CURRENCY AND EQUIVALENT
(As of May 30, 2006)
Currency Unit = Nigerian Naira
1 Naira = 0.0078 US$
US$1 = 127.21 NGN

FISCAL YEAR
January 1 – December 31
Foreword

This final STEPB report has been prepared under the supervision of the Federal Ministries of Science and Technology (FMST), Education (FMOE), and Finance (MOF). The STEPB Report was prepared by a team of Nigerian and International S&T and Education professionals. This final Synthesis STEPB report is based on 6 technical STEPB studies (Study Area Reports 1-6), which were prepared with teams of Nigerian and international consultants. The synthesis and technical background reports are available from the World Bank's Abuja Office and will also be available online. The Federal Universities, Polytechnics, Colleges of Education were consulted, and significant inputs were provided by the NUC, NBTE, NCCE, and other federal government agencies. This STEPB report also includes information from private and public service providers and enterprises. It also discusses the likely implications and impact of the Abuja Institute for Science and Technology (AIST), which will be one of the four planned regional S&T campuses in Africa.

The STEPB report was prepared at the request from the federal Government of Nigeria (FGN). It fits in the NEEDS strategy, which emphasizes the case for economic growth in Nigeria to reduce poverty and promote social welfare. As indicated by numerous international publications Science and Technology related post-basic education of high quality and relevance is one of the key indicators for stimulating economic growth in lower-income countries. Several rounds of consultations with the Honorable Ministers and Permanent Secretaries of the Federal Ministry of Finance, Federal Ministry of Education (FME) and Federal Ministry of Science and Technology (FMST), and with Federal Universities, Polytechnics and Colleges of Education were held during November 2005 to September 2006. Consultations were also held with other international donor organizations, notably UNESCO and the AfDB (Offices in Abuja).

The Federal Ministers of Education and Science and Technology appointed a technical task force for the coordination and supervision of the STEPB study. Jacob Bregman (lead education specialist, Africa Region, World Bank) was the STEPB study task team leader. Four joint workshops on STEPB issues, aiming to provide a forum for broad consultation with S&T and Post-Basic education stakeholders were held in Abuja, Ibadan and Lagos. This STEPB Synthesis Report will serve as an analytical tool to prepare a corresponding STEPB project at the request of the FGN.
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This Science & Technology Post-Basic Education (STEPB) Synthesis Report was jointly prepared by the World Bank Education Team, a Technical Task Team from the Federal Ministry of Education (FME) and the Federal Ministry of Science and Technology (FMST), and national and international consultants. The FGN (Ministries of FME and FMST) appointed a technical taskforce in November 2005, including representatives of federal post-basic education sector science and technology (S&T) stakeholders in Nigeria. DFID co-financed the study, which allowed support from the British Council in Abuja. In addition, the study significantly benefited from involvement by Federal post-basic education institutions involved in S&T activities in Nigeria (such as the NUC, NCCE, NBTE, NITDA, NUT, NECE, NACCIMA, and many others). The STEPB team also benefited from discussions with other development partners, notably the Abuja Office of the African Development Bank and UNESCO.

The STEPB study was prepared over a period of 8 months (November 2005 – September 2006), including three field missions by the international consultants. Teams of national and international consultants conducted the fieldwork for the STEPB six study area reports. With support from the FGN Technical Taskforce, DFID and the Abuja British Council Office four workshops were organized over the past 11 months to discuss progress, results and receive feedback. In addition, meetings were organized with the various public and private S&T stakeholders to discuss the findings from the six study area reports (STA reports). From this basis the final draft STEPB Synthesis report was prepared and discussed with the FGN Technical Taskforce. A list of Nigerian officials, counterparts, the STEPB team, and national and international consultants is added in annex to this Synthesis report. The STEPB study team hereby expresses its deep appreciation for the contributions of these stakeholders in deepening its understanding of the Nigeria situation and in helping to build large scale consensus around the issues regarding STEB.

The Honorable Minister of Education, the Honorable Minister of Science & Technology (Prof. Turner Isoun), the Permanent Secretaries of the two federal ministries, the FME Director of Primary and Secondary Education, the Head of the project coordinating unit of the Federal Ministry of Education (Dr. (Mrs) Jamilla Suara), the STEPB contact person in the Federal Ministry of Science and Technology (Dr. P. O. Obande), and the members of the FGN Technical Taskforce all deserve special thanks for facilitating the participatory research process and completion of the report (in particular, Prof. Peter Okebukola, the Executive Secretary of National Universities Commission and Dr. Nuru Yakubu, the Executive Secretary of National Board of Technical Education).

The STEPB study team was led by Jacob Bregman (STEPB Team Leader and Lead Education Specialist, Africa Region), and included: Halil Dundar (Sr. Education Economist); Olatunde Adekola (Sr. Education Specialist, AFTH3); Peter Materu (Sr. Education Specialist, AFTH3); and Robert Stephens (Telecommunications Specialist), all from the World Bank. And the following consultants: Dr. Andrew Clegg (Sr. Education and S&T Consultant, Namibia); Sara Farley (S&T Consultant), Prof. Kalafunja Osaki (Education Faculty, University Dar Es Salaam, Tanzania); Marcus Powell (Labor Market Consultant, Cambridge Education Consultants, UK); Wout Ottevanger (Curriculum and Assessment, Vrije University Amsterdam, Netherlands); Peter

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1 The six reports addressed the issues of: policy and planning; financing; curricula, teaching and learning; ICT in teaching and learning; response to the labour market and technical matters related to connectivity.
D’Souza (Education Economist, DFID); Professor Pai Obanya (Sr. Education Advisor, Ibadan, Nigeria); Prof. Munzali Jibril (STEPB Strategy and Policies, Bayero University Kano); Dr. Patience Awopegba (Curriculum, National Centre for Economic Management, Ibadan), Prof. Philip Omorogie and Teresa Hartnett (USA) (Cost and Finance Consultants); Prof. Gregory Wajiga (E-learning, Federal University of Technology, Yola). Coordination support was also provided by the Abuja Office of the British Council thru the CUBE project, which is funded by DFID.

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For the 6 STA background Technical Areas (STA# 1 – 6) Reports significant inputs were also received from Nigerian Consultants as listed in annex A.

Major write-ups and editorial advice for this Synthesis STEPB Report and for the 6 STA reports were provided by Dr. Andrew Clegg (Senior S&T and Education Advisor, Namibia) and Sara Farley (S&T Consultant).

The STEPB team members would like to thank Nigerian colleagues and experts from public and private institutions for their valuable advice, significant contributions and stimulating discussions.

Ijeoma Nwachulkwu, a summer intern student from Harvard, and Nigerian nationals provided inputs for the labor market data and conducted surveys in Nigeria. She has returned to Harvard. Ijeoma and students like her represent the future for Nigeria. Her enthusiasm and sharp intellect were much appreciated by the STEPB team.

This STEPB report will serve as the basis for the preparation of a proposed STEPB project, which will aim to improve the quality, relevance and effectiveness of Science and Technology Education in Nigeria and will stimulate more students to selected S&T related studies, leading to a better future for Nigeria.

The STEPB team would like to thank all development partners in Nigeria for their support and contributions (DFID, UNESCO, UNICEF, USAID, and many other individual contributors). We gratefully acknowledge financial support from DFID, and from the Norwegian Education Trust Fund.
Executive Summary

The STEP-B Context

People, institutions, countries, and multilateral organizations concerned with promoting environmentally and socially sustainable development cannot afford to neglect the importance of science and technology (S&T) as facilitators of growth, wealth, and health. Specifically, S&T serve as tools for: (1) achievement of the Millennium Development Goals, (2) enhancement of economic growth and competitiveness, and, (3) creation of knowledge to solve problems (i.e., research and development).

A number of international reports conclude that S&T capacity is required to reduce poverty and participate competitively in world markets. This capacity is required to access, adapt, use, diffuse, and generate science and technology knowledge. Yet global disparities in S&T capacities are acute. In fact, much of the difference in rates of growth between countries now is traceable to the widening gaps in distribution, use, adoption, adaptation, and generation of knowledge.

Nigeria has made a number of important advances in building up its science and technology capacity. Concerned about the lack of coordination, the FGN has recently established a National S&T Coordinating Council chaired by the President of the Republic to provide leadership in the development of S&T in the country. One element of the President's initiative is the plan to create the Abuja Campus of the first Africa Institute for Science and Technology (AIST), the first of four such campuses in Africa. The AIST–Abuja campus is under development as part of the Abuja Technology Village initiative, for which the FGN will provide incentives to attract private investment. There is also a joint effort underway with the UNESCO to develop a national strategy for science and technology and a presidential initiative recently proposed is the National Science Foundation, an independent funding body for competitive research and innovation projects and programs. In collaboration with UNESCO (Abuja Office), the FGN has launched a project to strengthen S&T education in primary and secondary schools and teacher colleges in Nigeria. Through this initiative science kits are distributed to primary and secondary schools in Nigeria, and assistance is provided to teachers colleges to strengthen pedagogy and methodologies for S&T teaching. The project also includes a component to strengthen local capacity to manufacture school equipment and consumables. In addition, the African Development Bank (AfDB) is co-financing a project that supports Secondary Education and Vocational Training as well as limited support to tertiary institutions.

Nigeria has also made substantial progress in increasing funding to post-basic education, the bulk of which goes to S&T education. In spite of increasing enrollments, unit costs have risen steadily over the last five years. Through the Education Trust Fund (ETF), special funding has been provided to the federal universities of technology (FUTs) as well as to all federal universities to improve teaching and learning facilities. Private funding of post-basic education has also increased as more private universities (now 25) and other post-basic institutions have been established.

Despite these worthwhile interventions designed to strengthen the country's S&T capacity, studies show that Nigeria is falling behind in terms of competitiveness internationally. This report examines how the quality and relevance of the technological components of Nigeria's federal education system may be refined in order to arrest this decline and encourage organizations and people to acquire, create, disseminate, and use the knowledge more

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effectively for greater economic and social development.

Policies to expedite a shift toward greater knowledge-intensity extend beyond the domain of science and technology. The World Bank's Knowledge for Development (K4D) program recommends the development of appropriate policies, institutions, investments, and coordination across (at least) four functional areas:

1. An economic and institutional regime that provides incentives for the efficient use of existing and new knowledge and the flourishing of entrepreneurship.
2. An educated and skilled population that can create, share, and use knowledge well.
3. A dynamic information infrastructure that can facilitate the effective communication, dissemination, and processing of information.
4. An efficient innovation system of firms, research centers, universities, think tanks, consultants, and other organizations that can tap into the growing stock of global knowledge, assimilate and adapt it to local needs, and create new technology.

**STEPB Synthesis Report Synopsis**

This STEPB Synthesis Report encapsulates the findings of six background reports, which are described in detail in the introductory chapter. They were conducted over a period of eight months to assist the FGN in prioritizing and drawing up a strategy for strengthening post-basic science and technology education at the federal level so as to increase Nigeria's capacity to exploit S&T and shift toward greater knowledge intensity in its products and processes. Specifically, the report concerns itself with science and technology in the post-basic education sector (area 2 above), which relates to areas 3 (information and communication technologies) and 4 (research and knowledge organizations for the use and creation of new knowledge and technology).

Taken together, the background reports and the resulting synthesis paint the picture of a post-basic education sector in the midst of expansion. A greater number of young Nigerians are transitioning from basic education to post-basic, which is an accomplishment of great importance. A greater proportion of national wealth is now directed to education than has been the case for almost a decade. Federal post-basic education sector benefits from the decision of policymakers intent on perpetuating its growth, yet without the data required to substantiate the value, need, and strategic vision for such prioritization, the sector's growth has not yielded demonstrable improvements in industrial or economic growth as investments in post-basic S&T education have done in other countries. Policy made in the absence of strategic vision or reliable data rarely exploits S&T's full potential to reduce poverty, promote economic growth and generate new knowledge, if ever. The effectiveness of post-basic institutions has been varied in terms of graduating S&T students, preparing graduates for participation in the workforce or exposing students to the skills and technologies - particularly emerging technologies such as ICT - that will afford them better opportunities to work smarter and live healthier and wealthier lives. These institutions merit a comparative review in order that all may benefit from the best practices in the sector. Armed with reliable data, consistent resources, and sustained political will and commitment, the positive reforms and many good practices identified in pockets of the post-basic sector can be spread widely, bringing with them the benefits of S&T education and the concomitant wealth with which it correlates.

The main messages of the study are summarized under five headings as described in the following sections.

- Policy and planning for competitiveness
- Teaching, Learning, Curricula, and Research in Post-Basic S&T Education
- The use of ICT to enhance teaching and learning in post-basic S&T education
- Financing Trends and Expenditure Patterns in Federal Post-Basic S&T Education

**Policy and planning for competitiveness**

Political will and some of the necessary policies to guide the development of education and S&T
exist in Nigeria but coordination between these two areas is weak. Without a more integrated and coordinated policy approach that better harmonizes priority-setting, strategy and governance in science and technology and education, the reality of transforming Nigeria into a knowledge economy remains elusive. Further information and effort is required to ensure that the supply of productive, skilled and semi-skilled S&T graduates from the post-basic education system matches industry demand.

The paragraph numbers in parentheses at the end of each recommendation indicate where, in the main document, the supporting arguments can be found.

The following main conclusions were drawn in relation to policies and planning.

**Conclusion #1** S&T and education are addressed as largely separate issues in the policy realm. This results in policy gaps, overlaps and unclear mandates. Greater coordination, communication, policy harmonization, and priority setting are required to address this disconnect (paragraph 33ff).

**Conclusion #2:** Without explicit strategies to better attune the post-basic S&T education sector to the needs of the labor market, a mismatch exists between the quality, preparedness, and supply of graduates and the needs of the labor market (paragraph 47ff).

**Conclusion #3:** At present, available labor market information is insufficient to explain the reasons behind this mismatch in supply and demand. It is not clear whether: (a) there are no jobs because the economy is not growing fast enough, or (b) employers hesitate/have no incentives to employ S&T graduates because the regulatory system is too onerous, or (c) demand exists but for better or different skill sets, and/or (d) S&T graduates are employed in the informal sector (about which little is known) but formally recorded as unemployed. Further research and analysis is required to clarify this question and better understand the landscape (paragraph 47).

**Conclusion #4:** Existing occupational data show that there is a rising demand for professional-level S&T graduates in some fields, particularly health, engineering and agricultural sciences. However, since the labor market is not static and demand for skills is continually changing, it is important that Nigeria develops a systematic approach to monitoring the labor market and providing signals to the Government, employers, tertiary education institutions and the public to facilitate planning and informed decision-making (paragraph 48ff).

**Conclusion #5:** Available educational management data are insufficient to provide the necessary information on which to build effective policies and strategies. A systematic and comprehensive management information system is required that will provide information not simply on student numbers but also on program efficiency and cost effectiveness (paragraph 41ff).

**Teaching, Learning, Curricula, and Research in Post-Basic S&T Education**

The combined effect of content-driven curricula, little hands-on learning, overloaded courses, and examination practices that cater only to the highest achievers lowers the prospects of graduates in the labor market and leaves learners discouraged from pursuing S&T studies. This is exacerbated by teachers who are often poorly trained to engage students in practical work and also by limited availability of the required equipment, few resources and inadequate facilities for experimentation and research. The secondary science curricula are outdated, both in content and approach and are in urgent need of reform. Female students, statistics show, are particularly ill-served by the system.

The following main conclusions were drawn in relation to teaching and learning in post-basic S&T

**Conclusion #1.** Overloaded and content-driven curricula and exclusive examination practices, both with little emphasis on skill acquisition mean that graduates at all post-basic levels are not well-prepared for the demands of the labor market (paragraph 59ff).

**Conclusion #2:** The prevailing teaching and learning styles that are content-driven in which the student is often a passive participant generate graduates that have inadequate skills for the
labor market and find difficulty in adapting their knowledge to new situations. Teacher education
and staff development programs largely fail to adequately address this issue (paragraph 61ff).

Conclusion #3 A significant factor mitigating against a more active learning pedagogical style is
the paucity of adequate facilities and materials for practical skills development (paragraph 87ff).

Conclusion #4 Though the National Master Plan for Technical and Vocational Education
(2000) advocates competency-based training, the traditional program structure lacks the flexibility
to accommodate the rapidly changing demand for new skills. Neither does this structure allow
the participation of various types of trainers and training institutions—formal and informal,
public, private and community—who could otherwise facilitate greater relevance and access.
Supplementing the existing structures with a National Vocational Qualifications Framework
(NVQF), would offer mechanisms to address these deficiencies (paragraph 71).

Conclusion #5 National public investment in research and development is inadequate and
inequitable and is directed mainly at the parastatal organizations. This leaves research in
higher education institutions under-funded. Alternative mechanisms by which resources are
disbursed, such as competitive bidding that encourage collaboration between institutions
would encourage the evolution of stronger research traditions (paragraph 77ff).

Conclusion #6 The under-representation and underachievement of female students in science
and technology programs represents both an inequity but also avoidable inefficiency in the
system. A variety of mechanisms are available that are effective in addressing this disparity and
also the issue of underachievement generally which would address not only inequities such as
these but also the high dropout rates characteristic of many science and technology
programs (paragraph 78).

Conclusion #7 Education components of teacher education programs tend to be overly theoretical at the expense of methodology and practice, leading to inadequate preparation for
classroom demands. Training opportunities for tertiary lecturers to improve their teaching styles
are not widely available (paragraph 69ff).

The use of ICT to enhance teaching and learning in post-basic S&T education

There are a few promising cases of effective use of ICTs in education but development of these is
uncoordinated and widespread availability is hindered due to several major constraints. The
high cost of ICT connectivity, the dearth of ICT technicians, limited teacher training in ICT-
facilitated teaching, and low rates of ICT literacy mitigate against the impact that low-cost, accessible ICT could have in broadening access to, and enhancing the effectiveness of,
post-basic education in Nigeria. Positive steps toward increasing institutions' connectivity and
matching prices to institutions' and individuals' ability to pay should be encouraged to further
capitalize on the potential of the rapidly growing ICT sector. An additional major impediment to
the further development of a planned ICT in education strategy is that the country lacks a
comprehensive policy on which to ground it.

The following main conclusions were drawn in relation to the use of ICT in the sector.

Conclusion #1 Development of the use of ICT in education is hampered by the absence of an
overall ICT policy and strategy for the education sector (paragraphs 34 and 95).

Conclusion #2 The high total cost of computer ownership is a major ICT uptake constraint.
Access to affordable and reliable Internet connectivity across the post-basic education sector is
limited to a few institutions for the following reasons: (1) the lack of a national terrestrial ICT backbone and consequent use of high cost VSAT bandwidth (2) the lack of a
national strategy that ensures that cost of facilities matches the means of the institution,
(3) power fluctuations/cuts and other technical problems limit reliability and (4) the high costs
of hardware, software licensing and maintenance (paragraphs 93ff and 100).

Conclusion #3 Human resource issues such as the shortage of ICT technicians, the low ICT
literacy rates among teachers and lecturers and
the lack of ICT literacy programs for students must be addressed before full advantage can be taken of teaching and learning opportunities offered by ICT (paragraph 95).

Conclusion #4 There are a number of promising ICT-in-Education initiatives in Nigeria with important lessons for the entire system. These embrace, *inter alia*, provision of affordable facilities, the development of learning portals and the development of Open Source learning platforms. These initiatives could potentially be scaled up to cover more institutions (paragraph 96ff).

Conclusion #5. ICT opportunities are not yet significant elements of either curricula or teaching and learning materials at any level. E-learning strategies and programs are not yet well developed and there are benefits to be gained from institutional cooperation at this stage of their evolution, particularly in their application to open and distance learning (paragraph 108ff).

Conclusion #6: The continued digitization of library catalogues and the development of the proposed Virtual Library offer opportunities to capitalize on the potential of ICT in education that would have widely felt benefits (paragraph 119).

**Financing Trends and Expenditure Patterns in Federal Post-Basic S&T Education**

Though up-to-date and reliable data are limited, observations of financing trends and expenditure patterns in Nigeria’s education sector show a demonstrable increase in education spending as a percentage of GDP since 1998. This increase is made even more dramatic by growth in per student expenditure even as a greater number of students pass through the post-basic sector. S&T education consumes a much larger proportion of the federal education allocation than non-S&T education as the per-student costs are almost two and a half times those for non-S&T subjects. Yet this financing decision is not buttressed by sufficient data linking either this S&T education funding level and the number, type, and skill set of S&T graduates needed in industry, or S&T graduates’ value-addition in industry compared to non-S&T graduates.

The following main conclusions were drawn in relation to expenditure trends and patterns.

Conclusion #1 Reliable, well maintained data regarding cost and financing of post-basic education must be gathered, tracked, and analyzed to determine whether admissions targets in S&T and other policies in the sector best facilitate the creation of the quantity, quality and relevance of the graduates produced (paragraph 122ff).

Conclusion #2: Across the post-basic education sector, current funding procedures are input-based, not related to performance and outputs, and provide little incentive for partnership with industry and the private sector. Such funding procedures are prone to inefficiency and do not encourage creativity and innovativeness (paragraph 139ff).

