	Poor – Basic & Good - Eng
University of Nairobi	26.4	16.3	Average
University of Botswana	0.5	7.5	Good – Eng. & Avg- Eng.
University of Ibadan	53.5	29.3	Poor
University of Cape Coast	15	-	Good
Université De Lomé–Togo	57.5	80	Poor
Average	*29.65*	*27.3*	

Generally speaking, from tables 7.4 and 7.5, it appears that universities which have newer equipment will not necessarily have bigger percentages of experiments being done. The most likely reason for this situation is the low rate of equipment maintenance. For instance the average age of basic science equipment at the Michael Okpara and JKUAT universities is about 5 years old and yet they both recorded higher percentages of 60% and 32% respectively of undone experiments. Indeed, both universities recorded that their basic science equipment are in a poor state of maintenance.

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There is a general deficiency in the number of technical staff engaged in supporting laboratory work for various courses. However, in some situations there are quite a significant number of staff manning a poorly maintained stock of equipment. We consider the situation with respect to engineering and basic sciences.

Technical staff analysis – Basic Sciences

Table 7.6 below shows the maximum, minimum and average number of technical staff in each of the departments across universities. As already mentioned, the stock of functioning equipment can significantly improve if there are competent technical staff who will carry out the maintenance of these equipment. However, we still find that even in departments where the average working-order

condition is quite low and with a number of experiments going undone, the number of technical staff is still relatively quite high as evident at the department of Archeology (in Ibadan) and Geography (in Ahmadu Bello and Nairobi) where the averages are 8 and 7 respectively. This is confirming the fact that most experiments go undone perhaps for reasons more to do with the unavailability of equipment (or due to their poor state) rather than lack of qualified laboratory staff. This is also an indication that the technical staff is not effectively utilized in some departments. Another case in point is the department of Computer Science where the average percentage of working equipment is 71.4% and yet the number of technical staff averages to about 8.

Table 7.6: Number of Technical staff engaged in laboratory work (Basic Sciences)

Technical Staff Analysis (Basic Sciences)				
	Number of Universities Analysed	Min No. of Technical Staff	Average No of Technical Staff across varsities	Max No. of. Technical Staff
Subject				
Archeology	1	8	8.00	8
Biochem	8	1	10.50	25
Biology	7	3	10.71	30
Botany	7	2	10.71	16
Chemistry	11	5	14.45	27
Computer	8	1	7.38	30
Geography	1	7	7.00	7
Geology	7	2	5.29	9
Math	6	1	1.50	3
MetLogy	1	9	9.00	9
MicroBio	3	3	13.00	22
Physics	12	6	13.17	33
Statistics	3	1	1.33	2
Textile	1	7	7.00	7
Zoology	7	2	9.71	18
Average		**8**	**15**	

Technical staff analysis – Engineering

The relationship between the number of technical staff and the working-order condition of equipment in the Engineering Sciences is similar to that in Basic Sciences. Generally, the number of technical staff does not seem to have a relationship with the general state of the equipment. For instance, the department of Geoinformatics at the University of Lagos has 8 members of staff and yet only 10% of the equipment are in good working-order condition. If we compare the

information given in table 7.7 below with that given in table 7.3, we notice that there is no general trend in the number of technical staff vis-à-vis the state of equipment.

Table 7.7: Technical staff engaged in laboratory work (Engineering Sciences)

Technical Staff Analysis (Engineering Sciences)				
	Number of Universities Analysed	Min No. of Technical Staff	Average No. of Technical Staff across universities	Max No. of Technical Staff
Subject				
Agricultural	9	0	7.44	15
Architecture	1	2	2.00	2
Building	1	3	3.00	3
Chem/Biochem	3	1	3.33	5
Civil	10	4	10.00	15
Design Tech	1	7	7.00	7
Electrical	10	4	10.10	28
Electronic	1	5	5.00	5
Environ	1	5	5.00	5
Geoinfo	1	8	8.00	8
Industrial	1	1	1.00	1
Mechanical	10	3	11.40	29
Metallurgical Eng	2	2	2.50	3
Metallurgy	1	3	3.00	3
Mining	1	1	1.00	1
Petroleum	1	3	3.00	3
Survey	1	11	11.00	11
Surveying	2	4	5.00	6
Wood	1	1	1.00	1
Average		**4**	**5**	

This scenarios may indicate the fact that technical staff are not only engaged in manning the laboratory 29

From the analysis of Table 7.7 we note that in general, the equipment in some of the newer universities are still in good working condition because they were recently installed. However, it is quite likely that with the passage of time, the performance of these equipment will degrade just like it has happened in some of the older universities where the equipment have not been replaced for a very long time. It is also true from the above analysis that the age of equipment will largely determine the quality of courseware provision. For instance, the University of Botswana, which records the lowest average age of equipment, indicates that almost 100% of the experiments are conducted.

Technical staff and equipment maintenance

It is apparent from the analysis that most equipment in departments are not well maintained. **Consequently, about 55% of equipment in most departments are not in a state in which they can be used to carry-out experiments**. The net effect of this scenario is that only a small percentage of experiments are done. In some cases, the analysis has shown that, the availability of technical staff did not make any difference to the stock of equipment in good condition. Either, the technical staff in these departments are not fully engaged or they are also available for other technical duties such as field-work supervision. It may also be due to the non-availability of spare parts as most of the equipment may no longer be manufactured.

Some Recommendations

It is recommended that universities address the issue of non-availability of the laboratory facilities for conducting the experiments for various courses. This situation, occasioned by malfunctioning equipment or no equipment at all, is a big challenge towards the improvement of the teaching of Science and Engineering subjects. Newer universities need to safeguard against a situation that seems to have engulfed older, well established universities, in which most of the equipment are, quite often, not replenished nor serviced.

The state of equipment has a bearing on the quality of education that is offered by a university. In the era of competition for the best students to join institutions, it will not be totally unexpected to find sponsors and even individual parents and students who wish to find out the kind of equipment that are available before enrolling students in a higher learning institution. Therefore, there should be deliberate efforts by individual universities towards ensuring that the necessary attention is given to the state of laboratory equipment in the various departments.

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To assist the teacher in achieving the learning objectives a number of tools and reference materials can be used. The lecturer may, for instance prepare notes from current sources and materials and then print and make copies for students. On the other hand, the lecturer may use an overhead projector as an aid to the delivery of content. It is also important that students have access to standard texts for a course. This makes the work of the lecturer easier and indeed enriches the teaching process.

Basic and engineering science subjects quite often require experiments to be conducted in laboratory settings or in the field. In situations where such experiments cannot be set up, modeling and simulation techniques may be used to demonstrate concepts. This requires that institutions acquire the relevant hardware and software tools to make such experiments possible. The cost of simulation can be significantly low and yet help achieve the objectives quite effectively.

In this study we examine the methods that are used to teach basic and engineering science courses in African institutions. We shall find out in general, whether universities in the region use printed notes to teach, or use overhead projectors, supply photocopy materials to students, use standard texts for teaching or employ simulation techniques to inculcate concepts.

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In this section we discuss issues related to the use of printed notes, standard texts, photocopy materials, projectors and simulation for teaching. To enable this discussion, a number of tables have been constructed to summarise the raw data collected. Tables 8.1a to 8.1e describe the use of different methods for instruction. The top row of each of these tables shows the category in question while the next row lists the universities. On the leftmost column of each table, we have two bands with the upper band representing Basic Sciences while the lower band represents Engineering Sciences band. For each band there are four rows.

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Lecturers who keep softcopy content of the subjects they teach can easily provide their students with printed materials. This is an advantage to the student since such notes are likely to be as current as possible. It is also easier for the lecturer to make changes as and when need be.

To be able to give printed notes one has to either prepare these notes using computer equipment in his/her office or have them typed by secretarial staff in the department. Whichever option, both need computer facilities in order to execute.

The use of printed notes for teaching is not widespread as shown in table 8.1a below. On average about 35.8% of the departments in the faculty of science use printed notes for teaching while only 22% of the departments in engineering departments do. The differences between basic and engineering sciences could be explained by the fact that in basic sciences, there are core courses that are taught by the use of computers and hence, inevitably both staff and students will have access to computer facilities which they would use for various functions including notes preparations.

There are also large variations among universities in both basic and engineering departments. Moreover, universities which recorded higher percentages of printed notes use by respective departments in basic sciences do not necessarily record higher percentages in engineering science departments. For instance Kwame Nkrumah, Michael Okpara and Nsukka all have over æ of their departments in basic sciences using printed notes. However, both Kwame Nkrumah and Nsukka recorded lower rates in engineering sciences.

Generally, from the above analysis, there is no direct relationship between statistics on staff with computers in their offices and the use of printed notes by departments. This may be corroborated by data on Nsukka which had a low percentage average of staff with computers standing at about 23.5%, while Addis Ababa and Botswana which had higher averages of 61% and 100% of staff with computers in their offices respectively had only 3 (33.3%) and 4 (44.4%) departments respectively that provided printed notes. This scenario may be explained by the fact that some of the staff who provide printed notes to students rely on departmental secretarial services.

This scenario seems to suggest that staff having a computer in their offices does not necessarily imply that they will use these computers to produce printed notes - a rather undesirable situation as it negates the spirit for which computers should be given to staff.

Table 8.1a: Use of Printed Notes

	Printed Notes															
		Addis	MOU	UZ	Mala	Ahma	Lagos	Kwame	Nsukka	JKUAT	Dar	Nbi	Bots	Ibad	Cape Coast	Avg
Basic	No response	6	3	6	6	3	5	6	3	5	15	4	6	3	5	
	No: of depts. Using the tech.	3	9	2	1	0	0	7	11	1	0	6	4	0	4	3.4
	No: of dept which replied not using the tech.	6	3	7	8	12	10	2	1	9	0	5	5	12	6	
	% of users among respondents	33.3	75.0	22.2	11.1	0.0	0.0	77.8	91.7	10.0	-	54.5	44.4	0.0	40.0	35.8 %
Engineering	No response	16	18	17	19	16	17	16	19	15	28	17	18	17	18	
	No: of depts. Using the tech	5	1	5	0	0	0	9	0	7	0	1	3	0	0	2.2
	No: of dept which replied not using the tech.	7	9	6	9	12	11	3	9	6	0	10	7	11	10	
	% of users among respondents	41.7	10.0	45.5	0.0	0.0	0.0	75.0	0.0	53.8	-	9.1	30.0	0.0	0.0	22%

Table 8.1b: Use of Standard Text

	Standard Text															
		Addis	MOU	UZ	Mala	Ahma	Lagos	Kwame	Nsukka	JKUAT	Dar	Nbi	Bots	Ibad	Cape Coast	Avg
Basic	No response	6	4	6	6	3	5	6	3	5	15	4	5	3	5	
	No: of depts. Using the tech.	1	0	0	0	0	1	0	7	4	0	1	4	10	0	2.0
	No: of dept which confirmed not using the tech.	8	11	9	9	12	9	9	5	6	0	10	6	2	10	
	% of users among respondents	11.1	0.0	0.0	0.0	0.0	10.0	0.0	58.3	40.0		9.1	40.0	83.3	0.0	
Engineering	No response	16	18	17	19	16	17	16	19	15	28	17	18	17	19	
	No: of depts. Using the tech.	5	0	1	0	0	2	0	0	7	0	1	5	7	0	2.0
	No: of dept which confirmed not using the tech.	7	10	10	9	12	9	12	9	6	0	10	5	4	9	
	% of users among respondents	*41.7*	*0.0*	*9.1*	*0.0*	*0.0*	*18.2*	*0.0*	*0.0*	*53.8*		*9.1*	*50.0*	*63.6*	*0.0*	

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Learning is made relatively more convenient and even easier when standard text-books are used for teaching. It is also cost effective to use standard text books in the event that other backup resources are not available to the students due to financial constraints. Furthermore, teaching is done more methodically and it is a means of ensuring provision of quality education.

In Table 8.1b a summary of departments that use standard text books for teaching is given. Although a few universities (Ibadan, Nsukka, and JKUAT) in the region have adopted standard text-books for teaching, their use is not widespread across universities. The table shows that both Basic and Engineering Sciences have an average of 2 departments per university that use standard text books. This is a quite low. It is instructive to note that the faculties of Science and engineering at the University of Ibadan have both recorded high percentages of departments that use standard textbooks. It is, however, interesting to note that this university has no widespread use of ICT facilities such as computers and photocopiers to support learning; a possible reason why the use of standard text-books is encouraged.

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Photocopying services are crucial especially in Basic and Engineering Sciences where diagrams and illustrations are often used and need to be reproduced for students. In addition, time is saved in the preparation of lecture notes and other teaching materials which are made available to students in a more convenient manner.

The cost of running this service may however be prohibitive in departments whose budgets are thin. Departments may therefore wish to charge a small fee for making photocopies for students. The effective saving that students make as a result of receiving photocopying services even at a fee is in terms of the time gained to copy notes – time which the students shall use in studies rather than transcribing notes.