Conclusion #3. Across the federally-funded post-basic education system, per student unit cost varies widely by type of institution. The range of per student allocations is striking, suggesting that the allocation procedures might have little to do with student demand and output. This points to potential inefficiencies in the delivery of post-basic education, including science and technology education. Considering the high costs of S&T programs (about 2.5 times that of social science disciplines), financing strategies that encourage efficiency and relevance are desirable (paragraph 133ff).

Conclusion #4: Poor governance can constrain efforts to diversify funding sources and increase efficiency. Governance issues need to be addressed in order to give higher education institutions more professional and administrative autonomy to maximize their efficiency (e.g. through introduction of alternative ways to generate income) (paragraph 141).

Conclusion #5: Currently the private sector plays only a very small part in funding post-basic S&T Education. Opportunities exist for expanding the role of the private sector, particularly in the area of research and this in turn would enhance both the quality and
Key recommendations

Chapter 6 of the report tabulates a number of detailed recommendations. While many of these are directed at educational institutions themselves, or those whose task is to support them, some are of national significance. These cross-cutting recommendations address systemic shortcomings and their implementation will provide a more conducive environment for the operation of the whole S&T sector. They are listed below.

There is a need for an overarching national strategy for S&T and innovation. For full effectiveness, S&T Education and training must be carefully integrated into the broader STI strategy, which in turn would link to other national policies and strategies. The key elements of this strategy are currently either absent or exist in uncoordinated isolation (paragraph 33ff).

The data management capacity of the sector must be strengthened. Without accurate, up-to-date and reliable data, planning, monitoring and evaluation becomes difficult, with adverse consequences on quality and efficiency. Existing mechanisms to collect, manage and disseminate post-basic education data should be strengthened. Efforts should be made to standardize instruments for data collection and, within each ministry, parastatal organization and tertiary institution. Data for the whole sector should be collated and be available from a single source (see, for example, paragraphs 41, 47, 80, 120).

The fragmentation of the management of the S&T sector must be addressed. The S&T sector is characterized by a fragmentation of management structures resulting in plans and strategies that overlap and sometimes conflict, and in policy gaps (paragraph 32ff).

Systems for monitoring labor market needs and responding to them must be improved. Current information on labor market needs is insufficient for planning purposes. A labor market observatory should be established that can not only identify needs but also report on how effectively the tertiary system is able to satisfy them (paragraph 48).

Steps must be taken to address the lack of terrestrial ICT bandwidth. The current dependence on expensive satellite links is unsustainable and inhibits the widespread introduction of ICT. Current moves to privatize the communications industry and to develop a terrestrial fiber backbone must be augmented by strategies to ensure that adequate subsidized bandwidth is available for educational purposes at a cost that matches the ability of the institution to pay (paragraph 97ff).

A comprehensive review and reform of the secondary curriculum is required. The secondary S&T curriculum has changed little in the last 20 years and no longer adequately serves the need of either the school-leaver or the tertiary sector. A major reform is recommended (paragraph 59ff).

A National Vocational Qualifications Framework and the necessary structures to manage it should be established. This is of particular importance to the TVET sector in order to create a training structure better able to respond to rapidly changing training needs and also able to embrace a wider variety of training institutions, public and private (paragraph 71).

Mechanisms must be put in place to improve the quality of equipment and facilities available for teaching at all levels as well as for research at the tertiary level. These measures are not limited to simply increasing funds available; collaboration between institutions, a more limited focus in programs offered and an improvement in the culture of maintenance are all measures that have the same end. In the case of university research, funding should be competition-based to provide incentives to enhance efficiency and strengthen collaboration with industry and partnerships among post-basic S&T institutions (paragraph 81).

More effective partnerships between the public and private sector should be established. The report notes many instances where the development of the S&T sector would be greatly
enhanced by effective partnerships between public and private institutions. Existing barriers to this kind of partnership should be removed and ministries should actively facilitate it (this theme runs through the whole report but significant paragraphs are 78, 85, 102, 115, 120, 125, 139, 148, 160).
Acronyms and abbreviations

AfDB  African Development Bank
AIST  African Institute of Science and Technology, Abuja
CASS  Continuous Assessment
CD    Compact Disk
CN    Concept Note
CPS   Country Partnership Strategy
DFID  Department for International Development (UK)
ECOWAS Economic Community of West African States
(E)MIS (Education) Management Information System
ESA   Education Sector Analysis
ETF   Education Trust Fund
FCE   Federal College of Education
FCT   Federal Capital Territory
FGN   Federal Government of Nigeria
FME   Federal Ministry of Education
FMST  Federal Ministry of Science and Technology
FSC   Federal Science College
FUT   Federal University of Technology
GeSCI Global eSchools and Community Initiative
GDP   Gross Domestic Product
GNI   Gross National Income
HEI   Higher Education Institution
ICT   Information and Communication Technology
INSET IN-Service Education and Training
ISP   Internet Service Provider
KEWL  Knowledge Environment for Web-Based Learning
K4D   Knowledge for Development (program)
MAN   Mathematics Association of Nigeria
MDG   Millennium Development Goals
NACCIMA Nigerian Association of Chambers of Commerce, Industries, Manufacturing and Agriculture
NARICT National Research Institute for Chemical Technology
NBTE  National Board for Technical Education
NCCE  National Commission for Colleges of Education
NCE   National Certificate for Education
NDE   National Directorate of Employment
NEEDS National Empowerment and Economic Development Strategy
NEPAD New Partnership for Africa’s Development
NERDC National Education Research and Development Council
NICTIB National Information and Communication Technology Infrastructure Backbone
NITDA  National Information Technology Development Agency
NITEL  Nigeria Telecommunications Limited
NOUN  National Open University of Nigeria
NUC   National Universities Commission
NUNet  Nigeria University Network
ODL   Open and Distance Learning
PER   Public Expenditure Review
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>PEP</td>
<td>Pre-Entry Program</td>
</tr>
<tr>
<td>PSNet</td>
<td>Public Service Information Network</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
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<tr>
<td>SMICT</td>
<td>Science, Mathematics and ICT</td>
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<tr>
<td>S&amp;T</td>
<td>Science and Technology</td>
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<tr>
<td>SEEDS</td>
<td>State Empowerment and Economic Development Strategy</td>
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<tr>
<td>SS</td>
<td>Senior Secondary</td>
</tr>
<tr>
<td>STA</td>
<td>Study Area (six STEPB STA reports)</td>
</tr>
<tr>
<td>STAN</td>
<td>Science Teacher Association of Nigeria</td>
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<tr>
<td>STEPB</td>
<td>Science and Technology Education Post Basic</td>
</tr>
<tr>
<td>TCO</td>
<td>Total cost of ownership</td>
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<tr>
<td>TVET</td>
<td>Technical and Vocational Education and Training</td>
</tr>
<tr>
<td>UBE(P)</td>
<td>Universal Basic Education (Program)</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Cultural and Scientific Organization</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
</tr>
<tr>
<td>VSAT</td>
<td>Very Small Aperture Terminal</td>
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</table>
1. Background and Sector Overview

1.1 STEPB study objectives and methodology

1 The Science & Technology Post-Basic Education (STEPB) study provides an analysis of the constraints and issues related to improving the quality and appropriate quantity of science and technology (S&T) post-basic graduates from the federal system. It addresses questions of policy and planning, teaching, learning and research, and whether graduates possess the relevant skills for the labor market and the expanding non-oil economy. The report also discusses preliminary findings in financing trends and expenditure patterns for the federal post-basic level. The scope of this study is limited to the federal post-basic education system in Nigeria.

2 The conclusions and recommendations in this report are meant to contribute to three questions debated in Nigeria today: (1) How can Nigeria catch up with the rapid international developments in Science and Technology? (2) What needs to be done to enhance the capacity of the Nigerian post-basic federal education system to produce the needed S&T graduates for mid-skill level and highly-skilled jobs? (3) How can the FGN and other stakeholders support a more vigorous economic growth by exploiting S&T know-how?

3 The STEPB Synthesis Report was jointly prepared by the World Bank’s Nigeria Education Team, a Technical Task Team from the Federal Ministry of Education (FME) and the Federal Ministry of Science and Technology (FMST), and national and international consultants (see Annex A for more details). The study began with the drafting of a Concept Paper that was discussed and agreed by the FGN, the World Bank, and DfID. DfID co-financed the study, which allowed support from the British Council in Abuja. The study significantly benefited from involvement by Federal post-basic education organizations involved in S&T activities in Nigeria (such as the NUC, NCCE, NBTE, NITDA, NUT, NACCIMA, and many others). The STEPB team also benefited from discussions with other development partners, notably the Abuja Office of the African Development Bank and UNESCO.

4 This STEPB study is part of the ongoing dialogue between the World Bank and DfID (joint development partners) with the FGN. The intent is to help inform decision makers, discuss methodologies for prioritizing problems and interventions, and to provide some ideas for moving the agenda. In early December 2005, the Honorable Ministers of Education and Science and Technology appointed a STEPB Technical Taskforce, which included representatives of S&T Post-Basic Education sector stakeholders in Nigeria. The study was prepared between November 2005 and June 2006 during which field missions by teams of national and international consultants were conducted to research the six study area reports that informed this synthesis report.

5 From its inception, the process of researching and assembling the STEPB study has been a highly participative and consultative one. With support from the FGN Technical Taskforce, DfID and the Abuja British Council Office, four workshops were organized to discuss progress, results and receive feedback. In addition, meetings with the various public and private S&T stakeholders convened to encourage discussion of the findings from the six study area reports (STA reports). A draft version of this synthesis report was prepared and discussed with the FGN Technical Taskforce.

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3 The Concept Note (CN) review meeting (by the FGN, WB, and DfID) took place on November 30, 2005. The CN was prepared at the request of the FGN to support the strengthening of its S&T sector, specifically related to Federal post-basic education and training. Several consultation workshops with the relevant sector ministries and S&T stakeholders were held during Sept. 2005 - June 2006, providing foundation for the CN. The Ministers FME and FMST appointed a technical task force to participate in the STEPB study.
The STEPB study team is deeply appreciative for the contributions of the many stakeholders who participated without whose expertise the resulting consensus around STEPB issues could not have been achieved. A list of Nigerian officials, counterparts, STEPB team, and national and international consultants appears in Annex A.

6 The overall objective of the STEPB study is to assist the FGN to identify and prioritize innovative strategies in S&T Education at the Federal Post-basic level that could likely contribute to sustained economic growth as defined by the FGN’s NEEDS document. Specifically the study objectives are to: (1) carry out a review of the quality of S&T Education and training at the federal post-basic level and propose strategic approaches to improve it; (2) provide international comparative perspective of best practices and lessons in S&T Education and training; and (3) recommend how to build on several recent efforts to strengthen S&T education and training in Nigeria with the aim to make its outcomes more relevant for promoting economic growth.

7 The Federal Government of Nigeria (FGN) has made education a top priority, with a special focus on Science and Technology. The Government has also requested its development partners to support the necessary increase in capacity of its Federal Post-basic Education sub-sector in order to make it better meet the demands from the growing economy. Many of the key subjects that can contribute to a better skilled labor force and move the country towards a ‘Knowledge Economy’ are in Science and Technology. For this reason the STEPB team has focused this study on S&T related issues and subjects. According to a labor market survey conducted in Nigeria, the skills viewed as most important for new employees are technical skills, with over 70% of employers describing them as “very important.” Further, trends in the demand for different occupations obtained from a job opportunity index constructed by the Nigerian Institute of Social and Economic Research anticipate a growth in the demand for S&T professionals, particularly in health and engineering. Without a relevant, accessible and rigorous system for S&T post-basic education and training, this demand will not be met, especially given the high rate of brain drain for skilled professionals in Nigeria.

8 The STEPB synthesis report is based on the findings, conclusions and recommendations of six technical study area (STA) reports. These six STA reports cover the following areas:

1) A review of policies and strategies in S&T innovation related to federal post-basic education and training in Nigeria;
2) A review of financing and expenditure trends for the federal post-basic education and training level with a focus on S&T (based on data availability);
3) A review of teaching and learning, curricula and assessment practices in S&T post-basic education and training at the federal level to identify and prioritize capacity enhancement needs and improve quality and relevance;
4) A review of the impact of ICT on teaching and learning, e-learning, and open learning arrangements at the federal level to assess existing capacity, and to identify and prioritize capacity enhancement needs;
5) A review of labor and employment issues related to federal S&T post-basic education and training (based on the labor market study done in 2000);
6) An assessment of the backbone connectivity readiness and needs of selected federal universities and higher education institutions (HEI) with recommendations on optimal broadband connectivity solutions for these institutions.

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4 According to a recent study, Nigeria is one of the top three African countries in the number of skilled emigrants to the USA and EU countries, second to South Africa (http://imagebank.worldbank.org/servlet/WDSContentServer/IW3P/IB/2005/10/21/000012009_20051021094619/additional/310436_360_200509297115383.pdf)

5 This work is based on the World Bank 2002 report: Financing Trends and Expenditure Patterns in Nigerian Federal Universities; and the World Bank’s 2004 Nigeria Education Country Status Report (Keith Hinchcliffe). The current review is part of an ongoing Public Expenditure Review (PER) for the Nigeria Education Sector led by Halil Dundar. The STEPB STA#2 covers only the cost and financing at the Federal Education Institutions for at Post-Basic Education level.
Chapter 1 (this chapter) provides a brief commentary on the country background, the social and economic context, and the scope, objectives and methodology of the STEPB study. Chapter 2 offers an overview of policy and planning for S&T education in Nigeria within a competitiveness context. Chapter 3 addresses S&T teaching, curricula, learning and research. Chapter 4 highlights e-learning and the use of ICT in S&T education. Chapter 5 presents preliminary findings in financing trends and expenditure patterns. Chapter 6 distils key recommendations for the FGN, STEPB institutions and other stakeholders.

Significant problems in data collection and validation require attention to complete the picture of post-basic S&T education at the federal level in Nigeria. This is particularly true for the cost- and finance data. Lack of valid data sets, difficulties with reconciling various data sources, and problems in verifying the outcomes with the real situation in federal institutions and schools challenged the authors’ ability to assert concrete conclusions. This posed problems for making firm conclusions. It is anticipated that the debate which will be stimulated by this report will contribute to increased commitment to data generation, tracking and management.

1.2 Country Background

Nigeria is a federation with a total population of about 137 million making it the largest nation on the African continent. There are 394 different languages spoken in Nigeria. Hausa, Yoruba and Igbo are spoken by over 50 percent of the population and are the major national languages. English is the official language and is widely spoken. Many less widespread languages are not written and devising instructional material in those languages is difficult. Nigeria has a three-tier government structure with Federal, State and Local Government Area levels. There are 36 states and the Federal Capital Territory (FCT) and 774 Local government areas.

The political and economic transformation taking place in Nigeria today provides an opportunity to turn the economy of Africa’s most populous nation around. Over the last 4 years, the FGN has begun to undertake significant economic and financial management reforms geared to reducing poverty as outlined in the country’s National Economic, Empowerment and Development Strategy (NEEDS). Among its core implementation strategies, the NEEDS emphasizes changing the way the Government works through improved efficiency, transparency and strengthened anti-corruption activities.

Nigeria has been quick to assume its international responsibilities. Nigeria is a leading player in the United Nations, the Commonwealth, the New Partnership for Africa’s Development (NEPAD), the Economic Community of West African States (ECOWAS); and plays an important role in peacekeeping throughout Africa. More recently, Nigeria was selected to host the first campus of the Africa Institute of Science and Technology (AIST), a continent-wide (regional) initiative of the Nelson Mandela Institute established to enhance Africa’s capacity to join the global knowledge economy. Planning for the AIST-Abuja Campus has started and the first courses (in cooperation with private sector employers) are underway. The campus will serve as part of the emerging Technology Village situated in the Federal Capital Territory (FCT). AIST’s planners envision an eventual student body of 5,500 with teaching and research facilities at international acceptable standards. The FGN is looking for private partners and investors to implement the plan.

Despite its reform efforts, Nigeria still faces significant challenges in accelerating growth, reducing poverty and meeting the Millennium Development Goals (MDGs). Nigeria’s economy depends heavily on the oil sector, which contributes 95 percent of export revenues, 76 percent of government revenues, and about a third of gross domestic product (GDP). But following many years of neglect of the non-oil sectors, GNI per capita (2004) remains low at about US$390 (Atlas method)

According to the World Bank’s World Development Indicators Database, Nigeria’s GNI per capita increased from US$260 to US$390 between 2000 and 2004.
which is below the sub-Saharan Africa average of US$600. It is important to note that Nigeria receives only US$2 per capita in official development assistance compared to an Africa average of US$28. Table 1 shows growth trends since 2000 in some key economic areas.

15 Key indicators in the Human Development sectors in Nigeria show mixed trends. Health and education indicators show slight improvements in some areas. Social protection indicators have not been tracked over time, but show high levels of vulnerability and low capacity among the poor to manage risk. There are distinct geographic differences in indicators with the North in general trailing the South and sharp differences between the poor and non-poor. In 2004, about 7 million children (25%) of the relevant age group (6-11 years) were not enrolled in primary schools. Girls continue to have less access than boys, with only

58% of girls attending (mainly primary) school, dropping to 20% in Northern Nigeria. The completion rate for primary education is only about 45%. Figure 1 shows how Nigeria compares with the average for lower-middle income countries in a number of general and S&T-related indicators.

| Table 1 Some key economic indicators (% growth p.a. unless otherwise stated) |
|-----------------------------|-----------|-----------|-----------|-----------|-----------|
|                             | 2000      | 2001      | 2002      | 2003      | 2004      | 2005      |
| Overall Real Growth         | 5.6       | 3.3       | 1.4       | 10.9      | 6.1       | 6.9       |
| Oil                         | 11.5      | 1.4       | -11.6     | 26.5      | 3.5       | 4.2       |
| Non-Oil                     | 2.8       | 4.3       | 8.0       | 4.4       | 7.4       | 8.2       |
| Agriculture                 | 3.9       | 3.9       | 4.3       | 6.5       | 6.5       | 8.2       |
| Industry                    | 3.6       | 8.7       | 8.9       | 6.4       | 4.6       | 8.2       |
| Services                    | 2.4       | 3.6       | 13.0      | 1.2       | 8.1       | 8.2       |

16 Growth performance of the economy has improved. Growth of the non-oil sector in 2004-05 has been above 7%. Private sector confidence in the economy appears to be strengthening evidenced by continued foreign direct investment flows. The FGN is also paying increasing attention to restructuring its expenditure policies toward better financing of MDG-related activities. A Committee chaired by the President was inaugurated at the end of June 2005 and will monitor implementation of the MDGs. The FGN has also launched implementation of matching grants to States to attract additional financing for basic education under its Universal Basic Education (UBE) Program. The national framework for reform, growth and poverty reduction (NEEDS) was launched in May 2004, and was complimented by the States’ SEEDS. This strategy is based on three pillars: (i) empowering people and improving social service delivery, (ii) growing the private sector and focusing on non-oil growth, and (iii) changing the way government works and improving governance. Based on this strategy, the World Bank and DfID have prepared a joint Country Partnership Strategy

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[7] www.worldbank.org/kam. This site provides a tool for the creation of spidergrams such as this one.
Figure 2 shows Nigeria in comparison to several other countries globally as a function of its capacity competitiveness. As it depicts, the industrialized leaders put strong emphasis on tertiary education, technology diffusion and the appropriate policy mix to encourage innovation, which has perpetuated their growth. Nigeria joins the ranks of Cameroon, Pakistan and Ethiopia—countries that are falling further behind in their competitiveness as measured along these three dimensions.

It is instructive to consider what are key elements of a policy mix that might stimulate Nigeria to move towards the upper right in Figure 1, closer to countries such as Singapore, South Korea and Taiwan. These would include: (1) a repositioning of the universities to respond more directly to the needs of industry, (2) an emphasis on entrepreneurial skills and technological learning to enhance technological competitiveness, (3) prioritization and specialization of rapidly growing, key sectors for industrial growth, and (4) explicit policies to encourage relations between academia, industry, the Academy of Science, and public research institutes. As important as finance for R&D and openness to trade and foreign direct investment are, research suggests that what matters for

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1 The joint World Bank - DFID Country Partnership Strategy was approved in mid-2005.

2 Capacity competitiveness is a composite indicator of three related measures: investments in human capital (e.g., gross enrolment in secondary and tertiary education), efforts directed toward diffusion of technology (e.g., gross fixed capital formation and measures of the spread of computers across the population), and relevant policy aspects (i.e., those that relate to the quality of governance and adherence to human rights across countries).
performance is not so much differential access to such flows but rather, the ability to take advantage of them, which knowledge capability affords. The quality, relevance, and access to the education system are central to a country's knowledge capability. All these issues are examined further in subsequent chapters of this report.

19 The decision by the FGN to give increased focus to S&T post-basic education aligns well with global trends. Changes brought about by the transition to a knowledge economy, rapid technological change, the expansion in the scope of information and communication technologies (ICT) and their diffusion in new and traditional economic sectors have important implications for education and training. Most occupations now demand higher levels of knowledge and skills, well beyond the basic education level; and a new range of competences such as adaptability, teamwork, communication skills and the motivation for continuous learning have become critical.