Table 8.1c: Use of Photocopy equipment

	Photo copy															
		Addis	MOU	UZ	Mala	Ahma	Lagos	Kwame	Nsukka	JKUAT	Dar	Nbi	Bots	Ibad	Cape Coast	Avg
Basic	No response	6	4	6	6	3	5	6	3	5	15	4	5	3	5	
	No: of depts. Using the tech.	4	9	7	2	9	4	0	11	3	0	8	4	10	4	5.4
	No: of dept which confirmed not using the tech.	5	2	2	7	3	6	9	1	7	0	3	6	2	6	
	% of users among respondents	44.4	81.8	77.8	22.2	75.0	40.0	0.0	91.7	30.0		72.7	40.0	83.3	40.0	
Engineering	No response	16	18	17	19	16	17	16	19	15	28	17	18	17	19	
	No: of depts. Using the tech.	5	0	5	4	9	1	0	5	7	0	2	4	7	0	3.5
	No: of dept which confirmed not using the tech.	7	10	6	5	3	10	12	4	6	0	9	6	4	9	
	% of users among respondents	41.7	0.0	45.5	44.4	75.0	9.1	0.0	55.6	53.8		18.2	40.0	63.6	0.0	

Table 8.1c shows a summary of the number of departments that provide photocopy services at the various universities. The table indicates that the use of photocopy services across universities and across departments varies widely. In some cases, the percentage of basic science departments that provide photocopy services is as high as 91.7% while in other universities the percentage is as low as 22.2%. In general, we note that about 56% of the 134 basic sciences departments provide photocopy services to students.

The situation in engineering sciences is somewhat similar; with only about 35% of departments across universities offering photocopy services. Few universities recorded the engineering faculties as having more than half of their departments offering the service. For example, only the universities of Ahmadu Bello, Nsukka, JKUAT, and Ibadan had over 50% of their departments providing photocopying services.

Although the initial investment in the purchase of a photocopy machine may look prohibitive, the long term benefits are quite enormous in terms of improvement of the quality of teaching, and content delivery convenience and therefore it is recommended that departments should invest in this form of ICT.

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A combination of different technologies can enhance the delivery of content and may significantly improve the quality of teaching. Common methods of delivery used in a university setup include lectures with students taking notes, giving notes on black/white boards, provision of handouts and use of presentation software and hardware to project slides. In this section, we consider the use of projectors as an aid to teaching.

As is the case with other technologies, projectors are not in widespread use. There is also marked variations across departments of the various universities. For instance, whereas about 82% of the basic science departments in Nairobi have projectors, only about 10% of the basic science departments in Jomo Kenyatta university use projectors.

Table 8.1d: Use of Projector

	Projector															
		Addis	MOU	UZ	Mala	Ahma	Lagos	Kwame	Nsukka	JKUAT	Dar	Nbi	Bots	Ibad	Cape Coast	Avg
Basic	No response	6	3	6	6	3	5	6	3	5	15	4	5	3	5	
	No: of depts. Using the tech.	4	0	7	3	0	2	7	0	1	0	9	4	0	4	2.9
	No: of dept which confirmed not using the tech.	5	12	2	6	12	8	2	12	9	0	2	6	12	6	
	% of users among respondents	44.4	0.0	77.8	33.3	0.0	20.0	77.8	0.0	10.0		81.8	40.0	0.0	40.0	
Engineering	No response	16	18	17	19	16	17	16	19	15	28	17	19	17	19	
	No: of depts. Using the tech.	5	0	7	1	0	0	9	0	0	0	3	5	0	0	2.1
	No: of dept which confirmed not using the tech.	7	10	4	8	12	11	3	9	13	0	8	4	11	9	
	% of users among respondents	*41.7*	*0.0*	*63.6*	*11.1*	*0.0*	*0.0*	*75.0*	*0.0*	*0.0*		*27.3*	*55.6*	*0.0*	*0.0*	

Out of a total of 139 Engineering Sciences departments which responded to this part of the questionnaire only 30 or 21.6% said that they use projectors during teaching. The variation is also widespread ranging between 0% to about 75%.

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Simulation is basically a specialized means of teaching concepts in a cost-effective manner. It becomes possible for real-life situations to be modeled using computer aided techniques. Events which could otherwise take several years to take place can be hastened in a computer simulation. They are programmed/simulated to occur within minutes or seconds and observations can be made based on these simulations. Science and Engineering subjects lend themselves quite naturally for such methodologies.

Only a few departments (14.1%) in Basic Sciences recorded the use of simulation for teaching while 31.2% recorded similar techniques as being used in Engineering Sciences.

We see a trend where in all cases, engineering faculties have many of their departments using simulation techniques than Basic Sciences do. This seems to confirm a fact that universities consider engineering subjects as better taught using simulation techniques than basic sciences and hence providing the necessary facilities. Indeed, due to the nature of the engineering subjects, most experiments would involve building miniature models of the real world and studying their behavior as opposed to carrying out laboratory experiments as in Basic Sciences.

Table 8.1e: Use of Simulation Techniques

	Simulation															
		Addis	MOU	UZ	Mala	Ahma	Lagos	Kwame	Nsukka	JKUAT	Dar	Nbi	Bots	Ibad	Cape Coast	Avg
Basic	No response	6	4	6	6	3	5	6	3	5	15	4	5	3	4	
	No: of depts. Using the tech.	0	0	2	2	0	1	1	3	0	0	2	3	5	0	1.4
	No: of dept which confirmed not using the tech.	9	11	7	7	12	9	8	9	10	0	9	7	7	11	
	% of users among respondents	0.0	0.0	22.2	22.2	0.0	10.0	11.1	25.0	0.0		18.2	30.0	41.7	0.0	
Engineering	No response	16	18	17	19	16	17	16	19	15	28	17	18	17	18	
	No: of depts. Using the tech.	0	0	7	0	0	3	6	5	7	0	5	4	7	0	3.1
	No: of dept which confirmed not using the tech.	12	10	4	9	12	8	6	4	6	0	6	6	4	10	
	% of users among respondents	0.0	0.0	63.6	0.0	0.0	27.3	50.0	55.6	53.8		45.5	40.0	63.6	0.0	

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It appears that the use of one type of teaching method is not necessarily preferred over another in a particular university. It is also uncertain on whether there is individual university-wide policy in the acquisition of the equipment that departments need for teaching and learning. Departments independently acquire what equipment they need as seems to be the case at the University of Nairobi where 81.8% of the departments have projectors in Basic Sciences while only 27.3% in Engineering do.

The use of standard text-books is not widespread. Only 15% of the departments across all the universities surveyed indicated that staff used standard textbooks. In such a situation staff and students rely on printed lecture notes. Several universities have departments where standard textbooks are not available.

Projectors are nowadays common phenomena as more and more departments recognize the need to improve on delivery of content. They are still fairly expensive and delicate machines which require diligent care and service. Most departments which have such resources would therefore rather not share them with others. It is recommended that each department should have at least one projector for use in teaching and also for use during seminar presentations.

Simulation is not possible when there are no computers. It is recommended that as more and more departments acquire computers, simulation exercises be designed alongside to improve quality of teaching.

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Execution of the functions of a department depends on the capacity of the hu-

disciplines; besides giving an indication on the economic differences among these countries. We also note remarkable differences in the average expenditures per student. In some departments, the allocations are as low are 12 US$ per student while in others it is over 3800 US$.

These allocations do not seem to be made in accordance with any firm criteria in terms of the type of course or the number of students per department. Departments that have higher average student populations do not appear to command higher budgetary allocations. For instance, both Botany and Chemistry have some of the highest averages of 424 and 451 students respectively and yet the average allocations per student was 124 and 561 US dollars respectively. Again, we note that the department of Biology in Zimbabwe has an allocation equivalent to US$827 while the same department in Botswana has over 1M US$ allocation. The average student population in this subject being about 570.

This analysis suggests that the allocations for departments are not dependent on the subject area. The most probable criteria for budgetary allocation is the sharing of the cake as equitably (in some cases equally) as possible. A case in support of this is the situation in JKUAT where all departments received equal amount of money. Perhaps this is a fairer way of sharing out the financial resources where the same is not adequate for any specific one.

Although some departments have relatively higher budgetary allocations, they do not necessarily have equipment that is better maintained. For instance, Biology, Geology and Physics are three departments that have very high average allocation per student and yet in chapter 7, we noted that the average percentage of equipment in working-order condition in these departments is not relatively any better than those departments that have lesser allocations. This may be due to the high cost of acquisition and maintenance of equipment in those subject areas.

We may make three remarks from this analysis:

- Student population and the type of course do not play significant determining roles on the level of yearly financial allocations per department in most of the universities in the region.

- Budget allocations in some institutions are as low as a few hundred dollars with a global average allocation per department in the basic sciences estimated at $40,000. This is equivalent to an allocation of $738 per student. These amounts are really very low and explain the poor state of the facilities that have been noted in the other parts of this report.

Table 9.1: Budgetary allocation for Basic Science courses

Department Budget Amounts Analysis (Basic Sciences)						Student Population					
Subject	No of Varsities Analysed	Min Amnt (US$)	Avg Amnt (US$)	Max Amnt (US$)	Variation in allocation	Avg Dipl. Pop.	Avg 1st Degree Pop.	Avg Masters Pop.	Avg PhD Pop.	Total Pop	Budget/ Student (US$)
Archeology	1	2,000	2,000	2,000			151	7	13	171	12
Biochem	7	1,143	7,763	29,828	28,685		237	15	12	264	206
Biology	6	827	191,182	1,025,999	1,025,172	99	432	33	6	471	2,435
Botany	5	2,000	10,494	29,828	27,828		395	24	6	424	124
Chemistry	9	498	28,125	126,975	126,477	89	422	21	8	451	561
Computer	6	499	10,893	37,285	36,786	103	248	40	8	296	221
Environ	0				-					-	
Geography	2	1,000	3,625	6,250	5,250		90	3	6	98	74
Geology	6	158	72,113	328,320	328,162	2	169	24	8	201	2,155
Lab Technol						55				-	
Math	9	100	17,241	63,639	63,539	133	353	19	6	379	410
MetLogy	1	1,250	1,250	1,250	-					-	
MicroBio	2	1,143	15,485	29,828	28,685		192	15	6	213	145
Nutrition	0				-						-
Physics	9	1,000	140,219	1,100,000	1,099,000	15	302	20	7	329	3,830
Statistics	2	2,300	14,200	26,099	23,799	200	275	16	9	300	95
Textile	1	1,143	1,143	1,143	-		342	28	12	382	3
Zoology	4	3,900	5,663	10,000	6,100		324	22	9	354	64
Average			***40,306***								***738***

- Although certain subjects like Mathematics and Computer Science have relatively lower budgetary allocations, the equipment in those departments are not necessarily in more severely degraded condition. This may suggest that departments have other sources of income such as research or donor funds that does not necessarily come from the central university budgets.

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Table 9.2 shows the engineering subjects established in various universities and the average financial allocations per subject. The table shows large disparities of average amounts allocated which are as low as US$125 in a Survey department and as large as US$130,917 for a Design Technology course. However, the average student population in those departments is comparable: being 130 and 107 students respectively. These figures suggest that the large disparities in allocations are not generally based on student population but rather could be due to economic power disparities in different countries.

The average financial allocation across all universities participating in the survey for Engineering Sciences is US$5520 per department; a figure much lower than the average for Basic Sciences allocation which is about US$40,305.

Table 9.2: Budgetary allocation for Engineering Sciences courses

Subject	No of Universities Analysed	Min. Amount reported (US$)	Avg. amount (US$)	Max Amount reported (US$)	Avg 1st Deg. Population
Agricultural	6	1,000.00	66,669.17	363,901.02	112
Architecture	1	21,176.47	21,176.47	21,176.47	137
Building	1	18,823.53	18,823.53	18,823.53	563
Chem/Biochem	3	1,428.60	7,564.44	11,764.71	407
Civil	9	287.00	44,130.82	266,760.00	308
Design Tech	1	130,917.00	130,917.00	130,917.00	107
Electrical	9	260.00	79,589.22	577,689.00	314
Environ	1	1,000.00	1,000.00	1,000.00	182
Geoinfo	1	2,857.00	2,857.00	2,857.00	310
Industrial	1	2,800.00	2,800.00	2,800.00	160
Mechanical	9	274.00	66,663.40	494,911.00	277
Metallurgical	2	1,000.00	2,875.00	4,750.00	288
Metalurgy	1	125.00	125.00	125.00	100
Mining	1	150.00	150.00	150.00	150
Petroleum	1	4,200.00	4,200.00	4,200.00	171
Survey	1	15,000.00	15,000.00	15,000.00	130
Surveying	2	125.00	562.50	1,000.00	179
Wood	1	1,000.00	1,000.00	1,000.00	40
Average			**5520**		

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In order to determine the relevance of the S&T education currently carried-out in these institutions, we shall examine the age of the current syllabus. Thus the date of the last revision of the syllabus will be used as an indicator of relevance. This of course assumes that the revision takes into consideration developments in the discipline and in society.

In this section, we take a general look at the ages of the syllabuses before we closely examine how universities and departments ensure that the quality of the academic programs is maintained.

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Table 10.1 below gives a summary of the ages of the syllabuses for each of the universities by indicating the oldest and newest in each case. The table also indicates the year when each of the universities were established in order to give us a feel on the rate at which revisions are made.

In general the syllabuses across the universities are not very old. Both older and newer universities review their syllabuses regularly. In almost all the universities, there are departments which have revised their syllabuses within this millennium. It appears however, that in general, older syllabuses are found in older universities. For instance in the universities of Zimbabwe, Malawi, Lagos and Nairobi – all relatively older universities, the syllabuses for Biology, Electrical Engineering, Mathematics, and Civil Engineering were last revised in diverse dates between 1987 and 1993. However, within the same universities, we also find some of the newest syllabuses in Mathematics (UZ), Agriculture (Malawi), and Chemistry in Lagos and Nairobi. These new syllabuses were last revised between 2001 and 2002. Each department has unique demands and requirements and perhaps we could attribute this diversity in terms of the dates of revision of syllabuses to this fact.