20 Evidence from newly industrialized countries (such as the Asian Tigers) shows that economic success has been linked to substantial prior investment in human resources—a key component of knowledge economies—which together with appropriate institutional policies, intellectual property protection, R&D performance, and adequate funding constitute a national innovation system. But the state of Nigeria’s innovation system, while improving, continues to demonstrate weakness in important areas. Available data indicate low levels of investment in S&T education and research capacity, which likely contributes significantly to weakness of Nigeria’s non-oil economy.

21 The World Bank-DfID partnership recognizes that Nigeria is at a turning point, one that requires a significant, consistent response from the international community. Working with the Federal Government within the NEEDS and SEEDS framework, the CPS specifies four priority areas: (a) support to national initiatives in the social sectors; (b) financing investments in infrastructure; (c) dialogue and advice on the investment climate and policies to grow the private sector; and (d) financial and technical support to work on improved accountability, transparency and fighting corruption.

1.3 Overview and Characteristics of Nigeria's Education Sector

22 Nigeria's education system comprises 6 years of primary, 3 years of junior secondary, 3 years of senior secondary and 4 years of tertiary education. The system is hindered by its complicated constitutional and legal framework. In particular, the division of responsibilities among the three tiers of government (together controlling 50% of resources) complicates accountability. Within the federal system the division of responsibilities between the federal Ministry of Education (FME) and its parastatals is not always clear, suggesting duplication and inefficiency. At the federal level, institutional roles and responsibilities sometimes appear to overlap or are out-of-date with recent developments. Underlying these problems is the inadequate capacity for planning and policy analysis and a lack of reliable statistical data, including enrolment data, financial data, and population projections.

23 The main institutions offering post-basic education are senior secondary schools, vocational and technical schools, monotechnics, polytechnics, colleges of education and universities. Approximately one third of the age cohort currently receives three years of junior secondary education which includes compulsory science and mathematics programs. At the post-basic level students either attend senior secondary schools where they receive a traditional academic-based education or technical and vocational schools where vocation-oriented education is offered. The latter is designed to prepare for entry to the labor market with an emphasis on job-specific skills in the applied sciences appropriate to technical, agricultural, commercial and economic
development. Economic self-reliance and preparation for self-employment constitute the stated thrust of this curriculum although opportunities for technical/vocational training are severely limited at this level.

Tables 2 and 3 provide a summary of the number of institutions and enrolments by type of ownership and by level/type of education. Table 2 provides the 2005 enrolment figures. The federally-funded education institutions include: 26 universities with about 490,000 students, approximately 384,000 of which are enrolled in S&T programs; 19 federal polytechnics with about 160,000 students; 33 monotechnics and 22 colleges of education with about 132,000 students; and 110 federal unity secondary schools about 132,000 students. In addition, the Federal Government provides funding for basic education delivered at the state and local levels through its UBE Program and its Education Trust Fund (ETF).

**Table 4:** Enrollment and graduate output by faculty in Nigeria's federal universities 1999/2005

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Enrolment</th>
<th>Graduate Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin</td>
<td>19,512</td>
<td>6,411</td>
</tr>
<tr>
<td>Agnc</td>
<td>20,874</td>
<td>3,093</td>
</tr>
<tr>
<td>Arts</td>
<td>23,771</td>
<td>8,752</td>
</tr>
<tr>
<td>Education</td>
<td>33,458</td>
<td>11,085</td>
</tr>
<tr>
<td>Engr/tech</td>
<td>39,229</td>
<td>5,325</td>
</tr>
<tr>
<td>Envr.Scs</td>
<td>10,866</td>
<td>1,423</td>
</tr>
<tr>
<td>Law</td>
<td>13,656</td>
<td>3,072</td>
</tr>
<tr>
<td>Medicine</td>
<td>20,725</td>
<td>2,187</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>4,879</td>
<td>553</td>
</tr>
<tr>
<td>Sciences</td>
<td>59,533</td>
<td>10,088</td>
</tr>
<tr>
<td>Social Sos</td>
<td>51,797</td>
<td>14,785</td>
</tr>
<tr>
<td>Vet.Med</td>
<td>2,318</td>
<td>251</td>
</tr>
</tbody>
</table>

particularly in emerging technologies. The need to meet the growing demand for high level technical skills in key sectors, such as the telecommunication industry, has triggered the
establishment of additional innovative training institutions, such as the Digital Bridge Institute (DBI).

26 The provision of education in Nigeria is a concurrent responsibility of the federal, state and local governments. Each level of government provides services that benefit its respective constituency. Thus the federal budget for education addresses four national interests: (a) to produce highly specialized skills for a national labor market; (b) to establish training standards and credentials that permit a national labor market to emerge for learned professions; (c) to increase understanding and tolerance across major ethnic division; and (d) to promote a sense of national identity. Tertiary education (e.g., universities, polytechnics and monotechnics) is provided by both federal and state governments, and a growing number of private institutions. State governments are the primary providers of secondary education with the exception of 110 federal secondary (‘Unity’) schools, and increasingly of post-basic education with a regional focus, while local governments have principal responsibility for the provision of primary education. A dynamic private sector also supplies education services.

27 Quality and relevance of education as currently delivered needs to be improved to provide children with basic life skills, knowledge and key competencies necessary to enter the labor force and lead a life as productive citizens. At the secondary level the government is facing decades of neglect. In a recent report by ESA, only 15 percent of employers of technical/vocational schools graduates surveyed rated the job-performance of science and technology graduates as good; while for polytechnics, colleges of education and universities, only 25 percent rated the graduates as good to very good.

28 There is anecdotal evidence of rather high failure and drop-out rates in the system. If this is indeed the case, it represents an inefficiency which could be reduced through a number of targeted measures. Even for those who pass through the post-basic education system successfully, joblessness is often likely. The National Bureau of Statistics estimates that 60% of the country’s 13 million unemployed consist of post-basic level education graduates. But another way, this means that a significant proportion of young people is failed by the education system and is forced to earn a living, unskilled, in the informal sector. This represents an acute inefficiency in the system, which does not provide relevant training to students as required to meet employers’ needs.

29 Young people require a second chance in order to gain the skills to become productive citizens in either the formal or informal sectors. At present, basic skills development for those who have been failed by the education system is mainly provided by the National Directorate for Employment (NDE). The NDE offers young people the opportunity to learn a trade through an apprenticeship in the informal sector, with the possibility of being absorbed into the labor market through self-employment. Despite the good intentions of this scheme, over a five-year period, only around 6,000 of the 119,000 who received training became self-employed. Short-term training opportunities for specific sought-after skills have been shown to serve as useful entry points for those seeking to participate in industry, particularly in SMEs. Regional case studies include Kenya’s Strengthening Informal Training and Enterprise Program (SITE) and Cameroon’s Program d’Appui au Milieu Artisanal da Maroua (APME). The establishment of a National Qualifications Framework would provide opportunities for this large group of young people, by providing a mechanism for the formal recognition of skills developed in the informal sector.

30 Many other countries have introduced Open Schools to address this problem; these

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11 Conclusions from the NASSIEIN study (National Strategy for Secondary Education In Nigeria). Secondary education strategy reports from four States (Enugu, Kaduna, Lagos and Rivers).


13 The issue of accurate data gathering is discussed in chapter 2

offer programs leading to senior secondary examinations by distance (e.g., via correspondence or online). In Nigeria such courses have become heavily subscribed. Although in percentage terms the failure and drop-out rate of these students tends to be high compared with those in schools, the actual numbers passing are significant because of the large enrolment numbers.
2. Policy and planning for competitiveness

Key messages:

- Effective policy and strategy development in science and technology education is fragmented leading to gaps, overlaps and unclear mandates; the establishment of the National Council for Science and Technology represents an opportunity to address these issues (33ff).
- There is a mismatch between the quality, preparedness, and supply of graduates and the needs of the labor market (47ff).
- Information on labor market trends is insufficient to explain the reasons behind the mismatch in supply and demand, and the consequent lack of understanding of needs inhibits effective planning (48ff).
- Policy and strategy development is hampered by inadequate educational management data collection and processing mechanisms both at the national level and within institutions (41ff).

2.1 Policy, planning, and governance

Science and Technology (S&T) is acknowledged within Nigeria’s National Economic Empowerment and Development Strategy (NEEDS) as key to Nigeria’s economic and social development. Placing S&T within the context of Nigeria’s development policy, the NEEDS emphasizes the twin pillars of S&T and education as instrumental to Nigeria’s economic growth:

The overall strategy is to diversify the productive base of the economy away from oil and to foster market-oriented, private sector-driven economic development with strong local participation. The goal is to develop an indigenous entrepreneurial class capable of competing in a global market in which technology and skills play dominant roles.

Nigeria’s National Economic Empowerment and Development Strategy (NEEDS), 2004

Sectoral policies in education and science and technology are designed to carry forward the vision of the NEEDS, but critical gaps threaten the achievement of the NEEDS goals. Post-basic S&T Education is predominantly guided by the 1969 FME’s National Policy on Education (Fourth Revision, 2004) and the 1986 FMST’s Science and Technology Draft Policy. The 1969 Education Policy defines the goals of science and technology education as well as technical and vocational education, stating that the government shall support all agencies involved in the promotion of the study of sciences and ensure that technical and vocational education form an integral part of general education to prepare citizens for the world of work, lifelong learning, sustainable environmental development and poverty alleviation. Taken together, these national policies for S&T and for S&T education identify the technologies the country wishes to develop and the means for their development. There appear, however, to be few links between the two documents and the processes put in place to implement them are incoherent, fragmented and not adequately coordinated.

A lack of policy coherence inhibits the effectiveness of the several policies in education and in science and technology. Since the formulation of the National Policy on Education, several pieces of legislation have been enacted or decreed to enforce the policy. In parallel, a National Policy on Science and Technology was developed, with its own goals and targets, apparently with little attention to S&T education and training. The result is proliferation of policy pertaining to the many dimensions of S&T post-basic education at the federal level. However, the manner in which these policies relate to one
another reveals a number of critical omissions and limited complementarity.

34 The Policy on Education, in particular, does not address adequately emerging issues such as information and communication technologies (ICT), performance-based funding, public-private sector partnerships and secondary education for all. Separately, a National Policy for Information Technology (2001) has the ambitious aim “to make Nigeria an information technology (IT) capable country in Africa and a key player in the Information Society by the year 2005, using IT as the engine for sustainable development and global competitiveness.” This ICT policy, however, while addressing all other sectors in detail does not have a chapter devoted to education. This omission in the ICT policy must be addressed before the impact of ICT on education can be effective. In addition, a holistic, pragmatic, achievable, and affordable ICT in education strategy that addresses the issues of hardware, connectivity, software, training, curricula and ‘ICT opportunities’ across all subjects is required. Achieving such coordination and complementarity in policy requires the formation of partnerships with the private sector and a range of stakeholders, particularly the National Information Technology Development Agency (NITDA) that bears the responsibility for implementing national ICT policy. Good examples of ICT in Education policies exist elsewhere.

35 Even in areas where the policy direction is clear, its implementation is frequently incoherent and inadequate. Effective implementation of policy requires a clear strategy that includes measurable indicators and clearly defined responsibilities and an ongoing monitoring and reporting exercise. The absence or inadequacy of any one of these jeopardizes policy implementation. This is further exacerbated by staff-turnover and related institutional memory loss. Numerous examples of this were noted; the implementation of the FME TVET policy, the establishment of the Virtual Library; the development of a comprehensive EMIS; the 60/40 science/arts ratio in tertiary education, university autonomy, the NCE as the minimum qualification for teachers, the implementation of quality assurance mechanisms for TVET. The precise root causes of this are unclear but they point to a failure of accountability and of effective monitoring. The message emerging is that policy implementation monitoring mechanisms should be tightened and responsibilities more clearly defined.

36 A critical policy gap is that between S&T and research. Specifically, the National Policy on Science and Technology does not have an explicit chapter on research. As a consequence, research policy is underdeveloped and no clear mandate charges a specific institution with the responsibility to take charge of the development of research in the country and to perform key functions such as to allocate research funds on a competitive basis or to encourage cooperation between industry, research institutes and universities to improve the quality of products and services offered by Nigerian institutions.

37 The resulting picture of the policy environment is one of over-bureaucratization with mission-overload in certain institutions and lack of inclusion with others. The Federal Ministry of Science and Technology alone relies on 35 separate parastatals to execute its mandate. With fewer parastatals, but still overly bureaucratized, the Federal Ministry of Education has 21 such entities under its authority including the National Universities Commission (NUC), the National Board for Technical Education (NBTE) and the National Council for Colleges of Education (NCCE). A simplification of the current over-complex and over-bureaucratized governance of the sector is a prerequisite for ensuring that S&T is better mainstreamed, more highly prioritized, funded, and harnessed for growth and competitiveness. The current proposal to reduce the FMST’s parastatals to just 17 is to be commended.

38 The necessary coordinating mechanisms at the highest level of government have yet to be
implemented to ensure that S&T is mainstreamed across critical sectors. The result is planning without budgeting, overlapping mandates, and lack of clarity. Responsibility for implementing science and technology policy is shared between several institutions including the Federal Ministry of Science and Technology (FMST) and the numerous parastatals that come under its purview, the Ministry of Education, its three boards that have oversight of higher education, the NUC, the NBTE and the NCCE, and, for secondary S&T curricula, the National Education Research and Development Council (NERDC). Strategies relating to ICT fall under the oversight of NITDA.

39 The Nigerian structure for science and technology planning and advice delivery appears to be led by three key players: the Presidential Advisory Council on Science and Technology, the proposed National Coordinating Council on Science and Technology, and the Nigerian Academy of Sciences. Currently under discussion, a planned National Coordinating Council in Science and Technology (NCCST) to be chaired by the President of the Federal Republic signals an ever-increasing seriousness of intent to better organize, consolidate, and manage S&T policy and planning. In theory, several Ministries with S&T-related mandates would be represented on the Council. Among the responsibilities detailed in the plan for the NCCST is the review of S&T curricula at the basic and post-basic education levels. If strategic planning and priority setting in S&T could be articulated by the Council in such a way that resources for research, training, and education reform were then tied to these, the Council’s potential to streamline and coordinate the nation’s S&T policy and planning would be considerable.

40 Experiences from other developing countries support the coordinating council model. Many countries have identified a need to streamline and coordinate their S&T policies and planning under one body. Box 1 outlines models from three different countries. The National Coordinating Council for Science and Technology, currently under discussion, is Nigeria’s response to the lack of any coordinating mechanism. Whatever coordinating mechanism eventually emerges for addressing the current fragmentation, it should be closely integrated into the systems, mentioned above, that monitor the demands of the labor market.

41 Initiatives to harmonize policy and develop strategies are hampered by the absence of adequate data collection and mechanisms. Monitoring and evaluating the performance of the post-basic education system hinges upon the availability of standardized, reliable, and timely data. The inconsistency of existing data-collection mechanisms limits accurate assessment of the performance of Nigeria’s post-basic educational system. Data collected by different parastatals often relies on divergent mechanisms, resulting in conflicting figures. Even when accurate data are collected, they are rarely published in a manner that makes them readily usable. It is also the case that within the

| Box 1: National Science and Technology Advisory Committees in Selected Countries |
|---------------------------------|---------------------------------|---------------------------------|
| South Africa’s National Advisory Council on Innovation; Est. 1997 | Tanzania’s National Commission for S&T, Est. 1986 | India’s National Science Academy; Est. 1935 |
| Chairperson, CEO, Trade and Industry representatives and 16-20 ministerial appointees on the basis of outstanding achievement in STI, experience, and insight | With 8 major advisory committees, sector-based and small secretariat of 3 directorates (Research and Coordination, ICT and documentation, Finance and Admin), the Commission coordinates and promotes research and technology development and reports to the Ministry of S&T and Higher Education | Established as the National Institute of Science of India, it now works under the Department of S&T; Secretariat composed of 10 people, a Council with 12 Sectional Committees that cover distinct knowledge branches; 4 standing committees with 1 year tenure, 4 advisory committees (8-15 people) |

same agency, incompatible data sets are sometimes provided. Without accurate data, analysis and recommendations are tenuous at best. To facilitate data tracking and management, the establishment of a comprehensive Educational Management
Information System, as proposed in the UNESCO EMIS study\textsuperscript{16}, is crucial. This initiative has been a component of donor-funded programs but a comprehensive system is yet to emerge.

42 Progress toward targeted enrollment in S&T is promising at all levels and has been achieved at the federal universities level. The FGN has articulated an enrolment policy with a target for science and technology programs in federal universities at 60% of all admissions. In the polytechnics, the target is 70% of admissions. Compliant with national policy, the overall percentage of science and engineering enrollment in the federal universities hovered between 50 and 60 percent from 1999-2005, and recent information from the NUC suggests that the target has now been achieved. Two causes for concern remain however; firstly there is a question around whether the numbers enrolled in different S&T courses actually meets labor market needs as there appear to be shortages in some areas (such as telecommunications) and overproduction in others. Secondly a question arises on graduation rates; anecdotal evidence suggests high failure rates in some programs but the data collected are insufficient to support or quantify this. A system of cohort monitoring is required to throw further light on this.

43 The most evident problem with the enrollment policy is that these fixed ratios for science:arts students do not take account of the quality of the programs into which students enroll, the mismatch between enrollment and graduation, or the needs of industry in contrast to number and types of students trained. Thus, the science:arts student ratio is less a demand-driven target buttressed by industry-articulated goals for human resources and more of a supply-driven model that conflates quantity with quality and relevance. Not surprising, the impact of the planned enrolment mix favoring science and technology on national goals attainment is unclear.

quality require sustained financial and political commitment.

The establishment of a NQF would also offer a mechanism for removing a significant impediment in the system as it currently operates; the difference in perceived status between the Universities and the Polytechnics which currently has a considerable impact on promotion, pay and job status. A National Qualifications Framework and a unified management structure would improve system efficiency and possibly open the way to Polytechnics and Colleges of Education awarding their own degrees, now a commonplace elsewhere. The teacher education colleges also could be allowed to develop, where appropriate, higher level specialist programs.

2.2 Policies and strategies to align STEPB to the needs of the labor market

Where other developing countries have improved their policies and training systems to foster greater entrepreneurial talent in their learners, increased success in harnessing science and technology for sectoral growth and competitiveness has occurred. A World Bank study compared 10 industrial sectors to identify specific policies that various governments employed to successfully encourage increased competitiveness. The study found that in addition to engineering and scientific skills, a critical mass of entrepreneurial talent capable of engaging with foreign firms, participating in technology transfer, and doing business with global buyers played a crucial role in technological deepening and adaptation across cases. Countries and sectors that had educational systems that fostered adeptness at technological learning, experienced positive transformation; without such systems, results were far less impressive. For example, case studies in Uganda for the fisheries sector showed that the shortage of entrepreneurial skills inhibited the emergence of large domestic firms there. Conversely, in Chile, the entrepreneurial talent in the human resources in both the wine making and salmon farming industries was sufficient to enable domestic producers to engage foreign firms in successful technology transfer. In Kenyan floriculture, there are large domestic firms with managerial talent, but the paucity of scientific skills has stalled local research and upgrading.

Available data coupled with anecdotal evidence suggests that the number and quality of S&T graduates produced does not match the needs of industry. As will be discussed further below, in certain key sectors such as ICT, insufficient numbers of skilled technicians graduate from Nigerian universities and polytechnics who are adequately prepared to fill the jobs available. At the same time, unemployment among graduates of some S&T programs in universities is high (60% in environmental studies, 50% in engineering and technology has been reported). Without conclusive data, it is not possible to determine which one or more of the following theories accurately explains this perceived mismatch in supply and demand: (1) The economy is not growing fast enough to absorb the S&T graduates produced in some disciplines; (2) The

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labor market regulations are so onerous that employers prefer not to employ those whom

Box 3: Mechanism used to address S&T skill needs in Ireland

The Irish Training Authority provides a range of training and employment services to jobseekers, community groups and employers. The National Policy and Advisory Board for Enterprise, Trade, Science, Technology and Innovation. Enterprise Ireland markets Ireland as an attractive location for inward investment.

Expert group on future skill needs
Skills Implementation
Business Education and Training Forum

The purpose of this institutional structure is to:
- Identify in a systematic way, the skill needs of different sectors.
- Develop estimating technique that will assist in anticipating future skill needs.
- Advise on the promotion of education links with business.
- Consider strategic issues in developing partnerships between business and education in meeting the needs of business.
- Advise on how to improve the awareness of job seekers of sectors where there are demands for skills, of the qualifications required, and of how they can be obtained.


they would otherwise elect to hire; (3) The demand expressed by employers is for better skilled graduates not more graduates; and/or, (4) Employers demand different skills from the graduates produced from what is being taught.

48 Understanding the match between demand and supply of science and technology graduates is a complex task fraught with rather unpredictable variables particularly without a mechanism for monitoring skill demand and identifying areas of skill scarcity. Box 2 illustrates how the Skills Development and Planning Unit grapples with this challenge in South Africa. Although Nigeria’s National Manpower Board conducts research into, and produces statistics on, the status of the labor market, much of the information is not readily accessible or is outdated. Additionally, a number of institutions, both public and private, provide information on employment opportunities but there appears to be no framework for linking the activities of these different players in a complementary manner for ensuring that the supplied information is current.