Table 10.1: Status of Syllabuses

Syllabus Analysis - Basic & Engineering Sciences							
Name of University	Country	Yr Establ-ished	Oldest Syllabus (Yr)	Dept with Oldest Syllabus	Most Recent Syllabus	Dept with Most Recent Syllabus	Age gap between oldest & newest Syllabi
Addis Ababa University	Ethiopia	1950	2000	Architecture	2001	Chem	**1**
Michael Okpara University of Agri-culture, Umudike	Nigeria	1993	2001	Biochem	2001	Biochem	**0**
University of Zimbabwe	Zimbabwe	1955	1993	Biology	2002	Math	**9**
University of Malawi	Malawi	1965	1987	Electrical	2001	Agricultural	**14**
Ahmadu Bello University	Nigeria	1962	2002	Agricultural	2002	Agricultural	**0**
University of Lagos	Nigeria	1962	1991	Math	2001	Chemistry	**10**
Kwame Nkrumah University of Science and Technology	Ghana	1951	2001	Agricultural	2001	Agricultural	**0**
University of Nigeria, Nsukka	Nigeria	1960	1992	Agricultural	1992	Agricultural	**0**
JKUAT	Kenya	1984	1995	Agricultural	2001	Comp Eng	**6**
University of Nairobi	Kenya	1970	1990	Civil	2002	Chemistry	**12**
University of Botswana	Botswana	1982	2000	Geology	2002	Agricultural	**2**
University of Ibadan	Nigeria	1948	1997	Chemistry	2000	Computer	**3**
University of Cape Coast	Ghana	1962	2002	Botany	2002	Botany	**0**

The need to make revisions to syllabuses seems to be well appreciated across

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It is one thing to review a syllabus to keep up with demands for various courses and yet quite another altogether to ensure that quality is maintained. Review and quality must go together if the intended objectives are to be realized.

There are several types of quality assurance schemes in use in the region. Some institutions use the system of external examiners while others use national and international accreditation arrangements. Below we examine these two modes and highlight how they are applied within the universities in the region.

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A common and popular method of achieving the goal of quality assurance is the engagement of an external examiner whose mandate is to check for consistency between the curriculum, the content taught and the examination process. Apart from using external examiners, universities also use other techniques such as a requirement that lecturers provide detailed course outlines for verification as well as involving assessors and stakeholders in vetting teaching methods and content.

All the universities sampled use one or more of the above techniques to ensure quality of the education given. In some departments, stakeholders who include industry partners may also be given a chance to contribute towards the review and/or development of the academic programs. Basic Science departments of Physics, Chemistry, Mathematics and Biology at the Addis-Ababa University are the only departments though that explicitly recorded that they use assessors and stakeholders for quality assurance. Several other departments across the rest of the universities said that they consult local stakeholders during curriculum review. It is also in Addis Ababa where it was explicitly recorded in the departments of Biology that detailed course outlines are submitted as a way of ensuring quality.

In both Basic and Engineering Sciences, the use of external examiners for quality assurance runs across almost all departments. Several departments also reported that they consult local stakeholders during curriculum review. This is particularly useful when universities intend to introduce industry-oriented programs.

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Accreditation is the form of quality assurance used by some institutions. It subjects all accredited universities to the same standards supervised by a regional or national accreditation board such as the institutions of professional engineers.

More than half of the universities indicated the existence of accreditation schemes in both Science and Engineering departments. All the accreditation bodies are national such as the Nigeria Universities Commission (NUC) and Higher education commission of Kenya. There are no regional accreditation bodies which monitor quality of courses.

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Chapter 4 of this report shows that there are departments which have very few enrolled students although such departments still have high student-lecturer ratio. Students are the clients for the various courses and a review of the syllabuses for such courses which have become less lucrative may be a necessary step. This will spur relevance and flexibility in terms of job-market and societal needs.

The use of external examiners as a means of ensuring that the quality of the programs is maintained is widely used. It is an integral part of the teaching and evaluation process in most of the universities. The level of delegation or authority that the examiners are given is quite high and this makes it a popular model for departments. A well coordinated external examination model can guarantee high quality of the academic programs.

Whatever model a university chooses will depend on the immediate and long term objectives. The cost of implementing either model can be substantial but the returns are of absolute importance. However, smaller institutions may opt for accreditation of their academic programs which is less costly.

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In response to demands by major donor and international financial institutions, African governments have over the last two decades neglected higher education institutions. Only limited financial commitments were made to universities most of which are public institutions. In light of this, there are many constraints in various science and technology departments in African universities that hinder the provision of quality and affordable education.

One of the objectives of this study was to obtain the views of the training institutions on the problems they consider to be the major constraints. Whereas, it is possible to make assessment on factors such as availability of staff, textbooks, etc, it is important that the institutions themselves be given the opportunity to identify those that they consider to be major problems requiring urgent attention. In this chapter, we consider some of these constraints.

. An ys so s v to n (h o h)

The questionnaire invited all respondents to list what they considered to be major constraints on the delivery of basic and engineering science education in their institutions. There was no prompting or suggestions on possible constraints. Thus the responses we received were genuine self-assessment of the state of institutions.

The constraints listed by the respondents were expressed in the words of the respondents hence the first step in the analysis was to group them according to the intended sense of the responses. The list of the constraints derived from this exercise is given in section 11.2 below.

The analysis involved a frequency count of all the identified constraints. From this frequency count we were able to rank the constraints.

. ǫ o nst nts nt

The main constraints that were recorded by departments across the board included the following:

Student attitude

This constraint, typically mentioned as "poor attitude due to dim job prospects in the market" was mentioned by two mechanical engineering departments. Students may develop poor attitude towards a course if the staff are not committed. Bad attitude may also be as a result of being forced to do a course that was not one's choice. This is rarely the case for a mechanical engineering course which is supposedly competitive in nature. Students may also loose interest if the facilities are poorly maintained or if they believe that there are no employment opportunities after course completion.

Staff Retention and Remuneration

This constraint was referred to in various ways. Some departments said that due to poor remuneration staff engage in other activities that are extraneous to their core functions at the department. There were a total of 82 cases (22%) where issues related to staff remuneration and subsequent low morale and departures were mentioned. In other departments there were cases where senior staff are not available to give guidance and direction.

Lack of Equipment

Without equipment for lab work, model creation, and other related experiments it is not possible to successfully run engineering or Science programs. This is the single most important issue in a university and yet the most poorly addressed by all of the fourteen universities. Respondents expressed this constraint in various ways such as "Lack of financial support to purchase the required equipment leads to poor morale" while in other cases they expressed the constraint as "Poorly maintained experimental kits that are outdated and hence only a few experiments are conducted".

Reference materials and journals

Library facilities are fundamental for an academic institution. This is where books and journals are stocked for reference and for other academic pursuits such as research. In various ways, several universities referred to this problem. Some referred to lack of journals, others mentioned reference books and still others

cited lack of library facilities. The pie chart below (chart 11.1) shows all these variations of this constraint represented as "Lack of Books".

Large Number of Students in class

A few Universities (2.9%) mentioned "large number of students" as a problem. The assumption here is that the respondents were concerned with the class sizes (i.e. number of students in a class). Departments said that due to large class sizes, the process of evaluation becomes tedious and time consuming.

Poor funding

Most of the constraints are as a result of poor funding from governments. However, in recent times more and more universities are charging some fees to subsidize government allocations. Departments expressed this constraint in various ways such as "Poor funding that lead to poor implementation of the programs" and "Poor funding that render laboratory equipment in poor state of use". Evidently, most of the constraints were expressed or viewed in terms of the limitations and challenges that they pose to the overall implementation of the programs.

Poor Management

This may be a major problem in most departments. However, only one department said that some of the academic programs are poorly managed and this leads to low morale among staff.

The issue of Students Inter-faculty Transfer

This appeared to be a major problem to the University of Botswana. The concerns were raised by departments where inter-faculty transfers were possible. They lamented that these transfers sometimes render their faculties to remain with less academically endowed students.

Research and Development Activities

Most of the research that is conducted in the universities in the region is made possible through the generosity of donor agencies who in most cases are interested in specific areas of research and output. Some universities expressed concern that there is little financial resources available in conducting research. Others said that there is little time available to carry-out research as most of their time is taken up making extra income to supplement their meager pay.

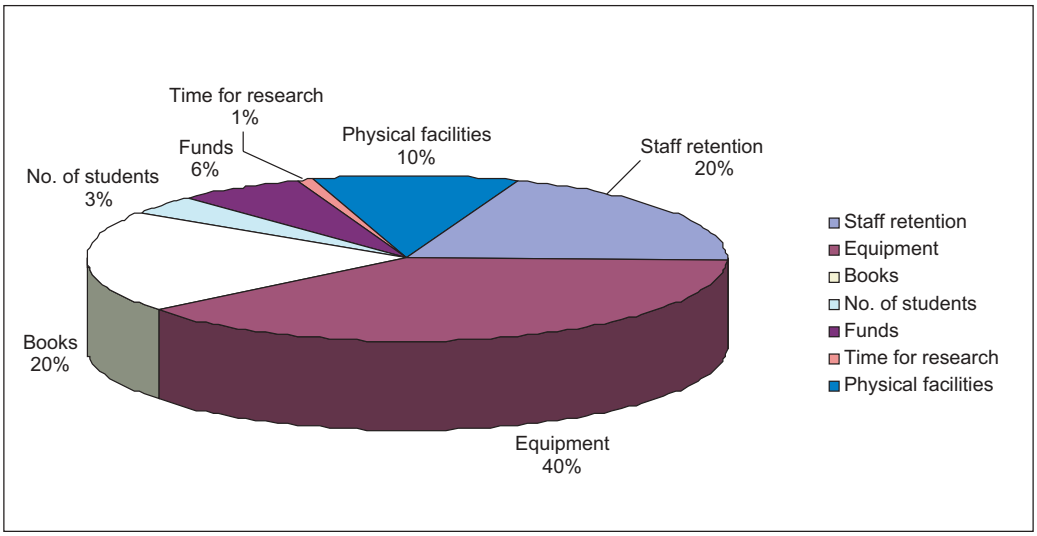

Chart 11.1: Major Constraints in Basic Sciences

Another major constraint that was cited by several other departments was the inability to retain qualified staff who are committed to teaching. This issue comprised 20% of the total number of respondents. In some departments, the problem of fewer senior members of staff was said to be a major constraint. Indeed experienced staff take the lead in conducting research which helps to raise the profile of a department.

Lack of adequate funding comprised 6.3% while poor physical facilities accounted for 10.2% of the total cases. Table 11.1 shows that poor funding was mentioned by almost all the categories of departments except Geography and Microbiology. This is not to say that these departments do not have shortage of funds but rather, the fact that between lack of adequate equipment and lack of books and journals, all departments identified one or the other as a major constraint and implied that funds allocated to run various programs are insufficient. Indeed from the analysis on student population vis-à-vis financial allocation per student (discussed in chapter 9), it was quite evident that allocation per student in several departments was quite low.

Apart from the above mentioned constraints which were mentioned by almost every institution, there were others which were suggested by only single institutions but may be a problem in several other universities which have not participated in this study. For instance the departments of Biology and Geology at the University of Botswana and Zoology at the Jomo Kenyatta University of Agri-

Table 11.1: Major Constraints

	Major Constraints												
	Lack of Stud Interest & direction	No of Staff, Commit-ment, Remune-ration, No Snr Staff	Old Eqmnt, No models, No audio/ visual aids, No Com-puters	Few Journals, Poor Lib facilities						Low Funds for R&D, Few Fellow ships	FewLabs, Offices, Lecture Halls, Internet, Space, Mainte-nance		
Generic class of problem	Student Attitude	Staff Retention	Equipment	Books	No. of Students	Funds	Poor Manage-ment	Transfer of Studs	Time for Research	Physical Facilities	Links to Indus-try	Dis-ruption of Acad Progs	No of Entries
Subjects													
Biochem		5	11	4		2				2			24
Biology		3	6	5		2		2	1				19
Botany		3	8	4	1	1				3			20
Chem/Bio		3	4	2	1	1				1			12
Chemistry		6	14	7	2	3				1			33
Computer		8	6	4		1				4			23
Geography		2	2	2									6
Geology		3	8	4		1			1	2			19
Math		7	11	7	1	2				4			32
MicroBio		2	2	2									6
Physics		5	13	8	2	4				5			37
Statistics		1	4	1									6
Zoology		1	7	1			1		1	1			12
Tot Science	0.0	41.0	79.0	42.0	7.0	13.0	1.0	0.0	2.0	21.0	0.0	0.0	206
%	0.0	19.9	38.3	20.4	3.4	6.3	0.5	0.0	1.0	10.2	0.0	0.0	

	Major Constraints												
	Lack of Stud Interest & direction	No of Staff, Commit-ment, Remune-ration, No Snr Staff	Old Eqmnt, No models, No audio/ visual aids, No Com-puters	Few Journals, Poor Lib facilities						Low Funds for R&D, Few Fellow ships	FewLabs, Offices, Lecture Halls, Internet, Space, Mainte-nance		
Generic class of problem	Student Attitude	Staff Retention	Equipment	Books	No. of Students	Funds	Poor Manage-ment	Transfer of Studs	Time for Research	Physical Facilities	Links to Indus-try	Dis-ruption of Acad Progs	No of Entries
Subjects													
Agricultural		4	8	5	1	1				1			20
Architecture		1	1	1		1							4
Building		1	1	1		1							4
Civil		7	8	6		2			1	5	1	1	31
CompEng		1	1	1									3
Design Tech		1	2										3
Electrical		7	8	7	2	2				7			33
Electronic		2	1	2						1			6
Geodetic		1	1	1									3
Geoinfo			1		1	1							3
Geological		1	1	1									3
Industrial		3											3
Mechanical	2	6	1	10		2				5			26
Materials		1		1						1			3
Metallurgical		2	4	2									8
Metrology			1			1				1			3
Mining		1								2			3
Petroleum			3										3
Survey		2	4	2		1							9
Wood			3										3
Total Eng	*2*	*41*	*49*	*40*	*4.0*	*12.0*	*0.0*	*0.0*	*1.0*	*23.0*	*1.0*	*1.0*	*174*
%	*1.1*	*23.6*	*28.2*	*23.0*	*2.3*	*6.9*	*0.0*	*0.0*	*0.6*	*13.2*	*0.6*	*0.6*	
Grand Total	2	82	128	82	11	25	1	0	3	44	1	1	380
%	0.5	21.6	33.7	21.6	2.9	6.6	0.3	0.0	0.8	11.6	0.3	0.3	