49 Trends in the labor market, and particularly the understanding of the informal sector, could be tracked and elucidated to relevant stakeholders by a labor market observatory. This would oversee a monitoring and evaluation strategy to better couple skill need with supply. The natural home for such an institution is probably the National Manpower Commission but the greater part of the work would be contracted out. Concurrently, building competence and capacity in those institutions identified as national leaders in entrepreneurial/business skill training by financing their cooperation with industry is also recommended. India’s creation of a National Science and Technology Entrepreneurship Development Board (NSTEDB) to foster the development of such activities as curricula reform and the development of specific modules targeting key skills among science and technology human resources offers a good model to explore.

50 Box 3 shows an effective solution developed by the Republic of Ireland when confronted with the challenge of reforming teaching and curricula practices in the nineties to better attune the post-basic education sector to the requirements of industry. The Irish solution involved establishing the Business Education and Training Partnership to define the roles and responsibilities of the different partners engaged in this process.

51 Future growth in the post-basic sector must be targeted more effectively to needs. The era of rapid growth for post-basic (and particularly higher) education in Nigeria has not yet ended, but the expansion of the sector needs to be more targeted and strategic to meet the needs of the labor market, with a special focus on the improvement of internal efficiency and the quality and relevance of science and technology programs. Despite additional

19 See India’s Ministry of Science and Technology’s Annual Report 2004-2005 for descriptions of the programs of the National S&T Entrepreneurship Development Board: http://dst.gov.in/about_us/ar04-05s-t
revenues available from current high oil prices, future growth in the education sector must be accomplished amidst increasing competition for public financial support. Facilitating enhanced efficiency within the post-basic education system liberates more resources for further sectoral expansion in the coming years.

52 *Maximizing efficiency in the post-basic education system entails deepening the understanding of the causes for the mismatch between supply of graduates and firms' demand for them.* Clues from recent labor market surveys\textsuperscript{20,21} suggest graduates lack key skills. Many countries around the world experience a mismatch between what is demanded in the labor market and what is produced by their higher education institutions. To what extent this mismatch occurs in Nigeria, especially with regard to the skills of S&T graduates, was the topic of a recent labor market survey during which employers were asked what skills new S&T employees require in order to perform their job effectively and to what extent these are very important, important, or not important at all. The results were not surprising and are illustrated in Figure 3. The skills viewed as most important for new employees in Nigeria are technical skills, with over 70% of employers describing them as very important. This suggests that technical skills are vital for enabling employees to perform their jobs effectively. At the same time, employers also view key skills as being equally important. However, when employers were asked to describe the degree to which S&T graduates have acquired such skills, 42% of respondents said that S&T graduates have poor technical and key skills. A similar proportion of respondents (37%) indicated that graduates did not have competent key skills.

53 In order to investigate these issues further, employers were subsequently asked why S&T graduates had poor technical skills. An overwhelming 80% of respondents thought the problem related to the quality of courses that were provided by higher education institutions. A similar proportion of employers thought that the types of skills taught at universities and polytechnics were not relevant to those used in industry. These findings suggest a mismatch between the type of skills acquired by S&T

\textsuperscript{20} The research for this study was undertaken between November 2005 and March 2006, spearheaded by Marcus Powell. The first stage involved a series of qualitative interviews with training managers, or those responsible for training, in order to understand what issues should be incorporated into the questionnaire. This was followed up by a small scale survey that involved 27 large companies completing a questionnaire. The purpose of the survey was to examine the skills and competence that today's Nigerian S&T graduates are bringing onto the labor market from the perspective of employers. Through undertaking such an enquiry it is possible to comment on the degree to which the country's higher education institutions are equipping technologists and other professionals with the type of skills and competencies required by employers.

graduates at university and those required by the labor market which merits a more comprehensive investigation.

<table>
<thead>
<tr>
<th>Qualification of university graduate</th>
<th>Skills identified as weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>ICT, entrepreneurship, critical thinking, self directed learning</td>
</tr>
<tr>
<td>Agriculture and veterinary medicine</td>
<td>Subject knowledge, practical skills and communication skills</td>
</tr>
<tr>
<td>Arts and Social Science</td>
<td>Communication skills, literacy skills and ICT</td>
</tr>
<tr>
<td>Engineering</td>
<td>Practical skills, problem solving and analytical skills, entrepreneurial skills, ICT</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>Practical skills, subject knowledge, ICT communication skills</td>
</tr>
<tr>
<td>Medicine and Dentistry</td>
<td>Entrepreneurial skills, critical thinking, problem solving and ICT</td>
</tr>
<tr>
<td>Education</td>
<td>Practical skills, subject matter, ICT communication and entrepreneurial skills</td>
</tr>
<tr>
<td>Law</td>
<td>ICT, communication and entrepreneurial skills</td>
</tr>
</tbody>
</table>

Source: NUC, Labor market expectation of Nigerian graduates - A report of national needs assessment surveys. 2004

54 The skills most lacking in S&T graduates are in those key skill areas related to carrying out tasks associated with employment in a modern organization. Evidence from a number of studies has suggests that graduates lack many skills needed to secure employment. Box 4 shows some results from a recent study by the National Universities Commission, the objective of which was to undertake a needs analysis and identify what knowledge and skills graduates require to enter the labor market successfully. The study suggested that recently qualified graduates exhibited a number of skill deficiencies, particularly lack of analytical, problem solving, communications, entrepreneurial and ICT skills. These underdeveloped skill areas put an additional burden on the cost of employment and are a factor in the widespread practice of poaching trained staff from competing firms rather than employing recent graduates. On a positive note, according to the aforementioned labor market survey by Powell, many Nigerian employers state that S&T graduates possess good literacy/numeracy skills and are also competent in team working (Figure 4).

55 Lacking exposure to entrepreneurial training and technological learning, graduates of post-basic S&T education have not facilitated value addition in key sectors. A study of 11 enterprise clusters in Africa included two in
Nigeria: Nnewi’s auto parts cluster with 85 firms and the Otigba computer hardware cluster with over 5,000 firms. The assessment of those factors most influential in firms’ success found that an “educated and skillful labor force is the core of innovation and firm competitiveness” in the clusters. And yet in the case of Nnewi Cluster, firms’ perceptions of government support in the provision of available skilled human resources was “very low” (77.1% of firms interviewed rated the government as weak in this area). As well, firms’ assessment of public university support to the cluster was very low with 89.4% of the interviewed firms indicating so. Until reforms of the post-basic education sector are informed by the needs of the private sector and mechanisms for such change benefit from private sector stakeholder participation, the gulf between government, academia, and industry will remain wide. The result of this divide is the continued production of graduates who lack the sufficient entrepreneurial skills, business skills, effective communication and computer literacy skills as well as those essential skills related to group problem-solving, analysis, and creative thinking that employers demand. This skill deficit has severe consequences for national development prospects and attainability of the NEEDS goals.

Table 5: Types of Industry-education links

<table>
<thead>
<tr>
<th>Type of link</th>
<th>% of respondents with such links</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work experience program</td>
<td>56</td>
</tr>
<tr>
<td>Involvement in curriculum</td>
<td>7</td>
</tr>
<tr>
<td>development</td>
<td></td>
</tr>
<tr>
<td>Group visits of learners</td>
<td>44</td>
</tr>
<tr>
<td>Talks</td>
<td>37</td>
</tr>
<tr>
<td>Joint research</td>
<td>30</td>
</tr>
<tr>
<td>Sponsorship</td>
<td>26</td>
</tr>
</tbody>
</table>

57 The failure of most S&T training programs, particularly at polytechnics, to integrate significant work experience opportunities into the learning experience means that graduates enter the world of work incompletely prepared. Thus, companies make substantial investments in further training. Less scrupulous companies tend to avoid this by poaching experienced employees. More innovative companies, however, have developed links with universities by which equipment and expertise have been provided to support relevant curricula and teaching.

58 Little career advice is currently available to potential S&T students. While some HEIs have forged links with schools to inform potential students about the programs they offer and the careers they lead to, there is no coordinated national careers advice system available to all students. Establishing such a program is a major operation involving collaboration across ministries, but it is something which lends itself to electronic media and Nigeria may wish to consider developing a career advice service as it integrates ICT into post-basic education. Experience elsewhere suggests that an increased understanding of the demands of higher education programs and of the career choices that they lead to, tends to add purpose to the student endeavor and to reduce failure and dropout rates.

3. Teaching, Learning, Curricula, and Research in Post-Basic S&T Education

Key messages:

- Overloaded and content-driven curricula and exclusive examination practices, both with little emphasis on skill acquisition mean that graduates at all post-basic levels are not well-prepared for the demands of the labor market (59ff).
- The lack of active learning opportunities that characterizes much science and technology teaching produces graduates that are ill-prepared to master new skills and adapt their learning to new situations (87ff).
- Lack of investment in laboratory and workshop facilities and their inadequate management and maintenance mitigate against the acquisition of practical skills (87ff).
- Supplementing the traditional TVET structures with a qualifications framework would lead to a better match between supply and demand and also widen the diversity of institutions able to offer effective training (71).
- Investment in research and development has been low by international comparisons and the mechanisms by which resources are disbursed mitigate against the evolution of strong research traditions (77ff).
- The under-representation and underachievement of female students in science and technology programs represents both an inequity and an avoidable inefficiency in the system (78).
- Education components of teacher education tend to be theoretical and content-focused at the expense of methodology, pedagogy and practice, leading to inadequate preparation for classroom demands (69ff).

3.1 S&T Curricula

S&T curricula across the post-basic education sector are too often not regularly updated, outdated, content-driven, overloaded, and inadequate for preparing students to enter the labor market. At the senior secondary level, research including data from chief examiners’ reports and interviews with employers suggests that the curriculum was designed with the more able students in mind

and is geared toward preparing students for further study at the tertiary level. However, with just 14% of graduates from the senior secondary level proceeding to higher education, the vast majority of learners are not best served with the current content. The implementation of the curriculum at senior secondary level, particularly in the technical subjects offered at the federal colleges of science and technology is hampered not only by inappropriate teacher-driven teaching strategies but also by a lack of resources, particularly poor maintenance of existing equipment and a failure to replace consumables. The result is that learners are not trained in ways that respond to employers’ needs.

In the higher level institutions the activities of the NUC, NBTE and NCCE ensure that intended curricula are regularly revised to meet new challenges but evidence, particularly from the labor market, suggests that
Box 5: From the National Curriculum Statement (Grades 10 – 12) for Physical Science in South Africa

Learning Outcome 1: Practical Scientific Inquiry and Problem-solving Skills

The learner is able to use process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of scientific, technological, environmental and everyday contexts. The thrust of this Learning Outcome is on the doing aspects and the process skills required for scientific inquiry and problem solving.

Learners’ understanding of the world will be informed by the use of scientific inquiry skills like planning, observing and gathering information, comprehension, synthesizing, generalizing, hypothesizing and communicating results and conclusions. In addition to investigation of natural phenomena, information will be used in problem solving. Problem solving is central to the teaching and learning of Physical Sciences. Higher-order thinking and problem-solving skills are required to meet the demands of the labor market and for active citizenship within communities with increasingly complex technological, environmental and societal problems. Problem solving involves identification and analysis of the problem at hand, and the design of procedures to reach solutions. These skills find application in all spheres of life and in all contexts.

The associated Assessment Standard includes:

- Learning has taken place when the learner is able to apply given steps in a problem-solving strategy to solve standard exercises.
- Attainment is evident when the learner, for example, draws a diagram, identifies what is known, selects a suitable equation, solves the equation and checks that the answer makes sense for a standard kinematics exercise. Apply known problem-solving strategies to solve multi-step problems.

Attainment is evident when the learner, for example, draws a diagram, identifies what is known, selects a suitable equation, solves the equation and checks that the answer makes sense for a standard kinematics exercise. Apply known problem-solving strategies to solve multi-step problems.

61 Across all post-basic education levels limited emphasis is given to acquisition of skills; both practical skills and intellectual skills such as problem solving. This is partly due to the fact that many of the S&T curricula, certainly those at the senior secondary level, have their origins in the 1980s when skills such as computer literacy, analytics, and group problem-solving were not necessarily considered for inclusion. The strong focus on content in the basic sciences in the various subject syllabi means science and technology programs at all levels do not prepare students adequately for the workplace.

This issue is common across Africa and Box 5 provides an example of how inquiry skills are formulated into the intended physical science curriculum standards in South Africa. The gap between the intended method of curriculum delivery and the manner in which curriculum is actually delivered in the classroom is due to a combination of several interrelated factors. The observed gap between intentions and implementation is an issue observed in most sub-Saharan Africa countries as well as in developed countries. A range of reasons could explain the observed gap in the Nigerian context: unrealistic curriculum demands, inadequate teacher preparedness, lack of laboratory equipment and other teaching and learning materials, and the absence of a supportive learning environment, including the lack of opportunities for professional development.

Instruction in science and technology subjects takes place, largely, in the form of lectures together with the occasional opportunity for students to engage in practical work. The dearth of practical work is due, partly, to the scarcity of supplies and equipment.

Equipment tends to be more readily available at polytechnics and universities, although in these institutions also, large numbers of students share what is usually a small amount of often outdated equipment. This issue is compounded by the inadequate training received by teachers and lecturers on how to facilitate enquiry-based hands-on practical learning activities, and also on how to improvise when equipment is damaged, incomplete or absent.

62 A substantial reform of the senior secondary school curricula in science and technology is long overdue. The basic structure of the curriculum for the sciences at Senior Secondary level has not been revised in more than 20 years (the most recent revision was in 1985). In the meantime the Science Teachers Association of Nigeria (STAN) has introduced additional topics into the curriculum, such as environmental science, to fill specific content gaps. As a result, the curriculum is heavily overloaded. This demands a substantial root and

25 This is not a specifically Nigerian issue. All countries participating in the Secondary Education in Africa (SEIA) study independently raised this as a crucial quality issue. For a further discussion, see the various reports at http://www.worldbank.org/afr/seia

26 A study in Rivers State showed that only 12% of the schools had laboratories for the basic sciences with sufficient equipment and materials (Obanya, 2005). For more details of this see the Nigeria country paper under the SEIA study detailed in the previous footnote.
branch reform by all concerned institutions - such as STAN and MAN, its mathematics partner body - led by the National Educational Research and Development Council (NERDC). New sets of curriculum standards are needed that are appropriate not only to the 21st century in terms of content and skills but also suitable for the wider ability range increasingly entering educational institutions. This is a major reform and will require a substantial capacity development program directed not only at NERDC staff but also at the cadre of lead teachers on which it will be relying for innovating, piloting and developing materials. A key element of the capacity enhancement program must be an understanding of the potential of ICT in teaching and learning and an ability to produce ICT-based materials. As shown elsewhere, there is an opportunity for the private sector to add value to this process, not only in ensuring that the curriculum content matches labor market needs but also, increasingly, in aspects of its delivery.

63 Current science curriculum development activities in Europe are based on the realization that the need for specialist training for the relatively few students proceeding to tertiary science studies has for too long been dominating the needs of the large majority of students for whom secondary school is their terminal science education. Recently developed curricula (such as 21st Century Science and Science for Public Understanding in UK, Chemie in Kontext in Germany, New Chemistry in the Netherlands) all have scientific literacy as a main focus. They all have a thematic approach, develop concepts within contexts, and include both teaching science (content) and teaching about science (nature of science). Curricula provide students as users of science a clear framework for understanding big science issues and science in the news. The curricula furthermore provide a careful differentiation between scientific literacy and specialist training for further science training.

64 The question of vocational training (job-training) at secondary level versus general vocational education (prevocational education) has been much debated in Africa for a long time. Donors traditionally supported the introduction, at junior and senior secondary level, of vocational training courses for those who were considered academically too weak to be able to continue for further education. In addition, most African countries used senior secondary (and to a lesser extent JSS also) as selection mechanisms for those who progressed into the universities. These emphasized academic abilities rather than the practical job-focused skills and competencies. Due to the newly emerging demands in the knowledge economy, driven by technological change and innovation, there is now a consensus emerging that early vocationalization of education (i.e., at the JSS level) does not deliver the expected benefits of better qualified labor market entrants and better employability. In today's economies, even in lower-income African countries, there is a need for 'Basic Education' graduates (having roughly 8-10 years of general education. In addition, the education sector at the post-basic level should be able to cater to a variety of different learners, both in formal and informal pathways and also for second-chance learners. Technology knowledge and skills are an important part of what is today considered as 'a minimal relevant package' for most senior secondary graduates.

65 The nature and place of technology in the senior secondary curriculum has received much attention internationally in the last two decades. It evolved as a process-based curriculum such as the earlier the trade and craft based vocational programs as these became more learner-centered and less prescriptive. As such, it was able easily to capitalize on the problem-solving opportunities offered by ICT. Different programs have emerged in different countries. In the Netherlands and in the Canadian states, for example, technology has emerged predominantly as a component of the science curriculum. In much of Europe, and particularly in England, it evolved as a distinct form of learning, complete with its own epistemology and growing research base, and it is increasingly a compulsory element of national

37 Osborne & Millar (1998). 'Beyond 2000: Science education for the future' has given direction to many new curricula in UK, Germany, the Netherlands. These have, it must be said however, not been without their critics.
curricula to grade 12. This view of technology education, based on design and problem solving processes, can now be seen in Africa in Botswana and more recently, South Africa.

66 The developments in technology education in Botswana and South Africa are heavily influenced by the English version of the subject and in consequence are expensive to mount. A version of technology education that is appropriate for the African classroom, that addresses specifically African needs - particularly entrepreneurship education - has yet to be clearly defined\(^{28}\) In Nigeria, technology education is not design-driven but remains of a traditional trade-related kind and is only available in the technical colleges. The proposed curriculum reform offers an opportunity to review this. Such a review affords an opportunity to address the challenge of how to develop a program that is affordable, design led, addresses real needs at the local level, uses ICT as a tool, and also capitalizes on indigenous technological and craft skills and knowledge. This mix has yet to be effectively exploited in Africa.

67 The purpose and nature of ICT as a senior secondary subject has not been fully debated in Nigeria. The general view of the nature, and the place in the secondary curriculum, of ICT skills has undergone a process of rapid evolution in the last two decades. Initially ICT skills were thought of as a separate subject that needed to be taught with computers. However, further technical developments, especially in the middle-and higher-income countries forced education to look at ICT in a wider context of technological innovation, information networks, and facilitating tools for job-performance. This led to a generally accepted view that some ICT skills, as well as some and basic technology knowledge, should be integrated into the JS curricula, and that a further elaboration (often mixed with vocational content) would be necessary at the Senior Secondary level. This is essentially the status quo in Nigeria except that few federal schools other than the Technical Colleges have equipped computer rooms and there is no computer studies curriculum in general education. The question then arose whether ICT should be offered as a separate subject or integrated into the newly modernized SS curricula, which offer students flexible, diversified pathways of learning in grades 10-12. The answer emerging, based on practical evidence in today's secondary schools, is that probably both are required. This is an issue that should be addressed by the curriculum reform debate.

68 At the tertiary level, the curriculum review should aim at a better balance between subject content and development of technical and intellectual skills required by the labor market. The regulatory bodies, NUC, NBTE and NCCE, develop standards for curricula at the tertiary institutions. These standards are also used for accreditation of programs at the universities, a process which occurs once every five years. Accreditation is essentially a peer review process as NUC, NBTE and NCCE co-opt peers from other institutions onto the teams carrying out the review. At all levels, revision to the curricula should aim to better balance the demands of the subject with the needs of students and society. Emphasis on subject content in combination with a strong focus on skills, including problem solving, inquiry and ICT skills should be prioritized.

69 Training provided to S&T teachers does not prepare them adequately for the demands of quality science teaching in a classroom. The teacher education curriculum of the Colleges of Education in science and technology maintains a strong content focus\(^{29}\) at the expense of teaching methodology, pedagogy and classroom practice. Much of the content teaching of those who will later become teachers or lecturers is done in a manner that does not provide clear examples of high quality, student-centered instructional

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\(^{29}\) 'Content' here refers to both science content and education content.
practices which they can later emulate and build upon. Minimum standards developed by the National Council for Colleges of Education (NCCE) guide teacher education curricula. These standards indicate a strong focus on content but are largely silent on how to teach the content. Content delivery matters in all subjects, but in S&T in particular, hands-on learning, group work, and inquiry-based practice constitute modes of learning essential for creativity and for engendering those skills and intellectual attributes that allow the student subsequently to participate productively in knowledge-based economies.

70 An increasingly significant trend internationally is to make schools the main locus of teacher training. NCCE’s plans to shift some of its training components to schools to make teacher training more school-based is a step in the right direction. This is now the almost universal practice in Europe but few African countries have yet embarked on this route although many are considering it. Examples already operational in Africa can be found in Gambia, Ghana (University of Education Winneba) and South Africa (University of Pretoria). Typically, students, in groups, spend one full year (last year of a four-years program) in one school and assume duties like a normal teacher under the guidance of a mentor. Peer observations and peer coaching are parts of the daily practice. In Winneba teaching is combined with developing teaching philosophies and portfolios. A key lesson to emerge from these developments is that the quality of the school mentoring is a major issue. Mentors must be brought into the teacher education program, and properly trained. These programs require much more focused training than is currently taking place.