Biology

The situation in Biology is quite similar to that in Biochemistry. However, the University of Botswana which did not record any constraints in Biochemistry had a unique constraint concerning the transfer of students after year I and II. The transfer is considered to have a bearing on the quality of the graduates produced as those left behind are less motivated and able. Botswana also identified low research output in Biology from academic staff due to lack of time for conducting research. The Universities of Lagos and Malawi in addition identified obsolete teaching equipment in the respective departments of Biology as a major constraint that was not, however, mentioned in Biochemistry.

Chemistry

The total number of entries for the department of chemistry was 33, of these, 42% were constraints concerned with lack of equipment while 21% were problems related to lack of Chemistry books and journals. Staffing issues accounted for 18% of the total.

. o nst nts t n n n n s

Twenty engineering departments were analysed. A total of 174 entries on various constraints were made. Again lack of equipment, books and staff retention were the three top issues that were identified by engineering departments. Lack of equipment accounted for 30% while books and staff issues accounted for 23% and 23.6% respectively. Other notable problems that bedevil engineering departments include poor physical facilities (13.2%) and poor funding (6.9%).

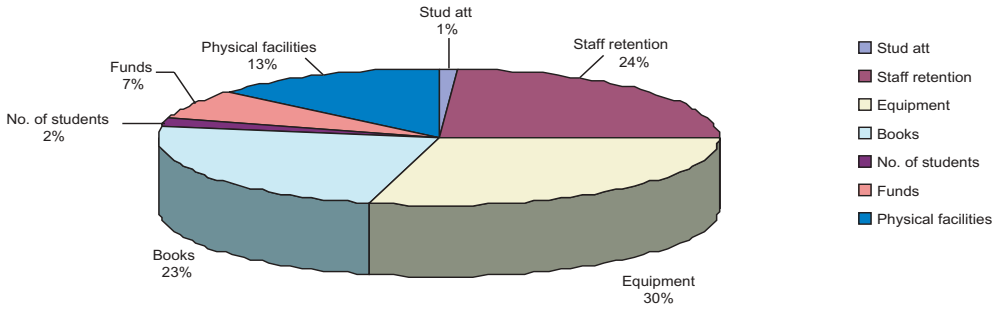

Chart 11.2: Major Constraints in Engineering Sciences

Quite interestingly, two Engineering departments in far apart universities in Lagos and Botswana mentioned that poor student attitudes and their lack of interest and drive are major constraints that affect the teaching of Mechanical Engineering courses. These are the only two departments which identified this as a constraint. It is not clear why this was a major problem in mechanical engineering department and not in any other engineering course even in the same universities.

Although the problem of large enrolments is not widespread among the twenty departments, a small fraction of 2.3% mentioned that the large number of students in their classrooms affect effective teaching. The problem was identified in Agricultural and Electrical engineering at the University of Botswana and Geoinfomatics Engineering in Lagos.

. on sonn o n ton

This study has identified several major constraints that impact negatively on the smooth implementation of the academic programs. The prevalence of these constraints is widespread and they affect both Basic and Engineering Sciences in relative equal proportions. Although these constraints are variously referred to in different ways such as lack of equipment for conducting experiments, poor staff retention, lack of books, and poor physical facilities, they all boil down to one main problem: the problem of low financial allocations per program or departments or student. These four constraints account for over 90% of the constraints cited respectively by either basic or engineering sciences.

A few other constraints which were individually mentioned by one or two departments included poor management of the academic programs, poor student attitude, and disruption of the academic programs. Although these problems were identified by only a handful of departments, they are issues of concern for most other universities that did not participate in this study. They should therefore be given due attention.

While we acknowledge the relative differences of the effects of one problem in different universities as being fundamental, we should not loose sight of the fact that the problems have counter effects and are cumulative in nature. Lack of adequate funding leads to the use of old and poorly serviced equipment which in itself leads to low staff morale and poor retention rate. Funds are also required to facilitate expansion of the physical facilities and purchase of books.

The constraints discussed in this study are widespread and affect the various departments quite significantly. The question of improving the status of the equip-

ment, and provision of modern laboratory facilities need to be addressed urgently. Also, maintenance policies must be enforced in order to reduce wastage. Staff retention is an even bigger challenge and lasting solutions need to be found.

h t y o n so ns n o n to ns

This study on the state of Science and Engineering education in African universities paints a picture that is found in most institutions of higher learning in Africa. From a deficiency of journals and other reference materials to poorly maintained laboratory facilities and under-funded programmes. However, in spite of all these, we still find that these institutions do not lack in ambition and innovation. They endeavor to establish departments in response to different country's manpower needs and have established quality assurance mechanisms to keep an eye on the quality of graduates that they produce. In this chapter we draw conclusions on the various issues that affect the teaching of science and engineering education.

t y j t v s

The study set out to assess the state of institutions offering training in Science and Technology. Specifically, the study was intended to determine the quality of the physical resources available in the various institutions, the nature of the human resource available both at the level of academic staff and the technical support staff, the financial support for the institutions, the major areas of constraints, which in the opinion of the institutional administrators, require urgent attention and the intervention strategies for the strengthening of S&T institutions in Africa.

h t son

The study first undertook an analysis of the factors that influence the teaching and training of scientists and engineers in higher education institutions. The analysis identified the various resources and facilities that are essential for effective and quality training in the sciences. This was followed by a questionnaire survey among a few institutions to determine the quality and quantity of the resources identified. The survey, which covered only a small group of S&T training institutions in the region, is meant to illustrate the relative magnitude of the various constraints confronting institutions and also present views of all priority cases for intervention. The information summarized in this report will help donors and governments to develop intervention strategies for capacity building in Science and Technology.

b o nv s t s

It was not possible to include all institutions in the region in the survey. The institutions, which participated, were selected in a manner as to enable one to get a snapshot of the general state of the institutions in the region. First, a few countries were selected to represent various regions: West Africa (2 countries), Eastern Africa (4 countries), Southern Africa (4 countries), and Francophone West Africa (2 countries).

sto nn t t

A structured questionnaire was the main survey tool and it was constituted in a manner as to assess all the factors that influence the training, teaching and learning in science and technology institutions. These factors affect the quality of the human resource generated by the institutions and each was thoroughly investigated in the questionnaire. The analysis of the contents of the questionnaire was intended to find out the staff situation in each department of the basic and engineering faculties, student population, state of library facilities, availability of books and reference materials, the use of ICT to support teaching and learning and the state of laboratory facilities. The other issues that were analysed included the teaching methods used, relevance of the syllabus, financial situation and the constraints that impact on the implementation of the programs.

t n ss s

In general S&T training institutions have no problem in attracting students to their courses. The only constraint on students' enrollment is the lack of scholarships or the financial support. This finding confirms the widely held view that there is an explosion in the demand in higher education in Africa. There are however, subjects such as physics where enrolment is still low.