71 Curricula used at the technical and vocational education and training (TVET) institutions do not match the changing needs of industry. In Nigeria there is evidence of gap between the content integrated into the TVET curricula used at Federal Colleges of Science and Technology, Monotechnics and Polytechnics, and the content employers expect learners to have grasped to participate productively in the labor market. Students have indicated unhappiness with both the curriculum content and the facilities available at TVET institutions. 31 The interactions of TVET institutions and industry remain limited to periods of work placement for students. The proposed National Vocational Qualifications Framework, if linked with a system of TVET competency-based standards, would better align what is taught to what is required by the labor market. As Box 5 indicates, many countries in the region are reexamining their TVET programs with a view to adjusting them to the changing needs of the industrial sector. Inevitably, the private sector, which constitutes the consumers of technical and vocational education and training graduates, has been involved heavily in the process, with new public-private partnership models redefining the TVET institutional landscape. Some countries have used mechanisms such as training levies to encourage private sector (including the informal sector) participation in providing TVET training through a rebate system for recognized programs.

3.2 S&T Teaching and Learning

72 Data cannot replace the lessons from personal experience shared by Nigerians who have pursued S&T studies in Nigeria's post-basic education system. Personal stories gathered over the course of the study crystallize the picture of S&T teaching and learning in the post-basic level: teachers are under-trained for the task of teaching; the necessary equipment is rarely available to all students for rigorous training, and; practical experience in the classroom is rare. The personal stories of two Nigerians—a graduate and a current university student—provide anecdotal evidence of the observed trends (Box 6).

31 Facilities are characterized as obsolete, certainly compared to those used in industry.
pointing to a decline of (2000), unqualified teachers are often preferred because the profession unattractive to school leavers. 

Understandably, this makes it difficult for newly reluctant to employ teachers from outside their home state frustrates this objective. The situation is compounded by the fact that unqualified teachers are often preferred because their salary levels are much lower. Understandably, this makes it difficult for newly qualified teachers to obtain a job and also makes the profession unattractive to school leavers. 

There is persistent anecdotal evidence pointing to a decline in standards of teaching in secondary schools. There is a complex interplay of factors that determine supply, demand and quality of science and technology teachers. Many surveys attest to a substantial shortage of well-qualified science and technology teachers in both schools and colleges. The Federal Government has attempted to improve the quality of teaching (thereby improving the perceptions of teaching as a profession) by prescribing the Nigeria Certificate in Education as the minimum teaching qualification. However, the evidence that some states are reluctant to employ teachers from outside their home state frustrates this objective. The perception of teaching as an unattractive career choice is also indicated by the decline in applications to teacher colleges in recent years. Applications dropped by 50% between 1990 and 2000 while the acceptance rate increased from one third to over 90%. A further widely reported factor affecting science and technology teacher quality is lack of equipment and teaching materials in the colleges. Teachers emerge lacking practical problem solving competencies and so are unable to pass these on to their students.

Although opportunities for initial training of teachers and lecturers are reportedly satisfactory, limited opportunities are available for updating formal qualifications. Little investment is made in continuous professional development of teachers and lecturers in order to ensure that staff at the institutions remains abreast of the changing technologies in their field. Although an in-service training policy for teachers exists, it is insufficiently funded to permit its effective execution. The situation is exacerbated by loss of key staff, especially at the first generation universities; staffing profiles of many departments tend to be bottom-heavy as more experienced and enterprising staff are

Box 6: Vignettes of S&T learners in today’s Nigeria

Ijeoma

Ijeoma, at age 23, is currently a Ph.D student at Harvard University with a background in law and human rights advocacy. Her introduction to science came through Integrated Science (“Interscience”), a compulsory class in the secondary school in Nigeria. Although heavy on theory, the well-illustrated textbooks that were used for Interscience brought basic scientific concepts home to her. Her first secondary school had very limited laboratory space and facilities: “I remember science practicals where there would be at least 70 of us crowded in a lab trying to see what we could of the experiment the teacher was demonstrating.” With this background, she was able to pass her exams but not follow her dream of becoming a doctor. “My practical foundation in the sciences was simply too weak to follow the rapid, individualized, experiments through which science was taught in the better-equipped federal government college I attended for senior secondary school. Besides, I had a strong interest in the arts.” In university, she took an “Introduction to Computer Science” class which emphasized theoretical understanding and role memorization of the history of information and communications technologies. Students also had to learn the parts and functions of the computer. She did not get to touch a computer throughout university and was forced upon graduation, by a growing sense of technological incapacity to function in the international legal and media environment that she worked, to teach herself how to use technology. Ijeoma learnt to type by coming to work early to practice her keys, learnt to use the internet by the costly effort of spending long hours in a local cybercafé after work before installing a computer at home. These efforts paid off by enabling her use technology to expand her legal and political knowledge and inform the strategic educational and professional choices she would make in the coming years. Power supply, limited access to technological facilities and trained support, however, were perennial problems throughout her science and technology learning in Nigeria.

Sherifat

Sherifat, 17, is currently a medical/surgery student at a Nigerian federal university who sees her science training as “great in theory but low on practicals.” She adds, “most times we don’t see what we talk about, we just imagine them.” She wants to study abroad at some point because she does not consider her university education as “of standard.” For her, practicals should give science students like herself adequate scope to “follow established processes, to find out more on existing knowledge and probably discover something else in the process.” Apart from reforms to practicalize learning, Sherifat would like to see more research happening, more equipment in the labs, and an upgrading of curricular standards. These obstacles currently hamper science learning in her experience.

attracted to more lucrative positions outside of the university system.

<table>
<thead>
<tr>
<th>Box 7</th>
<th>How appropriate are the existing senior secondary examinations to expanded ability range?</th>
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<tbody>
<tr>
<td></td>
<td>Two countries that have introduced systems that cater, both in their intended curricula and their assessment systems, for a wider range of ability are South Africa and Namibia. The full curriculum in South Africa has only been fully in operation for the last year and it is too early to judge its effectiveness. In Namibia, however, the system has been operating for a decade and some of its characteristics are worth noting:</td>
</tr>
<tr>
<td></td>
<td>• There is no pass/fail borderline. Students are assigned a grade in a scale from A to G. Some students, usually around 5%, are ungraded.</td>
</tr>
<tr>
<td></td>
<td>• Employers and institutions taking the students after they leave school are free to specify minimum grades in particular subjects that a student must achieve in order to be considered for such employment or further education.</td>
</tr>
<tr>
<td></td>
<td>• It is generally accepted that to study a subject successfully at a higher level academically, students must gain at least a grade C in the subject (ideally higher in subjects such as mathematics and physics).</td>
</tr>
<tr>
<td></td>
<td>• The curriculum is a differentiated one and was initially based on the UK IGCSE which catered for 5+% of the age group.</td>
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<tr>
<td></td>
<td>• The examinations consist of carefully prepared criterion referenced questions that ensure that grade boundaries reflect a constant level of achievement year by year.</td>
</tr>
<tr>
<td></td>
<td>• To achieve this, questions are designed that are susceptible to unambiguous marking schemes that award one mark for a correct point made in the answer. ’Impression marking’ is never used.</td>
</tr>
<tr>
<td></td>
<td>• The examination questions are a carefully generated mix of questions of graded difficulty spread over two (or sometimes more) papers of graded difficulty such that they, taken overall, discriminate equally well through all the grades.</td>
</tr>
</tbody>
</table>

76 Examination practices are exclusive, not inclusive, discouraging students to pursue S&T studies. In almost all examinations in science and technology subjects at senior secondary schools the failure rate is over 50%, with the exception of advanced mathematics courses where streaming on the basis of ability has taken place. Both the curriculum and the examinations favor the bright and able students who proceed to tertiary-based institutions 33 This problem will become more serious when larger numbers of students of more diverse ability flow from basic education into senior secondary education. Examinations should be designed to be inclusive to cater to a much wider ability range. The way examinations could be structured for an expanded ability range is illustrated by an example from Namibia in Box 7 77 Although some ‘second-chance’ mechanisms are in place in Nigeria at various levels, little information exists on their effectiveness. Many tertiary institutions run some kind of pre-entry program for entrants into science and technology programs. These provide students who have not quite reached the required entry standard an opportunity for skill upgrading. The Colleges of Education operate such courses to attract more students into their programs though, as noted previously, many of those students who successfully complete these skill upgrading courses elect to leave the Colleges of Education seeking university admission. University pre-entry programs are financed mainly from student fees and from local university funds. Data are not available on how effective these are. Pre-entry programs for S&T students are common throughout Africa and Box 8 shows a successful cost-effective pre-entry program at the University of Dar es Salaam that has been running for many years. It addresses the issue of girls’ access to performance in the sciences and engineering. As it runs only for six weeks its effect is primarily that of raising confidence to succeed in what is a male-dominated environment rather than addressing significantly, any knowledge gaps.

33 Only 14% of the students proceed to tertiary institutions, FME (2003). Education sector status report.
Main features of the pre-entry program (PEP) for girls at the University of Dar es Salaam

- The program runs for six weeks, immediately preceding the start of the academic year.
- Takes female students who have a ranking just below the cut-off point for admission.
- Program consists of lectures, practical work, getting to know the university/library and generates confidence and a 'hard working' spirit which has proved to be very useful and has provided the girls with an advantage over their male peers (as evidenced by monitoring responses from the 4th year girls).
- Drop-out rates among the girls who have come through PEP is about zero, partly attributable to the good work ethics instilled in them during PEP.
- Some of the students in the program have gone on to master degree level.
- Costed at about US$1,000 per student.
- Increased enrolment in the Faculty of Science from 10% to 30%.

Despite the fact that the issue of improving girls education is being actively addressed at the basic level, post-basic level programs in science and technology are still characterized by stereotypical male-dominated enrolment patterns and low achievement of female students. At all levels female students in S&T-based studies are under-represented. Table 6 shows that male students far outnumber female students in S&T programs at Federal Colleges (81%), Polytechnics (60%) and Universities (73%). At Polytechnics, in particular, enrolment follows a stereotypical pattern with female students taking the 'softer' options such as business management and secretarial programs, leaving technical subjects like welding and plumbing to male students (Table 7). It is only at the Colleges of Education that female students outnumber their male counterparts especially in the South of the country, though not so in S&T teacher education programs.

There are many well-tried and successful strategies for addressing gender bias, ranging from affirmative action recruiting policies to addressing bias in instruction and instructional materials to the engagement of female instructors as role models. With only a small effort and little additional investments, a large pool of students can participate in otherwise under-subscribed courses. Such programs could be useful in addressing the gender imbalance in Nigeria’s STEPB system. International evidence reveals the importance of mentoring for women in science and UNESCO has published a training manual containing material for use by science teacher educators to help their students address these issues. The Third World Organization for Women in Science (TWOWS) and Women in Global Science and Technology (WIGSAT) offer ideas for how to establish such programs.
3.3 Research

80 Insufficient data are available to provide conclusions regarding research in the post-basic education sector. Neither up-to-date figures nor in-depth studies regarding S&T research and development—either within the post-basic education system, the public sector or the private sector—are available at present to inform substantive conclusions for this report. Without comprehensive data to track research expenditures, catalogue research performed by sector and institution, and monitor research outputs, outcomes, and impact (e.g., patents, publications, etc.), the systematic development of research within the context of post-basic education and outside of academia is difficult to stimulate.

81 What is known of research in Nigeria suggests that the limited funding allocated is spread thinly among a large number of organizations/institutions with little strategic focus. Much of the research performed in Nigeria occurs in the university setting with 58 universities performing research (26 Federal, 23 State and 10 Private) and 44 polytechnics recognized as centers for research and development (R&D) activities. The federal institutions, together with the FMST research institutes, receive around 1% of the Federal Budget, an allocation which is considerably below what is needed to support adequately its operations, particularly in the capital-intensive R&D operations in such areas as Biotechnology, Space Research and Information Technology. For 2004, the approved Recurrent Budget of the Ministry was N3,352,167,903 (US$ 26 million with 1 NGN = 0.00780001 USD)\(^{37}\), constituting 0.6% of the national Recurrent Budget of N539,286,472,751 (US$ 4.206 billion). This is significantly lower than the 1980 Lagos Plan of Action’s target of 1% of GDP by 2000. The recent move to provide federal universities with targeted funding for research equipment from the ETF is a welcome intervention. With resources so scarce, Nigeria cannot afford to distribute what exists for research funding evenly across a system characterized by uneven quality, relevance, and output. Instead, a process of recording, benchmarking, and qualifying the research output of academic, private, and public institutions should precede explicit efforts to consolidate the research system in such a way as to maximize resources and reward excellence. Targeted funding through competitive tendering would allow centers of excellence to evolve, encourage more involvement by the private sector, and ensure a clearer alignment between research and national needs. As well, Nigeria may wish to review its allocation to research and development to ensure the funds designated for R&D facilitate high quality research relevant to national needs, recognizing the OECD national average of 2-3% of GDP for R&D.\(^{38}\)

82 Nigerian universities, particularly the long-established ones, have a long and distinguished record of research. Scientific and technological research in universities tends, however, to be small scale and funded from departmental budgets. Most researchers tend to publish in local or regional journals that are not on internationally-recognized lists that analyze and report on publications and citations; hence Nigerian academic research is often not given the international recognition it may deserve. Research output could be improved and made more relevant to national needs with the creation of the necessary structures to encourage targeted funding, competitive bidding for key national projects (in competition, or cooperation, with national research institutes), collaboration with industry, and the development of centers of research excellences, etc. Box 9 shows the mandate of one such structure, South Africa’s National Research Foundation, which has successfully increased the production and visibility of South African research and postgraduate training as result of strategic funding.


\(^{38}\) Using data from Ephraim Okon and the SCOPE 2015 exercise for which Nigeria’s research and technology development capacity was analyzed, historic levels of spending on R&D ranged from 0.05-0.43% of GDP. See Okon, E. “Research and Technological Development in Nigeria.” SCOPE 2015. PREST, UK at: http://fes.mzn.ac.uk/PREST/SCOPE/documents/National_Report_Nigeria.pdf.
Recent proposals by the Ministry of Science and Technology to encourage research should have a positive impact once established. These include various measures including competitive funding and institutional cooperation. The announcement of the science and technology endowment fund should also have a major impact.

Most universities offer at least some research training but this rarely affords graduates research careers outside of the university setting. It is widely agreed that the most current employment option for PhDs is at the universities. Since these positions are poorly remunerated, many PhDs leave university posts and either emigrate or seek management positions in the private sector. This results in a shortage of qualified university teachers and a low production of PhDs in some critical areas such as mathematics, resulting in decreased university research capacity. Poor university-based research infrastructure and shortages of journals and reference books further reduce universities’ research capacity.

With such a small investment in research, higher education institutions appear unattractive to industry for the purposes of collaboration. Universities and other institutions of higher education, such as technical colleges constitute under-utilized institutions in efforts to promote sustainable development. In the absence of links with industry, research in Nigerian Federal Universities and other federal public research institutions will inevitably not be as focused and effective at addressing national development needs as it otherwise could be. In such cases, federal public universities are in danger of becoming ivory towers. To engage in academia-industry collaboration, both parties must offer clear advantages to the other to make the partnership attractive. At current levels, FGN’s financing to university and polytechnic research is too low to create the enticing research environment that draws industry partners into the mutually beneficial research and development arrangements that define the research landscape in, for example, the East-Asian knowledge economies and elsewhere in the developed world. With Nigeria’s private sector making only sporadic contributions to the S&T system and only a small proportion of companies engaging in science-driven innovative activities, industry’s need for guaranteed quality and timeliness in delivery of results imposes pressures on researchers beyond what they can realistically deliver in the frame of current public support.

The combined observations of inadequate policy direction, inadequate funding, uneven research training, and lack of a clear picture of the nature and locus of the most effective R&D activities all point to the need for a radical overhaul of Nigeria’s R&D effort. This is a not uncommon situation worldwide in countries in a similar position as Nigeria. Significant international examples can be found in South Africa and in Latin American countries.
such as Argentina\textsuperscript{39}, all of which, like Nigeria, were characterized by a considerable but uncoordinated and underutilized R&D potential in well established universities, under-developed public-private research links, a plethora of government funded research institutes of variable quality, and a private sector characterized on the one hand by large multinationals that shifted their research needs to teams elsewhere, and on the other, a prevalence of small to medium sized enterprises involving little innovation. A process\textsuperscript{40} of analyzing the R&D needs and activities followed by the development of a strong policy on research supported by an appropriate institutional framework and strategies is urgently needed. This would result in a structure through which the country could be better able to direct its research capacity towards its national goals, would attract external and private finance, would facilitate collaborative work with institutions overseas and would make the system more attractive to good Nigerian researchers who are currently tempted abroad.

3.4 Facilities and inputs for research, teaching and learning

Without greater investment in laboratory and workshop equipment and materials, students will continue to emerge from programs without the practical experience required by industry. Effective learning in S&T programs requires substantial investments in physical resources at all post-basic education levels. Reports on the lack of the necessary resources to carry out experimental work in S&T programs portray the Nigerian system as under-equipped. In schools, equipment for practical work is often either absent completely or in such a poor state of maintenance that it cannot be used. At Federal Colleges, Monotechnics, Polytechnics and Universities, available equipment is frequently obsolete and unfit for training students for places in the workplace which use much more advanced equipment. Consumables may be available through a variety of cost-sharing schemes, although official discouragement limits these. A few of the more influential universities are able to attract funding for, or gifts of, specialized equipment from industry partners with which they collaborate. For effective implementation of S&T programs substantial investments need to be made for resources, not only at senior secondary level, but at all post-basic levels. UNESCO’s science kits program and the accompanying support to NASENI to produce school equipment locally is a promising approach that deserves continued encouragement and support, although a wealth of experience both in Nigeria and elsewhere indicates that these are likely to have minimal impact unless they are accompanied by an integrated and sustained training and monitoring program\textsuperscript{41}. Further, institutional specialization in which specific institutions address training needs in narrower fields would allow more effective use of the limited funds available for equipment.

Curriculum reform at senior secondary level should include a focus on less equipment-intensive practical work. This is an international trend driven not so much by cost considerations but by the view that science at this level should focus on everyday observations and issues rather than special conditions created in laboratories. Box 10 compares the cost of different approaches to science teaching in Africa. Nigeria has a number of parastatal institutions dedicated to making low-cost school science equipment which evidence suggests are currently less than effective. The suggested science curriculum revision should take cognizance of such current trends and also of


\textsuperscript{40}The Frascati and Oslo manuals developed by the OECD for analysing R&D effort offer useful mechanisms for realising this process.

\textsuperscript{41}There is a wealth of research evidence that demonstrates that often the main issue is not lack of equipment but an inability to use and maintain it. This is too frequently not fully recognized and unfortunately greatly complicates efforts to improve the quality of practical work in S&T programs, particularly when the equipment is provided by a donor whose interest tends inevitably to be short-term. For a further discussion of this issue see the link to the SEIA/SMICT work in Box 10.
cost-reducing initiatives such as the use of micro-scale equipment.

Collaboration in research and training affords researchers increased access to scientific and technical equipment. Resources for science and technology training at the university level necessarily include a host of consumables, equipment (in addition to computers), laboratory facilities, and sometimes land (such as in the case of field trials for agricultural research, etc.). Limited data are available regarding the availability of these physical inputs for the purposes of science and technology-related training at the post-basic level. However, given the low levels of investment in research, it is certain these physical inputs are less plentiful than needed. One way of coping with these resource constraints is to partner universities with research institutes within and outside Nigeria for the conduct of research, thereby leveraging access to equipment, all the while building valuable university relationships with research organizations, be they in the public or private sectors. In fact, an emphasis on networks of centers of excellence is made in several international reports on the importance of science and technology for development including that of the InterAcademy Council and the UN’s Millennium Development Goals Task Force 10 on Science, Technology and Innovation.\(^{42}\) Transforming isolated universities into partners for industrial development and research in turn offers opportunities to make learning experiential and relevant while maintaining insights into industrial needs that keep teaching fresh.


<table>
<thead>
<tr>
<th>Box 10</th>
<th>A comparison of the cost of science equipment for four different programs, SMICT, report, SEIA program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical practical requirements</strong></td>
<td><strong>A-level physics</strong></td>
</tr>
<tr>
<td><strong>Class size - 24</strong></td>
<td>Secure storage room</td>
</tr>
<tr>
<td></td>
<td>Laboratory with mains electricity</td>
</tr>
<tr>
<td></td>
<td>6-12 low-voltage packs or outlets</td>
</tr>
<tr>
<td></td>
<td>6-12 sets of equipment covering all main topics, including multi-purpose oscilloscopes</td>
</tr>
<tr>
<td></td>
<td>* Demonstration models of expensive items</td>
</tr>
<tr>
<td><strong>Class size - 36</strong></td>
<td>* Secure storage room</td>
</tr>
<tr>
<td></td>
<td>Laboratory with mains electricity</td>
</tr>
<tr>
<td></td>
<td>6-12 low-voltage packs or outlets</td>
</tr>
<tr>
<td></td>
<td>6-12 sets of equipment covering all main topics, including multi-purpose oscilloscopes</td>
</tr>
<tr>
<td></td>
<td>* Demonstration models of expensive items</td>
</tr>
<tr>
<td><strong>Class size - 40</strong></td>
<td>Access to demonstration equipment related covering specific topics</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cost as a percentage of A-level costs</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

priorities from which to begin the identification and coordination processes. Once these steps have been taken at the national level, a similar process of screening for regional and international partners to compliment the efforts of Nigerian-based centers and integrating them into the research network would further enhance resource utilization. Box 11 shows potential regional partner countries that could from the basis of an agricultural research network.

91 Another opportunity for Nigeria to exploit in the process of growing its own network of centers of excellence and linking these into regional and global networks is the worldwide network of technical colleges that is being promoted by UNESCO. These are the UNEVOC Centers and they are represented in Nigeria by Yaba College of Technology. As a relatively new program, UNEVOC’s impact has yet to be felt.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Potential regional partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>Burundi, Cameroon, Egypt, Gabon, Ghana, Morocco, Senegal, Tunisia</td>
</tr>
<tr>
<td>Plantain</td>
<td>Cameroon, Gabon, Ghana</td>
</tr>
<tr>
<td>Cassava</td>
<td>Burundi, Cameroon, Congo, Gabon, Zimbabwe</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>Ghana</td>
</tr>
<tr>
<td>Yams</td>
<td>Cameroon, Cote d’lvoire, Gabon, Ghana</td>
</tr>
<tr>
<td>Pineapple</td>
<td>Uganda, South Africa, Kenya, Cameroon, Ghana</td>
</tr>
</tbody>
</table>

Source: Africa Technology Policy Studies Network, Nairobi, Kenya. 2004

4. The Use of ICT to Enhance Teaching and Learning in Post-Basic S&T Education

Key messages:

- Development of the use of ICT in education is hampered by the absence of an overall ICT policy and strategy for the education sector (34, 95).
- The high total cost of computer ownership is a major uptake constraint. Cost-cutting opportunities are available or anticipated and pockets of good practice exist around which a strategy for effective and affordable ICT in education can be built (95ff, 100).
- Human resource issues such as the shortage of ICT technicians, the low ICT literacy rates among teachers and lecturers and the lack of ICT literacy programs for students must be addressed before full advantage can be taken of teaching and learning opportunities offered by ICT (95).
- E-learning strategies and programs are not yet widely developed and there are benefits to be gained from institutional cooperation at this stage of their evolution, particularly in their application to open and distance learning, to take advantage of existing pioneering initiatives. There are however, promising initiatives that can be replicated (96ff).
- ICT opportunities are not yet significant elements of either curricula or teaching and learning materials and there are no well-developed local science and technology learning portals (108ff).
- The computerization of libraries and the evolution of the proposed virtual library offer an opportunity to capitalize on the potential of ICT in education that would have widely felt benefits (119).

4.1 ICT provision

The availability of information and communication technologies (ICT) in a society correlates highly with a host of human development indicators. ICT, if accessible, affordable, and used by individuals who have benefited from proper training, has huge potential to increase the accessibility and quality of education and training, expand users’ breadth and depth of skills, facilitate research and share research results, and spawn the creation of networks.

Nigeria’s ICT sector is experiencing rapid expansion amidst major challenges, challenges that will determine the ability of the post-basic education institutions to capitalize on the potential of ICT. As a result of government reforms launched in 2000 and 2001 to stimulate competition and private sector investment into the telecommunications sector, Nigeria has one of the fastest growing telecommunication markets in the world. The number of telephones increased from less than 500,000 subscribers and a teledensity of less than one percent in 2000 to nearly 20 million subscribers and a teledensity of nearly 16 percent in 2005. Despite serious problems of accessing the Internet, the number of Internet users increased from a mere 107,194 in 2000 to more than 2.24 million in 2004 and as a result Internet penetration levels increased from 0.1 per 100 people in 2000 to about 1.75 per 100 people at the end of 2005. Until 2002, international connectivity for telephones and the internet was entirely dependent on costly VSAT satellite links.

In 2002 the potential for good affordable international connectivity improved dramatically when the submarine cable (SAT-3) established a landing point in Nigeria. However, the impact of SAT-3 has been less than expected as most Nigeria telecommunications operators and HEIs still use VSATs to connect to other countries and to the Internet because of the lack of investment in a national ICT backbone that links the SAT-3 landing facility to the rest of the country. As a result most internet traffic in Nigeria, especially
Internet traffic between Nigerian universities is routed via the Europe or India via satellite instead of being routed directly through Nigerian landline-based facilities. As this report is being written, plans to privatize Nitel, the state provider, are about to reach fruition. This could change substantially and rapidly the ICT environment as a result of the likely investment in a comprehensive fiber network to attract users onto SAT-3 and away from satellites.

95 Systemic weaknesses in ICT provision, characteristic of a system in the early stages of development, must be addressed. Because a comprehensive policy on ICT in education provision has not yet been developed, provision of ICT to post-basic education institutions has been uncoordinated and limited to just a few. Their experiences, however, yield valuable information to guide the expansion of provision. Broadly, the ICT challenges confronting the post-basic education sector include the following;

- Lack of affordable bandwidth;
- An over-dependence on costly proprietary software and limited experience with open source operating systems and software;
- No agreed standards for computer literacy for both students and lecturers;
- No agreed standards for minimum physical provision;
- Limited development of online educational resources including libraries;
- Few ‘ICT opportunities’ in teaching curricula and little development of ICT-based teaching and learning resources;
- Minimal development of a skilled and affordable technical support structures;
- Limited ICT capacity among teachers and lecturers;
- Few cost sharing and cost reduction mechanisms.

96 The use of ICT has not yet become institutionalized in higher education institutions although promising practices are emerging. A national debate is gradually evolving around how ICT might best serve the interests of Nigeria’s post-basic education sector. The Nigerian Universities Commission (NUC) has embarked on a Nigerian Universities Network (NUNet) project to ameliorate this problem; this is a network with nodes in several federal and private universities with a gateway and coordination at NUC. NUNet has helped the universities to develop capacity and has encouraged the development of infrastructural facilities and cooperative cost-reduction ventures. There have been few similar coordinated or substantial developments in Polytechnics and Colleges of Education. Schoolnet Nigeria, a local member of the international Schoolnet network, has been established as a not-for-profit company. It draws part of its income from private sector donations and supports the introduction of ICT in senior schools both financially and technically.

97 The Partnership for Higher Education in Africa has, in recent years been addressing capacity gaps in selected federal universities, one of which has been lack of affordable bandwidth. Their bandwidth consortium has been an initiative operating in a number of African countries, initially with rather limited success but positive signals are emerging from the Nigerian member universities. It is an initiative to bulk-buy bandwidth, and manages it on behalf of its members. The South African TENET (Tertiary Education Network, a not-for-profit company, see box 12) is the model that is being followed and it will also, through the Partnership, provide bandwidth management training.

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44 See, for example, Ajayi, GO, 2002, Bridging the Digital Divide – The Nigerian Case Study. ICTP Trieste, Italy, and Ajayi, GO, 2003, National Infrastructure and Support for a Virtual Library. NITDA, Abuja.

45 The Partnership for Higher Education in Africa was established in April 2000 as a collaborative initiative of four Foundations – the Carnegie Corporation of New York, the Ford Foundation, the John D and Catherine T MacArthur Foundation, and the Rockefeller Foundation. In April 2005, the Partnership will have been operating for five years. The Nigerian projects are mainly supported by the Carnegie Corporation.
Box 12  
Some facts about TENET
Taken from http://www.tenet.ac.za

Constitution
Tertiary Education Network (TENET) is an Association
Incorporated under Section 21 (Registration Number
2000/020780/08). TENET was founded in August 2000 jointly by
the Committee of Technikon Principals (CTP) and the SA
Universities Vice-Chancellors' Association (SAUVCA). Each of
these bodies appoints four members of TENET. The Articles of
Association provide for a Board of up to nine Directors, who are
appointed by the Members at General Meetings of TENET.
TENET is also registered as a nonprofit organisation, with
registration number 014-801 NPO, in terms of the Nonprofit
Organisations Act, 1997

Purpose
TENET's main purpose is to secure, for the benefit of South
African Universities and Technikons, Internet and information
technology services, involving, inter-alia
• the management of contracts with service providers;
• ancilliary operational functions in support of service delivery;
and
• the provision of other value-added services as may from time
to time be needed in support of the higher educational sector
in South Africa.

98  The overall picture remains, however, of
institutions with little or no ICT provision and
few signs yet of a well-developed ICT culture
among lectures and teachers. ICT-literacy is
not yet a required element of degree programs
except for those having an explicit ICT
orientation and the wide use of ICT among the
student population exists in only a few
institutions (examples noted are the University
of Ibadan, the University of Jos, University
of Lagos, and the Obafemi Awolowo University,
Ife.) ICT (computer studies) is not yet an
examinable subject in senior schools but has
been introduced in federal Technical Colleges.

99  Even when a national fiber optic
backbone has been installed, the cost of
bandwidth will be beyond the ability of many
educational institutions to pay. The cost of ICT
provision is currently at least an order of
magnitude higher than it need be. While the
relatively wealthy HEIs will probably be able to
afford to purchase the bandwidth they require,
this will never be the case for Junior and Senior
Secondary Schools. Providing bandwidth at a
cost that matches the institution's ability to pay
is a challenge for the Ministry of Education
which must arrange with providers a mechanism
for bulk buying and redistributing at an
affordable cost. This suggests the need for
either a government subsidy or/and provisions
for the wealthier institutions to subsidize
services for the poorer ones. Box 13 describes
the Namibian solution to this problem. Recent
advances in Nigeria such as the establishment of
a public-private partnership to regulate
bandwidth provision, may offer a possible
mechanism to resolve this dilemma.

Box 13  Cost effective handling of maintenance issues -
Schoolnet Namibia

Schoolnet Namibia has a regular throughput of young grade 12
leavers that have failed to gain employment. These do not
receive a salary but are trained in various aspects of network
management and maintenance on refurbished
thin client networks driven by Linux servers. When a network is
established in a school, two of them stay in the vicinity of the
school for several months, at their own expense, working with
teachers and pupils on aspects of network management. At the
end of 12-18 months with Schoolnet the young trainees receive
a detailed certificate which is recognized at the Polytechnic
where they are not only given entry on the basis of the certificate
but are exempted from a number of the basic courses.

Total cost of computer ownership - Schoolnet Namibia

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>School preparation (furniture, electricity wiring, UPS etc)</td>
<td>1,700</td>
</tr>
<tr>
<td>Server - P4, 2x 80Gb - network and laser printer</td>
<td>3,310</td>
</tr>
<tr>
<td>20 Workstations (refurbished diskless)</td>
<td>5,360</td>
</tr>
<tr>
<td>Total installation costs</td>
<td>10,370</td>
</tr>
<tr>
<td>Annual recurrent costs; maintenance, ISP (64k 24/7), printer</td>
<td>1,240</td>
</tr>
</tbody>
</table>

100 The concept of 'total cost of ownership'
is not well understood by many institutions and
is particularly important in secondary schools
which may receive donations of computers.
Many schools, including all the federal ones,
have received donations of computers and these
too frequently remain largely unused because
all the other elements that must be in place
before they can be used effectively (training,
connectivity, reliable power supply,
maintenance, software, etc) are largely either
absent or unaffordable. A major problem
experienced by HEIs is maintenance of the
whole system when qualified technicians can
often earn much more in the private sector.
Creating an environment when computers can be
used effectively in education is a complex
problem that cannot be solved effectively and
affordably by the school acting alone. Boxes 13
and 14 give information how these issues have been addressed elsewhere.

Box 14 Affordable educational bandwidth in Namibia

In Namibia, the provision of ICT facilities to schools has been handed to Schoolnet Namibia, a not-for-profit company financed mainly from local industry. The Ministry of Education is represented on the Schoolnet board but does not have a majority representation.

A second company has been established to purchase educational bandwidth from Namibia Telecom and resell it to educational institutions, via Schoolnet at a rate determined by ability to pay. Schoolnet, Namibia Telecom and the Ministry of Education are all represented on the board. This bandwidth can be subsidised by Schoolnet.

101 At the current rate of ICT provision, connecting all Nigeria’s schools to the Internet would take 1,000 years. The principal agency currently promoting the connectivity of schools in the country is Schoolnet Nigeria, a not-for-profit, independently governed company that is currently financed (75%) from the Education Trust Fund. The remaining 25% of the funding comes from commercial sponsors, principal among which is the cellular phone company, MTN. In the last three years it placed networks of computers in almost 120 secondary schools (none federal), a little over 1% of the total. The computers are new, operate Microsoft platforms and software, and the schools chosen are in groups within easy reach of commercial support companies that oversee the work and training. There is no initial cost to the schools though they are expected to take over the maintenance costs after the first year. Internet connectivity is usually provided via a VSAT link that costs upwards of USD 300 per month. At such a cost the lack of any nationwide dialup system for internet services imposes severe limitations on the usefulness and affordability of land-based internet links, even if the system could technically handle such a service.

102 Schoolnet Nigeria well recognizes that their service currently provided is very expensive and far from sustainable. They are in the process of negotiating with the necessary partners to bring down the cost of minimum service to a level that schools can afford though they are still far from this goal. Addressing the issue of provision of equipment and connectivity in schools must be given much greater priority in terms of resources and organization if any significant impact is to be made. Effective public private partnerships will be required to create a network of centers nationwide to develop workable and affordable solutions to the problem of supplying and supporting schools according to their needs and ability to pay Schoolnet Nigeria provides a model for one such partnership but different possibilities could be considered; some may be national, others may serve a community or State; still others may be negotiated between individual schools and those who benefit from their output. Central to the effectiveness of these many possible partnerships, one between the FME and bandwidth suppliers requires immediate attention and commitment.

103 Effective expansion and management of ICT educational provision will require innovative cost reduction strategies. A mix of cost reduction or cost recovery strategies will be required if Nigeria is to move from its current high-cost model to one in which ICT-for-all becomes an attainable goal. Examples of possible strategies include the evolution of HEI computer centers into companies that recover costs by providing services to the community and the operation of school ICT facilities as community/school-based internet cafés, both of which have succeeded elsewhere.

104 The use of open source software and operating systems would not only reduce long-term licensing costs but also stimulate a local software industry. A cost reduction mechanism with considerable potential is the use of open source operating systems and software. This is

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46 The Schoolnet movement was founded in Canada in the 1990s and has since spread worldwide. National Schoolnet institutions are typically not-for-profit companies that raise money from various sources to provide ISP and e-learning resources to teachers and students. Schoolnet Africa is a continent-wide body, based in South Africa, that assists and serves national institutions.

47 Figures supplied suggest about US$300-400 for a 15 workstation network rising to about US$1,000 for 120 workstations. The service is often provided by European, Indian or Israeli ISPs.

48 Open source software is communally developed by a world-wide community of software developers, and is freely available under a 'creative commons' licence (essentially the opposite of copyright - nobody can charge directly for it and must make publicly available
particularly effective, for example, when used in conjunction with networks of diskless refurbished computers driven by a state-of-the-art server remotely controlled. This system has been shown to be particularly stable and virus-free and therefore useful for schools. Moreover, a nationwide network of refurbishing centers can double as maintenance centers. Such refurbishing centers that are often largely funded by industry (e.g., computer providers and software companies such as Microsoft\(^4\))), have been effective internationally. In such instances, savings resulting from not having to dispose of old machines, an increasingly significant ownership cost, can be significant. The FMST proposes to develop a local assembly line for the MIT $100 laptop. This is a diskless machine using open source software will reduce somewhat the cost of the computers in school networks and has the potential to stimulate the growth of a local open source software development community.

105 Two open source developments of note in Nigeria are (a) the development of a learning system at the University of Jos in collaboration with a major open source development center in South Africa, the University of the Western Cape and (b), the development for sale of Wazobia Linux, an integrated operating system and Office software package Leapsoft Ltd. It is being produced in the main local languages as well as English.

106 A variety of different initiatives are appearing offering the potential to ‘bridge the digital divide’, many have much to offer but this is a minefield through which FGN must tread with care. ‘Empowering the masses through the digital revolution’ and similar phrases have been used by a host of initiatives claiming considerably more than they have so far delivered. They range from refurbishing the developed world’s digital cast-offs, through the much publicized ‘One Laptop Per Child’ (OLPC) project to various panaceas offered by the big players such as Microsoft and Intel. Many of these have much to offer but it is wise to evaluate them with some care before making commitments to any. Some are driven more by effective publicity than by real achievement while others may have hidden motives directed towards the eventual sale of software licenses once the client has become dependent on the brand (termed ‘consumer lock-in’ by the analysts). What is important is that FGN and educational institutions must clearly analyze their own problems and develop their own effective, costed solutions, involving external initiatives only when objectives coincide. This complex issue is much discussed on the Internet\(^5\).

4.2 Trends in ICT-enhanced teaching and learning

107 ICT is well embedded in effective teaching and learning activities worldwide. There is no shortage worldwide of examples of ICT being used effectively to enhance teaching and learning. These cover a wide spectrum from the one hand, comprehensive self-instruction learning platforms to, on the other hand, small examples of ICT being used, particularly in science, to illustrate a small point in a way that the printed medium cannot. Nigeria has much to gain from selectively importing and adapting what is available - often freely. The Global e-schools and Community Initiative \(^5\) of the United Nations (GeSCI) has been established to support the evolution of ICT-enhanced learning in developing countries; Ghana is one of the two pilot countries on the African continent.

108 Neither curricula nor learning materials at the post-basic level reflect available opportunities to use ICT. The use of ICT as an aid to teaching and learning is very limited and opportunities are not reflected in any curriculum documents or teacher guides. There are few

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5. See http://www.gesci.org/
home-grown resources for teaching and learning but there is some evidence (from state schools) that external resources are being used by some teachers and schools. Schoolnet Nigeria franchises a learning platform called LearnThngs which is originally UK based and is made available via the Schoolnet portal. This is currently financed by Schoolnet and is available free to its clients, none of which, however, is a federal school. This site offers a wide range of good teaching and learning aids originally for the UK GCSE curriculum. No information is available on how well it is used and teachers have not received training on how to use it.

Schoolnet Nigeria has plans to develop indigenous teaching and learning materials using teams of its own trained teachers working with local software developers. There is a long tradition in Nigeria of teacher-generated teaching and learning materials. The Science Teacher Association of Nigeria (STAN) has, for many decades, been the lead producer of locally published science textbooks. Producing digital content, both for teachers and students would be a natural extension of this work. It is important that teachers are involved in any such programs; a major criticism of many that have evolved elsewhere is that they have been developed by technical experts with little knowledge of the classroom and have failed to meet the real needs of students.

Computer literacy and, more importantly, the capacity to use ICT in teaching and learning, remain under-developed among the science and technology teaching force. As noted, the ICT landscape in post-basic education is currently characterized by a general paucity of skills but also by pockets of good practice. In higher education, universities like Jos and Lagos are developing experience in managing student e-learning through both proprietary and open source learning systems and in training their lecturers to produce learning materials. In secondary education, Schoolnet Nigeria is managing to harness the energies of enterprising teachers interested in developing their own skills in producing teaching and learning materials for the secondary sector. These initiatives, however, remain relatively small and isolated and evaluating them would inform increased funding to similar programs. This area is one where the influence of the private sector is likely to be crucial in providing training, in catalyzing and organizing the development of materials, and in providing affordable connectivity. Government should see itself as encouraging, facilitating, coordinating and controlling quality rather than attempting to be the provider.

Perhaps inevitable at this stage of national ICT development, computer literacy among teachers at all levels is reported to be low. Although a comprehensive survey has not been undertaken, it is reported that no teacher education institution has yet instituted a successful a policy of ensuring that all its graduates are computer literate. Schoolnet reports, however, a significant cadre of computer literate science teachers. Some training has been provided by the ministry of education for technical college teachers. Limited computer literacy training has been offered to some teacher education lecturers. Some have been trained 'in-house' to become computer literacy teachers as there is currently no other route for the training of this cadre.

Computer literacy training in HEIs is also reported to be limited except for programs for which it is a requirement. Some of the wealthier institutions are beginning to offer ICT services campus-wide but this is still far from widespread.

Recognized national standards for computer literacy are not yet in place. There are not yet any general standards for computer literacy such as those laid down in the ICDL (International Computer Driver’s License) and development so far has been ad hoc and usually linked to the requirements of other courses. As noted elsewhere there is no senior secondary computer studies program other than that offered in the vocational schools. Training in general computer literacy seems to be almost entirely limited to private sector programs. The development of national minimum standards would greatly assist those developing new S&T teaching programs which incorporate ICT skills.

The widespread incorporation of ICT into teaching and learning is hampered by lack
of, or high cost of, infrastructure and by lack of training. Even when affordable infrastructure is in place, the magnitude of the task of persuading teachers to make effective use of ICT in their work is considerable and frequently greatly underestimated and goes much further than simply supplying computers to schools and HEIs. Key to the success of this will be the use of ICT by teachers in their own learning programs, emphasizing the importance of computer literacy in Teacher Education programs.