We can make conclusion about three important aspects pertaining to staff: availability and associated problems of recruitment; the quality of teaching staff and the efficiency in the utilization of available staff. On average, across the region, about 40% of the established posts in science and technology training institutions are vacant. The main obstacle to recruitment of staff is the poor remuneration and other benefits. Brain drain and the inability of most institutions to train their own staff have compounded the problem of staff availability. A short-term solution would be dual degree programmes (or network degree programmes) in which staff of two neighboring institutions are pooled together to offer degrees in the two institutions. Staff quality, as indicated by the qualifications of its mem-

bers, ranges from moderate to low. Across the region only about 50% of staff in S&T training institutions have Ph.Ds and hence the need for universities to put more effort in motivating staff to train for higher degree qualifications.

y n o n s t s

Except for a few institutions surveyed in this study, the problem of scarcity of relevant and current journals continues to be of concern in most institutions. The absence of journals and good library facilities means inability of staff to do research, publish and contribute to knowledge. As a way forward it is recommended that universities establish mechanisms of acquiring and sustaining subscriptions to journals (online and/or print) in at least all taught subject areas.

t s

It was evident from the analysis that there is need to improve access to ICT facilities in most of the universities. There were also remarkable disparities in the number of computers in each university. On average, there are about 6.5 computers per basic science course and about 9.1 computers per engineering science course for an average student population of 240 students per engineering course. **This averages to about 26 students per computer in the engineering disciplines.** We also note that in general, only 10 out of 30 departments across disciplines have more than half of their staff who have computers in their offices. **Put another way, two-thirds of the institutions surveyed do not even meet the staff: computer ratio of 1:2.** These statistics point to a situation which requires a substantial input of resources in order to achieve an efficient ICT infrastructure and access that wille415 Tm08.7

universities need to safeguard against a situation that seems to have engulfed older, well established universities in which most of the equipment are, quite often, not replenished nor serviced.

nst to n tb s

Instructional methods vary from university to university and indeed from department to department as the need for their use more and more depends on individual departmental initiatives as opposed to specific policies. Most universities, though, encourage departments to improve their teaching approaches through the use of technology-mediated methods. But they do not necessarily provide the support to achieve this objective. For instance, only a few departments, even in the same faculty, use projectors for teaching.

On the issue of the use of standard text books, printed notes and simulation, it was apparent that their use was not widespread due to lack of clear policy and requisite financial support. It is highly recommended that such modern teaching methods and aids be implemented in order to improve the overall quality of teaching.

n n n t y o to n ss s

The analysis showed that there is no uniform way of distributing financial resources to departments across universities and even within universities. In some cases, the allocation was equitably distributed across departments. Yet in a few other cases, the allocations were in relative proportions to student enrollments. If quality is to be maintained in the provision of Engineering and Science Education, the universities and by extension governments must be ready to give reasonable financial support to help run the science and engineering departments.

v n n ty ss n

The study found out that the use of external examiners as a means of ensuring that the quality of the programs is maintained is widely used. On the other hand, the accreditation model was also preferred in a few of the institutions. Whatever model a university chooses will depend on the immediate and long term objectives. The cost of implementing either model can be substantial but the returns are of absolute importance.

The study found that there were regular reviews of the courses. In general, the syllabuses across the universities are not very old. This may be a good indicator of the relevance of their programmes. However the process of the revision has to

be examined in greater detail to be able to make a definitive statement on relevance of the courses.

o nst nts

This study has identified several major constraints that impact negatively on the smooth implementation of the academic programs. The prevalence of these constraints is widespread and affects both Basic and Engineering Sciences in relative equal proportions. Although these constraints are variously referred to in different ways such as lack of equipment for conducting experiments, poor staff retention, lack of books, and poor physical facilities, they all boil down to one main problem: the problem of low financial allocations per program or department or student. These four account for over 90% of the constraints cited respectively by either basic or engineering sciences.

A few other constraints which were individually mentioned by one or two departments but which could be found in other institutions included poor management of the academic programs, poor student attitude, and disruption of the academic programs.

Overall, these constraints are widespread and affect the various departments quite significantly. The question of improving the status of the equipment, and provision of modern laboratory facilities need to be addressed urgently. Also, maintenance policies must be enforced in order to reduce wastage. Staff retention is an even bigger challenge and lasting solutions need to be found.

Undoubtedly, this study has brought out several issues that need intervention in terms of injecting more financial resources that will improve the state of equipment and overall infrastructure. In order to implement the academic programs there is need to develop strategies of sharing the available manpower as well as train more. Both basic and science curricula needs to be re-examined for relevance, rationalization and efficient utilization of the resources.

This situation basically translates to a common denominator: inadequate financial resources and perhaps lack of adequate policy on the role that Science and Engineering Education can play in a country. Resolution of these constraints cannot therefore, be confined to an individual university but rather would extend beyond the confines of university management bodies. Political goodwill, informed decision making process and prudent management of the resources already in the possession of individual universities would be a necessary first step.

A n x

List of participating Institutions and Questionnaire Respondents

Universities Under Analysis			
No.	University Name	Country	Responded (Y/N)
1	Addis Ababa University	Ethiopia	Yes
2	Obafemi Awolowo University Ile Ife	Nigeria	Yes
3	Makerere University	Uganda	Yes
4	Moi University Eldoret	Kenya	Yes
5	University of Zambia	Zambia	Yes
6	Michael Okpara University of Agriculture, Umudike	Nigeria	Yes
7	University of Zimbabwe	Zimbabwe	Yes
8	University of Malawi	Malawi	Yes
9	Ahmadu Bello University	Nigeria	Yes
10	University of Lagos	Nigeria	Yes
11	Kwame Nkrumah University of Science and Technology	Ghana	Yes
12	University of Nigeria, Nsukka	Nigeria	Yes
13	JKUAT	Kenya	Yes
14	University of Dar es Salaam	Tanzania	Yes
15	University of Nairobi	Kenya	Yes
16	University of Botswana	Botswana	Yes
17	University of Ibadan	Nigeria	Yes
18	University of Cape Coast	Ghana	Yes
19	Université de Lomé	Togo	Yes
20	Ecole des Mines	Niger	Yes
21	Universite de Cocody	Cote d'Ivoire	No
22	Universite de Yaounde	Cameroon	No
23	Lagos State University	Nigeria	