115 Effective use of ICT in teaching and learning requires carefully planned and simultaneous development of all its different elements. These elements include connectivity infrastructure, dedicated educational bandwidth, computer networks in schools, ICT opportunities in the curriculum and digitized course materials available via a dedicated science and technology education portal. Ensuring the coordinated and simultaneous development of all these will require national planning and strategies implemented in a manner that encourages rather than suppresses, the kind of individual initiative on which it must inevitably depend. Private sector involvement has been shown elsewhere to be crucial in this process.

116 Effective use of ICT in teaching and learning also requires cohesive management structures and institutional arrangements. Compared to other African countries, Nigeria has a large number of promising initiatives on ICTs development both public and, particularly, private. Yet some of the core constraints to effective exploitation of the benefits of ICTs—backbone infrastructure, bandwidth, human capacity—remain a challenge. Although NITDA has the mandate over the coordination over ICTs development in the country, the policy developed under its aegis does not cover key areas like education. The three ones strategy adopted for HIV/AIDS—one policy, one strategy and one coordinating body—could have lessons for ICT development as well. Nominaly, all the three ones are already in place in Nigeria but it would appear that NITDA either lacks adequate capacity or might not have sufficient stakeholder buy-in to take up its leadership role effectively. This could possibly lead to inefficient use of resources and difficulties in assessing achievement. As Nigeria considers strengthening the contribution of ICT to development, it would be beneficial to critically review the institutional arrangements currently in place with a view to streamlining them to improve cost-efficiency, planning and goal setting and most importantly, monitoring and evaluation of performance.

117 The use of Open and Distance delivery methods is widespread but uncoordinated, limited to tertiary programs and so far has not involved e-learning methods. Many Universities have developed distance versions of their programs; some, such as the University of Lagos, have a long history of teaching in this way. The National Teacher Institute (NTI) currently trains some 75,000 teachers in this way. The National Open University of Nigeria (NOUN) was established only two years ago but is rapidly becoming the most significant player. However there are no major nationwide ODL programs that yet use e-learning as the mechanism for instruction although NOUN has a unit that is actively working on establishing such a program. As yet there is no nationwide educational network as there is, as yet, no national fiber-optic backbone in place. Neither is there a nationwide network of connected ODL centers. Any program that NOUN establishes must therefore, of necessity, be initially CD-based and hence limited in scope.

118 Some e-learning courses have been developed as pilot programs in a number of HEIs but the information gained by them has yet to be disseminated. A number of HEIs, such as the Universities of Jos and Lagos, have embarked on the process of putting some of their courses online. The University of Jos is one of a number of African Universities developing an Open Source learning management platform and adapting their course materials to it. It is important that these developments should be properly monitored and evaluated so that lessons learned from them can be applied to other programs.

52 This is another initiative of the Partnership for Higher Education in Africa and the University of Jos is working closely with the University of the Western Cape in South Africa which is playing a dominant role in developing the Open Source e-learning platform known as ‘KEWL nextgen’.
learned are available for other universities embarking on this route. Capacity gaps, such as a shortage of staff with the ability to generate and manage such programs, will become evident during this monitoring process and training programs will be required to fill them.

119 Digitizing libraries and electronically sharing materials between institutions is an important ICT application in higher education. Many HEI libraries have yet to be digitized and the long-planned Virtual Library project has yet to get off the ground. While the NUC has set standards for university library automation, which have been adopted by other HEIs, levels of implementation appear somewhat low, particularly in colleges. The main reasons for this seem to be inadequate awareness raising among the institutions, a reluctance to budget for such processes and a lack of trained ICT personnel in the libraries. The computerization of library operations is an essential prerequisite for any institution seeking to improve its teaching and learning through ICT.

120 Private sector ICT interventions offer ideal opportunities to offset costs and build up an ICT generation. Schoolnet Nigeria is not yet as well developed as some other Schoolnet programs, neither is it yet fully financed with local, private funds. However, its long-term plans to bring affordable connectivity to every state represent the most favorable way forward at a time when government spending priorities remain elsewhere. Experience elsewhere has shown that private sector involvement has been instrumental in the development of the effective use of ICT in teaching and learning, in much the same way as the private publishing industry has brought quality to printed learning materials. Governments retain the function of quality oversight that can be exercised in a variety of ways. In some countries digital materials are given some kind of seal of approval if they are deemed sufficiently good and appropriate to the curriculum. An interesting extension of this in England is the use of virtual funding; each school can draw on a centralized fund to purchase digitized materials but only if the materials have been approved for the scheme.

121 A number of promising capacity development and educational initiatives are under development. The Foundation Partnership for Higher Education bandwidth project, the Nigeria ICT Forum—a civic organization comprising universities’ IT professionals interested in development of ICT in education in Nigeria—and the Digital Divide Initiative are three capacity development initiatives in the tertiary sector. The FMST is a partner in two initiatives promoted by Microsoft and Intel that have a wider clientele. Impact assessment of these is not yet possible given their recent development. Elsewhere on the continent novel solutions are emerging that build on the tripartite model of a commercial sponsor, a commercial provider and government. Worldspace and DSTV already offer educational services through relatively inexpensive data download mechanisms from their satellites. Different models are emerging elsewhere under the Schoolnet umbrella. All these initiatives should be watched, adapted and scaled up where appropriate.
5. Financing Trends and Expenditure Patterns in Federal Post-Basic S&T Education

Key messages:

- Inadequate data and inconsistencies in existing data impede effective analysis of financing trends and expenditure patterns (122ff).

- Funding procedures are input-based, not related to performance and outputs, provide little incentive for partnership with industry and the private sector, are prone to inefficiency and do not encourage creativity and innovativeness (139ff).

- Expanding the role of, and opportunities for, the private sector in post-basic education could mobilize additional resources and encourage quality and relevance (139).

- Providing higher education institutions with a greater degree of professional and administrative autonomy is a prerequisite for improving their responsiveness and efficiency (141).

- Opportunities exist for enhancing the internal efficiency of many science and technology programs through measures such as pre-entry programs, clinics to identify student problems early, better career information in schools, etc (133ff).

5.1 Data constraints

122 Too little data monitoring and planning and too few effective management information systems exist at both the institutional and the system level. These shortcomings impede the adequate assessment of performance and quality. Data on enrolment, attrition, staff, cost and finance, and outputs (number of students, graduates, research outputs, etc) at the system level are not readily available or collected and analyzed in a reliable manner to examine overall education expenditures by source of revenue, by function (administrative, instructional, research, etc); or by field (science and technology, social sciences, arts, etc). Major strategic choices require careful collection and analysis of additional data, focusing on enrolment, staff, costs and finance (both budgetary and non-budgetary), outputs and should cover both state and federally funded post-basic education institutions.

123 Inconsistencies in the data impede the formation of concrete conclusions and analysis with respect to financing trends and expenditure patterns. The statistics provided contain errors in data collection, reporting and interpretation. Data series were often incomplete and frequently fail tests of internal consistency and logic. For example, the data provided indicate that improbably large changes in enrolment and staffing occurred in very short periods of time. A study is currently underway to improve data quality and to analyze public spending on education in more detail.

124 The task of education data collection in Nigeria is indeed a difficult one as constructing a truly complete and accurate picture of the level and patterns of funding entails obtaining information from over 100,000 public and private entities. In turn, these institutions operate under the supervision of 800 or so government institutions. Added to that, an unknown but larger number of private institutions further complicate the picture of the institutional environment. The STA 53 Report reviewing federal expenditure represents a first step toward clarifying key trends in federal spending for education. In addition, the ongoing education expenditure review and a set of companion studies address spending by state and local governments, will provide more detailed

53 This report is a distillation of six study area (STA) research reports; the second deals with these financing issues.
analysis to shed a brighter light on issues related to costs and financing of education in Nigeria.

125 *The extent of the private financial contribution to public education funding is unknown.* Anecdotal evidence suggests that private spending accounts for an increasing share of total education expenditures even in the public sector where parents often cover the direct costs of education through the purchase of books and even furniture for their children to use in schools. No information is available on the extent of this contribution, neither is there any available collated data on the extent of private funding of the tertiary science and technology sector.

5.2 Federal education expenditure

126 *Spending on education as a share of GDP tripled between 1998 and 2001 and appears also to have increased in years since then.* Based on partial estimates, total state, local (LGA), and federal education expenditures taken together tripled as a percentage of GDP between 1998 and 2001, rising from 2.3% to 6.2%. As a share of total government expenditures, total education expenditures increased from 14.2% to 17.5%\(^{54}\). Data are not available to examine overall public spending on education since 2001. However, it is likely that overall public spending on education has further increased since then because of additional available funds for the implementation of the universal basic education (UBE) program and Millennium Development Goals-related activities financed by the debt-relief initiative during the past year.

127 *As a proportion of GDP, Nigeria’s education expenditure is high by both regional and global standards.* According to the 2005 Education for All in Africa report,\(^{55}\) on the African continent, the current public expenditure on education ranges from 0.4% of GDP (DRC) to 9.6% (Lesotho). The statistical mid-point on the continent is 3.2% with a cross-country average of 3.9% of GDP, compared to the Asian average of 3.2% and the European average of 5.2%. The average share of government expenditures in other sub-Saharan African countries was 19.6% as a share of total government expenditures and 4.7% as a share of GDP in 1996.

128 *The federal government accounted for approximately one fifth of total education expenditures in 2001.* It is important to note that state and local governments are those levels mainly responsible for the provision of basic and secondary education. Increasingly so it is these non-federal levels bearing the cost for tertiary education. In 2001, it was estimated that state and local governments accounted for approximately 37% and 43% respectively of the total education expenditures by government. Thus, the federal government accounted for just 20%.

129 *In 2005 the federal allocation alone to education totaled 194.8 billion Naira (US$ 1.5 billion where US$1 = 127.74 NGN). Of this amount 40% was devoted to capital expenditures and 60% was designated for recurrent expenditures. Eighty percent of the total education and training budget was granted to the Federal Ministry of Education (FME) and its dependents and the Education Trust Fund (ETF)\(^{56}\).* Figure 5 shows that the largest component of the FME budget—52.5 billion Naira (US$ 408 million)—was earmarked for the nation’s 26 federal universities (including the National Open University). The 17 federal polytechnics were allotted 9% of the federal budget for education, 6% targeted the 17 federal Colleges of Education, and a further 6% supported the operation of Federal Unity schools. The UBE Program and the ETF where allocated 14% and 10% respectively. The remainder of the budget—about 6%—was provided for other items including the head

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\(^{56}\) The ETF is not, strictly, part of the Federal budget, but is added on here for ease of explanation.
quarters of the FMOE and its 12 parastatals, and for the national library.

Figure 5  Allocation of federal budget for education, 2005

130 Federal expenditures for education have risen over the past four years. Between 2001 and 2005 federal government expenditures on education increased from 8.3% of overall expenditures to 13.6% (or 1.5% of GDP). The majority of federal education spending is on post-secondary education (including Universities, Colleges of Education, Polytechnics, and Monotechnics). This figure includes federal funding for basic and secondary education at the state and local levels provided by UBEC and ETF for special initiatives.

131 Federal education expenditure has increased in absolute terms and on a per student basis, growing by as much as a third since 1999. In 1999 the Federal Ministry of Education's recurrent budget was 38.3 billion Naira (US$300 million); in 2006 it is authorized to spend 129.2 billion Naira (US$1 billion). The real value of the 1999 budget expressed in 2006 Naira purchasing power is approximately 84.6 billion Naira (US$ 662 million). Therefore, the purchasing power of the federal education budget increased about 53 percent over eight years. During this period, the cohort of potential students increased by approximately 20 percent, resulting in a per student expenditure increase of roughly one third.

132 What are the observable results of the increase in educational spending? Policy makers will be interested in questions such as what changes (such as a greater number of qualified graduates procuring jobs in the productive sector, more Nigerian youth accessing post-basic education as a percentage of the relevance age cohort, etc) resulted from this increase in federal spending? Until sufficient data are tracked, gathered, and analyzed to facilitate an impact analysis of these perceived financing trends, answers to these and other important policy questions cannot be provided to guide decision making.

133 Budget allocation per student by level and types of education varies substantially among federally-funded institutions and sub sectors. Based on available data, unit costs of different levels and types of institutions cannot be estimated because of the lack of data on overall actual spending. In federal universities one expects greater diversity in unit costs because universities ought to focus on a limited set of disciplines in order to create national centers of excellence and to exploit economies of scale in teaching and research. Figures show university budgets per student range from N294,815 (US$ 2,300) for the University of Ibadan to N25,801 (US$ 200) at the University of Abuja: spending at Ibadan is 11 times greater per student than at Abuja. The difference is traceable to differences in staffing ratios. Ibadan has one faculty member for every 10.4 students while Abuja has a faculty member for every 136.3 students. The differences in staffing ratios also reflect inconsistencies in the definition of staff and enrolment. For example, the University of Abuja includes its distance education students in its reports of fulltime students.
Variation in expenditure per student between different institutional types—Polytechnics, Monotechnics, Federal College of Education, Federal Universities—is so great that averages shed little light on sector-wide trends. The very wide range of costs (table 8) among federal educational institutions suggests that there may be substantial opportunity for increasing the cost-effectiveness of service delivery within individual degree programs, faculties, or whole institutions. The quality of education may also vary among institutions with some producing world class research and cutting-edge training while others restrict their missions to meeting the economy’s needs for trained manpower. The very large variations in cost may also be due to significant differences in financing, perhaps resulting from the influence of the national assembly in setting budgets. The existence of persistent differences in funding for apparently similar institutions requires explanation.

Across the federally-funded post-basic education system, the federal allocation per student varies widely by institution. Monotechnics, for example, are allocated almost four times that which federal Universities are allocated.

At present, the main sources of funding for federally-funded institutions are public sources such as federal budget grants and non-budgetary resources. The federal government has a tuition-free policy at all levels of education. In recent years, the Government also liberalized the fee policy for tertiary education institutions, especially in post-graduate studies even though education services are still financed predominantly by the public sector. Unfortunately, the present use and extent of non-budgetary resources in the education sector as a whole is not yet known.

Figure 6 shows the sources of funding of Federal universities as reported by the NUC, excluding funding from ETF. Internally generated revenue comprises only 9% of aggregate university revenue. Of particular note is that student fees constitute just 2.6% of institutional revenue. Federal universities report that externally funded research grants, fees, investment income and private donations account for between 3-12% of their total budgets. The federal universities offer classes to students who have not been formally admitted to degree programs. These programs operate on a full cost recovery basis and are not included in the official budgets and accounts of the universities. These classes include bridging...
programs in preparation for seeking admission to universities as well as courses in preparation for professional recognition.

138 In Federal Colleges of Education, on average, internal generated revenue represents only 15% of total income (excludes funding from ETF). Polytechnics, Monotechnics, and Unity schools do not report the off-budget private financial support being provided to them, but anecdotal evidence for the Federal Unity schools in Abuja suggests that the amounts being contributed may be significant. One school reported that over the past five years 'PTA' contributions constitute 36% of the federal budget for overhead and that in one year parental contributions actually exceeded the official budget for expenditures.

139 **Expanding the role, function and involvement of the private sector in post-basic education could mobilize additional resources and stimulate competition, encouraging greater quality and relevance.** With regard to the expansion of private education, Nigeria has already made significant progress achieved in the development of private education, but further encouragement is an attractive policy option, while offering parental choice and competitiveness in the sector. There is a particular need to expand the private sector in general and vocational/technical education to provide more and relevant middle level skills to the economy. This should be accompanied by a system of incentives from the federal government to create a healthy and competitive post-basic education system, with a mix of public and private providers. Public policies towards the development of the private sector should include the establishment of an appropriate regulatory framework that would be conducive to encouraging private sector investments in the sector. Policy actions need to focus on refining and reforming the framework for private sector participation in education at all levels of the system, including quality assurance procedures (e.g., licensing, accreditation), tax treatment of private sector schools and universities, and admission procedures and policies. Particular attention needs to be given to accreditation and quality control in the provision of both public and private education programs, which requires strengthening education management information systems at the national level.

140 **Competition between institutions for federal resources demands resource diversification. Institutions must be free to elicit funds from alternative sources to help cover costs.** Even with its present high oil prices, Nigeria remains one of the poorest nations in the world. Incomes are about $430 a year per capita, and expenditures for goods and services by all levels of government represent only about $100 a year, per person. Therefore, plans for public expenditure continue to be seriously constrained by financial realities, and further expansion and improvement of the post-basic education system cannot be achieved without a series of finance reforms. Yet without concentrated efforts to maintain high quality data, such reforms will not be founded on a clear understanding of the trends or challenges. Alternative funding sources, some of which are already in place, may include (a) financing of public education through greater private resource mobilization (e.g., cost sharing, income generating activities) and (b) the increase in private education providers.

141 **Governance issues should be addressed in the course of reviewing income generation and fee policies.** A prerequisite for improving the efficiency and flexibility of higher education institutions is a greater degree of professional and administrative autonomy. Since the restoration of democracy in 1999, government has encouraged the universities to re-claim their autonomy through a presidential pronouncement made on the occasion of the inauguration of new governing councils for the universities in May 2000 and through the issuance of a document entitled Government Policy on Autonomy by the FME in August 2000, and through the passing and signing of The Universities (Miscellaneous Provisions) (Amendment) Act 2003 which restored to governing councils the right to appoint and remove vice-chancellors, among other powers. Education colleges and polytechnics would benefit from similar structures.
5.3 Expenditure patterns in post-basic science and technology education

Almost 80% of the federal government's direct teaching budget goes to S&T programs. Data are not available to examine expenditures for S&T programs in the federal post-basic education system, but disaggregating federal education expenditure on S&T from education generally can be approximated by calculating the proportion of the direct teaching budget in academic programs in S&T as a proportion of all academic programs. Science and technology in the federal education budget (conservatively estimated) constitutes 79% of the direct teaching budget of the federal government. If one restricts the analysis to institutions under the direct control of the FME, then 70% of federal expenditures on education are directed towards science and technology and 30% are allotted to instruction in the arts and social sciences. This is summarized in Box 15.

143 Funding sources for S&T education include some line Ministries that fund education and training in specific S&T-related areas. The Federal Ministry of Health manages 16% of total federal education and training funds to operate schools for the training of nurses, midwives and medical technicians. The Federal Ministry of Petroleum oversees training programs representing about 3% of the total federal education and training budget and the Ministry of Agriculture spends about 2% of federal funds for education in the agriculture sector. Thirteen other ministries and agencies together receive the remaining 3 percent of funds for education not allocated through the FME some of which is used for S&T education (see Box 15 for a summary of characteristics of costs and finance of federally-funded education institutions). Attempts to distinguish expenditures by program objective with particular emphasis on science and technology are stymied by the inadequate data available that do not distinguish expenditures for science and technology education from that for the arts and social sciences.

Box 15 Finance characteristics of education at the federal level

Federal educational expenditure
- The federal budget for education is currently about N186 billion, including 28.4 million Naira allocated for UBEC for special initiatives at the state level.
- Just over a fifth (21%) of the federal education budget is implemented by ministries other than education — principally health, agriculture and petroleum.
- Just under half of FME budget (32% of the federal education budget) goes to support the federal university system.
- Polytechnics absorb N19 billion (10% of the federal education budget).
- National Colleges of Education receive N10 billion a year (5% of the federal education budget).
- 25% of federal education budget is for capital expenditure, almost half of which is targeted on the federal university system.
- Education absorbs 25% of the recurrent budget for executive agencies.

Patterns of expenditure in Federal Education Institutions
- Federal universities spend approximately N100,000 per student per year.
- Federal polytechnics spend approximately N50,000 per student per year.
- Federal monotechnics spend approximately N150,000 per student per year.
- Reported expenditures per student vary among institutions by large factors: 20 fold for universities, 5.5 fold for polytechnics, and 7 fold for monotechnics.
- Cost of instruction in technical/scientific disciplines is 2.5 to 2.7 times as big as in the social sciences and humanities at all levels of education.
- Three-quarters of the total budget for federal universities is reported to be spent on instruction in science and technology.

Trends in Federal Spending for Education
- Inflation-adjusted (“real”) budget for tertiary education has increased by just over a half between 2001 and 2004 went to raise the salary scale for university academics rather than to either increased staff numbers or non-staff inputs.
- Most of the increase in budget has gone to university academics rather than to either increase the number of staff or provide additional non-staff inputs.

Source STEP-B Financing and expenditure study (2006)
Therefore, estimates of federal expenditures for science and technology have been derived by drawing on a number of assumptions.

The cost of instruction is roughly two and a half times higher in the sciences, engineering and health professions than in social sciences and arts. To get to this figure, several assumptions must be made. First, the National Universities Commission (NUC) has issued guidelines for the calculation of budgetary needs. These guidelines specify the ratio of students to academic staff, the distribution of academic staff by rank and the ratio of academic staff to administrators. The guidelines also specify that 60 percent of an institution’s recurrent budget should be used for the payment of salaries and 40 percent for the procurement of goods and services. Second, if universities were to adhere to these guidelines, the cost per student enrolled in the sciences would be 2.4 times as much as the cost per student enrolled in education, the arts and the social sciences. This figure is lower than the international standard of 2.7 to 3.0 times.

These calculations suggest that increasing enrolment in the sciences by 100 students would require a reduction in enrolment in the arts of 240 students. If one assumes that science and technology education costs 2.4 times as much as education in the arts, social sciences, law and business then 78 percent of the university budget would be required to educate 60 percent of the students and 22 percent is used to education the remaining 40 percent. The federal education budget allocates about 45 billion Naira a year (US$ 352 million) to science and technology education and 13 billion Naira a year (US$ 102 million) to law, business, education, arts and social sciences education.

Given the choice between educating 100 students in S&T disciplines versus 240 in non-S&T disciplines for the same cost, several important questions must be answered that current data do not allow. For example, what is the marginal value in terms of economic growth, productivity, and value addition in industry of an S&T graduate compared to a non-S&T graduate? Is it 2.4 times as much? In particular sectors are S&T graduates’ value (measured in marginal productivity, for example) more or less? Do those sectors targeted for growth in the coming decade require S&T graduates more so than non-S&T graduates? And if so, do they require 2.4 times as many? Revisiting the 60:40 S&T to non-S&T University admissions policy and the 70:30 S&T to non-S&T admissions policy at the Polytechnics is encouraged as data become available to answer these questions.

Initiatives to strengthen science and technology education might usefully consider developing both cutting-edge opportunities for instruction and research in a small number of institutions and less rigorous professional training in others, particularly in engineering disciplines to better utilize scarce public resources. The huge range of actual per student expenditures suggests that budget management and expenditure control need to be improved. As a consequence, two of the more important side-effects resulting from the proliferation of high cost, low quality programs in the post-basic education system have been: (a) a reduction in available resources for overall education, and (b) very high average instructional costs. The existence of a remarkable range of practices offers the opportunity to study rigorously the relationship between inputs and outputs in education. Nigeria should also consider the possibility that it may be able to better address the educational needs of the nation with a system of education and training that provides different opportunities to students with differing abilities and aspirations.

Many opportunities exist to enhance institutional efficiency in teaching and research, especially in federal Universities, Polytechnics and Monotechnics. Data are lacking to examine in closer detail the costs and financing of federally-funded Polytechnics and Monotechnics, especially state-funded post-basic education institutions, but preliminary evidence suggests substantial opportunities for economies of scale may be present in teaching and the conduct of research in most institutions. Where quality is benchmarked and at a particularly high level with respect to teaching, research performance, and collaboration with...
industry, select programs in S&T instruction (e.g., specific Faculties in S&T that elicit the majority of research contracts from public or private sector partners) and research could be consolidated and denoted “Centers of Excellence.” Such Centers of Excellence have proven very successful in maintaining high caliber training and research in specific S&T areas in a number of international settings. From a policy perspective, the financing aspect of Centers of Excellence often most appealing is their allure to partners interested in co-financing for purposes of joint research, partnership building, and collaboration.

149 Tertiary institutions are not protected from the vagaries and uncertainties of the federal budgetary processes. University planning is undermined without reliable, predetermined commitments for financial support from government. If free to determine their own fee structure and forecast in advance how much internally-generated revenue might be elicited in a year, universities would be facilitated to strengthen both their planning processes and their autonomy to the benefit of their research capacity. Table 9 shows that the proportion of the formula-based funds actually disbursed to federal universities varied drastically between 1997 and 2001, with amounts disbursed ranging between 35% and 60% of the amounts allocated. The rolling strategic plans that most universities prepare can only function effectively in a climate of financing stability.
6. Recommendations

6.1 Recommendations of system-wide significance

150 The following are key issues that need to be addressed in order to achieve sustainable improvement of post-basic S&T education in Nigeria at the federal level. These are overarching concerns that cut across all the study areas. They concern national policies and strategies which, if not addressed, will hinder full achievement of any other interventions undertaken.

151 There is a need for an overarching national strategy for S&T and innovation. Post-basic S&T education and training is intended to produce the human capital required for a science, technology and innovation (STI) development. It is one among many components of such a development. For full effectiveness, S&T education and training must be carefully integrated into the broader STI strategy, which in turn would link to other national policies and strategies. This strategy is currently missing but it is understood that the FGN intends to develop one with assistance from UNESCO. This welcome effort needs to be expedited as soon as possible (paragraph 152).

152 The data management capacity must be strengthened. Inculcating a culture of, and developing capacity for, regularly updating data at institutional and national level is critical. The STEPB study team experienced considerable difficulties in obtaining accurate and reliable data, particularly as regards enrollment and financing of post-basic S&T education. This is despite the existence of several past initiatives by the FGN and its development partners to improve data management. Without accurate, up-to-date and reliable data, planning, monitoring and evaluation becomes difficult, with adverse consequences on quality and efficiency. Existing mechanisms to collect, manage and disseminate post-basic education data should be strengthened. Efforts should be made to standardize instruments for data collection, to publish data at regular and predictable intervals and, within each ministry, parastatal organization and tertiary institution, there should be a specific office(r) responsible for data management. Data for the whole sector should be collated and be available from a single source (see, for example, paragraphs 41, 47, 80, 120).

153 The fragmentation of the management of the S&T sector must be addressed. The S&T sector is characterized by a fragmentation of management structures resulting in plans and strategies that that overlap and sometimes conflict, and in policy gaps. The management is spread over many public and private entities operating under the supervision of numerous federal, parastatal, state and local offices and an unknown number of private institutions. Recent steps to address this fragmentation are welcomed and encouraged. Without addressing the problem of fragmentation, it is difficult to ensure a coordinated development of the S&T sector and cost-effective utilization of resources (paragraph 32ff).

154 Systems for monitoring market needs and responding to them must be improved. Current information on market needs is insufficient for planning purposes. A labor market observatory should be established that can not only identify needs but also report on how effectively the tertiary system is able to satisfy them (paragraph 48).

155 Steps must be taken to address the lack of terrestrial ICT bandwidth. Strategies for the development of the S&T sector will depend increasingly on the application of ICT, both to management and to teaching and learning development. The current dependence on expensive satellite links is unsustainable and inhibits the widespread introduction of ICT. Current moves to privatize the communications industry and to develop a terrestrial fiber backbone must be augmented by strategies to ensure that adequate subsidized bandwidth is available for educational purposes at a cost that
matches the ability of the institution to pay (paragraph 97ff).

156 A substantial review and reform of the secondary curriculum is required. The secondary S&T curriculum has changed little in the last 20 years and no longer adequately serves the need of either the school-leaver or the tertiary sector. A major reform is recommended including capacity building in the institutions charged with it, as well as attention to the implementation in the classroom (paragraph 59ff).

157 A National Vocational Qualifications Framework and the necessary structures to manage it should be established. This is of particular importance to the TVET sector in order create a training structure better able to respond to rapidly changing training needs and also able to embrace a wider variety of training institutions, public and private (paragraph 71).

158 Mechanisms must be put in place to improve the quality of equipment and facilities available for teaching at all levels as well as for research at the tertiary level. These measures are not limited to simply increasing funds available; collaboration between institutions, a more limited focus in programs offered and an improvement in the culture of maintenance are all measures that have the same end. In the case of university research, funding should be competition-based to provide incentives to enhance efficiency and strengthen collaboration with industry and partnerships among post-basic S&T institutions (paragraph 81).

159 More effective partnerships between the public and private sector should be established. The report notes many instances where the development of the S&T sector would be greatly enhanced by effective partnerships between public and private institutions. Existing barriers to this kind of partnership should be removed and ministries should actively facilitate it (this theme runs through the whole report but significant paragraphs are 78, 85, 102, 115, 120, 125, 139, 148, 160).

6.2 Detailed recommendations

160 The following are recommendations to the FGN on possible interventions to address gaps observed through the STEPB background studies. The recommendations are categorized into short (up to 3 years) and long term in order to assist in prioritization and resource allocation.
### 6.2.1 Policies, Planning and Signals from the Labor Market

#### Area 1  Policy, Planning and Governance

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<th>Responsibility</th>
<th>Assumptions</th>
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<tbody>
<tr>
<td>11 Designate a single body, such as the newly created National S&amp;T Council with responsibility for the development of S&amp;T education in the country</td>
<td>S&amp;T strategy for education under a single body</td>
<td>FGN</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>12 Commission a study of the institutional framework responsible for implementing S&amp;T education and training in Nigeria to identify opportunities for improving efficiency and effectiveness</td>
<td>Study report</td>
<td>FME, FMST</td>
<td></td>
<td>33ff</td>
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<tr>
<th>Long-term recommendations</th>
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<th>Assumptions</th>
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<tr>
<td>13 Develop and implement an overarching national strategy for S&amp;T development. This should have a section that fills the current policy gap concerning research. Major thrusts across all policy elements should concern mechanisms for ensuring that the S&amp;T needs of the labor market are satisfied, for building links between the public and private sectors and for mechanisms for attracting non-government funding into the sector</td>
<td>S&amp;T strategy for education in place and operationalized</td>
<td>FME, FMST</td>
<td>Close working relationships are developed between all institutions involved</td>
<td>33ff</td>
</tr>
<tr>
<td>14 Implement rationalization of parastatal organizations under the FME and FMST</td>
<td>Number of parastatals under the FME and FMST reduced</td>
<td>FME, FMST</td>
<td>Close working relationship between FME and FMST</td>
<td>37</td>
</tr>
<tr>
<td>15 Review the legislation(s) on governance of tertiary institutions to allow more administrative and professional autonomy of institutions (with appropriate accountability safeguards), particularly as relates to appointment of senior officers and charging of fees</td>
<td>Revised legislation or a government decision to revise the legislations</td>
<td>FME, NUC, NBTE, NCCE</td>
<td>Willingness by Government to relinquish the control they currently exert and continue to provide funding</td>
<td>140</td>
</tr>
<tr>
<td>16 Implement the planned national EMIS structures. Review the data collection mechanisms in the tertiary sector to include more accurate data, including cohort tracking, on student throughput by program</td>
<td>EMIS structures in place Data available</td>
<td>FME, NUC, NBTE, NCCE</td>
<td>Technical expertise is available Recurrent expenditure is met</td>
<td>41</td>
</tr>
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#### Area 2  Policies and Strategies to Align STEPB to the Needs of the Labor Market

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<th>Assumptions</th>
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<tbody>
<tr>
<td>17 Commission a comprehensive labor market study to get a better understanding of the reasons behind the observed mismatch between needs of the labor market and outputs of STEPB institutions</td>
<td>Labor Market Study Report</td>
<td>FME, FMST, NITOA</td>
<td>Technical Expertise is available</td>
<td>47</td>
</tr>
<tr>
<td>18 Designate select tertiary institutions in major industrial cities to establish programs in labor market studies</td>
<td>At least one labor market studies program launched in a tertiary institution in a major industrial city</td>
<td>FME, NUC</td>
<td>Designated institutions are willing and have the capacity to run the programs</td>
<td>47</td>
</tr>
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### 6.2.2 Teaching, Curricula and Research in Post-Basic S&T Education

#### Area 1  
**S&T Education Curricula**

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<th>Assumptions</th>
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<tr>
<td>2.1 Review, restructure and implement, secondary S&amp;T curriculum and assessment methods to achieve a healthier balance between content and practical skills development for the dual purposes of preparing students for tertiary education on one hand and for the labor market, on the other.</td>
<td>New S&amp;T education curriculum for senior secondary schools finalized and in use</td>
<td>FME, NERDC</td>
<td>Government is willing to commission assistance from non-governmental organizations such as STAN and MAN</td>
<td>62</td>
</tr>
<tr>
<td>2.2 Encourage tertiary institutions to revise their curricula regularly and involve employers and the private sector in the review process.</td>
<td>Number of federal tertiary institutions that have reviewed their curricula during the last five years with participation of employers and the private sector</td>
<td>HEIs</td>
<td>Tertiary institutions are willing to involve Employers and the private sector in curriculum review</td>
<td>68</td>
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| 2.3 Strengthen the capacity of NERDC and related organizations (STAN and MAN) to manage S&T curriculum development and to continually conduct educational research to inform planning and decision-making. | Regular research reports  
Curriculum materials  
NERDC annual reports | FME, NERDC | Government is willing to commission assistance from non-governmental organizations | 62 |
| 2.4 Develop and launch a National Vocational Qualifications Framework (NVQF) to accommodate hanging demands in skills and to allow participation of private and community-based trainers. | NVQF policy and implementation plan in place | NBTE lead agency in cooperation with all stakeholders including key private sector representative institutions  
Link with ADB-funded TVET project  
Government willing to fund NVQF recurrent expenditure | 44  
71 |
| 2.5 Encourage tertiary institutions to implement regular tracer studies to get feedback from beneficiaries of their programs. | Tracer study reports | NUC, NBTE, NCCE | technical expertise and recurrent funding for tracer studies is available | 47 |
### Area 2  S&T Teacher education and support

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<tr>
<td>2.6 Strengthen INSET program for teachers, linked to the revised curricula, by providing additional funding for professional development with priority to new areas of knowledge, teaching and learning (computer literacy, use of ICTs in learning, activity- and problem-based learning, etc)</td>
<td>Number of participating teachers</td>
<td>FME</td>
<td>Additional recurrent budget is provided</td>
<td>62</td>
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<td></td>
<td></td>
<td></td>
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<td>75</td>
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<tr>
<td>2.7 Reform initial teacher training curricula to provide adequate coverage of new areas of knowledge and new teaching methodologies, both theory and practice, and to give increased prominence to methodology and school practice</td>
<td>Revised curricula written and operational</td>
<td>FME, NCCE</td>
<td>Teachers colleges have adequately trained teachers and requisite facilities and equipment</td>
<td>69</td>
</tr>
<tr>
<td>2.8 Encourage HEIs to institute/further support programs to improve the quality of tertiary level instruction, particularly linked to the introduction of new, more student-centered methodologies such as the use of ICT in teaching and learning</td>
<td>Lecturer clinics (Academic Development Centers) established. New modes of teaching and learning operational</td>
<td>HEIs</td>
<td>A supportive incentive system in place in tertiary institutions to motivate lecturers to participate in clinics and apply the new methodologies</td>
<td>68</td>
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### Area 3  S&T Teaching and Learning

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<tr>
<td>2.9 Encourage federal universities to introduce affirmative action programs for girls to increase the proportion of girls in universities’ S&amp;T programs. Approaches which have worked in other countries e.g. bridging/pre-entry programs and targeted scholarships should be explored</td>
<td>Increased % of girls enrolled in university S&amp;T programs</td>
<td>Universities</td>
<td>There are sufficient numbers of adequately qualified girls graduating from senior secondary schools</td>
<td>78</td>
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### Area 4  S&T Research

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<tr>
<td>2.10 Strengthen research in universities and research centers by introducing competitive funding with incentives to encourage collaboration with industry and among tertiary institutions</td>
<td>Number of collaborative research projects with industry</td>
<td>FME, FMST, NSTC</td>
<td>Cooperation between FME and FMST. Industry is willing to partner with universities in research</td>
<td>81</td>
</tr>
<tr>
<td>2.11 As a component of the development of the national research policy and strategy, institute data collection services to record, benchmark and quantify the research output of HEIs and develop a process for competitive funding that encourages institutional cooperation and promotes excellence</td>
<td>Data collection process in place</td>
<td>NUC, NBTE, NCCE, FMST</td>
<td>Transparency and professionalism in governance &amp; management of the competitive system</td>
<td>82</td>
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<tr>
<td>2 12 Encourage development of centers of excellence around leading research universities. Such a center could bring together a cluster of institutions comprising university, a polytechnic, a teachers college, a research center and several federal SSS within the same geographical area, working together under the leadership of the university</td>
<td>Number of STEP/ clusters established</td>
<td>NUC, NBTE, NCCE</td>
<td>Willingness of the various parties involved to work together</td>
<td>81</td>
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</tbody>
</table>

**Area 5   Facilities for Teaching, Learning and Research**

<table>
<thead>
<tr>
<th>Short-term recommendations</th>
<th>Performance Indicators</th>
<th>Responsibility</th>
<th>Assumptions</th>
<th>Para</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 13 Continue with current ETF funding to strengthen teaching, learning and research facilities in federal universities and expand the program to include polytechnics and teachers colleges involved in S&amp;T teachers training</td>
<td>Amount of ETF funding disbursed for this purpose</td>
<td>ETF, FMF, FME, NUC</td>
<td></td>
<td>87</td>
</tr>
<tr>
<td>2 14 Partner with UNESCO to improve facilities and consumables for S&amp;T teaching and learning in S&amp;T federal secondary schools</td>
<td>Proportion of federal S&amp;T/SSS have at least one well-equipped and functioning laboratory</td>
<td>FME</td>
<td></td>
<td>87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>2 15 Make this ETF funding program permanent and introduce a incentives to encourage efficiency, innovation and diversification of funding sources (e.g. matching funds)</td>
<td>ETF policy statements and disbursement records</td>
<td>FMF, FME</td>
<td>Leadership at tertiary institutions has the necessary skills to initiate and lead reforms towards innovation and improved efficiency</td>
<td>87</td>
</tr>
<tr>
<td>2 16 Strengthen the capacity of NASENI, NARICT and other similar initiatives to produce affordable school equipment and consumables locally</td>
<td>Increased number of federal schools with well equipped laboratories for S&amp;T subjects</td>
<td>FMST, FME</td>
<td>NASENI and NARICT products are competitive in the labor market</td>
<td>88</td>
</tr>
<tr>
<td>2 18 Encourage greater specialization by institutions, and collaboration between institutions, to concentrate, and hence make more effective use of, both human capacity and expensive physical resources</td>
<td>Reduction in diversity of programs offered by institutions Emergence of specialist departments and HEIs</td>
<td>NUC, NBTE</td>
<td>Agreement obtained between institutions</td>
<td>89</td>
</tr>
</tbody>
</table>
### 6.2.3 The Use of ICT to Enhance Teaching and Learning in Post-Basic S&T Education

#### Area 1  ICT in Education policy

<table>
<thead>
<tr>
<th>Short-term recommendations</th>
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<th>Para</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 Develop a wide-ranging ICT in Education Policy, and related strategy, building on the foundations laid by the national IT policy</td>
<td>Policy in place</td>
<td>NITDA and FME, FMST</td>
<td>Strong cooperation between NITDA and FME</td>
<td>34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>32 Develop a rolling, achievable and costed plan for the infusion of ICT into all phases of education</td>
<td>Strategic plan in place and operationalized</td>
<td>NITDA and FME, FMST</td>
<td>Adequate recurrent funding is available</td>
<td>34</td>
</tr>
<tr>
<td>33 HEIs to develop their own costed ICT policies and plans based on existing good practice</td>
<td>Institutional ICT policy in place and implemented in at least three tertiary institutions</td>
<td>Adequate funding available</td>
<td>96</td>
<td></td>
</tr>
</tbody>
</table>

#### Area 2  ICT physical provision

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>34 All players negotiate a sustainable mechanism for providing subsidized educational bandwidth to institutions at a cost that they can reasonably meet</td>
<td>Mechanism in place</td>
<td>FME, FMST, Telecommunication s companies, Schoolnet, others,</td>
<td>Bandwidth will be in place and for sale</td>
<td>99</td>
</tr>
<tr>
<td>35 Develop a national terrestrial fiber network capable of handling foreseeable traffic and connected to the world network via the SAT-3 cable</td>
<td>Network in place in main centers within two years and an expansion is planned into more remote areas</td>
<td>Telecommunication s companies</td>
<td>Ntel privatized, Necessary agreements can be reached</td>
<td>94</td>
</tr>
<tr>
<td>36 All players agree on a long-term strategy for the provision of ICT services to (federal) schools Services to include agreed hardware and software, connectivity, technical training, teacher training and partial cost recovery mechanisms</td>
<td>Strategy in place and operationalized</td>
<td>FME, FMST, Schoolnet, private operators</td>
<td>Necessary physical infrastructure exists</td>
<td>107ff</td>
</tr>
<tr>
<td>37 HEIs to develop strategies for developing their ICT services informed by the experiences of existing examples of good practice Services to include agreed hardware and software, connectivity, technical training, teacher training and cost reduction and recovery mechanisms</td>
<td>Strategy in place and operationalized</td>
<td>NUC, NBTE, NCCE, private operators, international partners</td>
<td>Necessary physical infrastructure exists</td>
<td>107ff</td>
</tr>
</tbody>
</table>

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</tr>
</thead>
<tbody>
<tr>
<td>38 Widen the plan to offer affordable ICT provision to educational institutions by developing</td>
<td>Private sector partnerships</td>
<td>FME, FMST,</td>
<td>Ministries have well-developed</td>
<td>101ff</td>
</tr>
</tbody>
</table>

56
### Area 3  ICT - enhanced teaching and learning

<table>
<thead>
<tr>
<th>Short-term recommendations</th>
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</tr>
</thead>
<tbody>
<tr>
<td>3.10 Computerize all federal HEI libraries and the train support technical staff, administrators and users</td>
<td>All federal universities polytechnics and colleges have computerized libraries</td>
<td>NUC, NBTE, NCCE</td>
<td>Sufficient trainable staff and trainers exist</td>
<td>119</td>
</tr>
<tr>
<td>3.11 Initiate the agreed stepwise development of the national virtual library</td>
<td>National virtual library online and in use</td>
<td>NUC</td>
<td>A reliable and affordable national ICT backbone is in place in all cities near STEP8 institutions</td>
<td>119</td>
</tr>
<tr>
<td>3.12 Develop a hierarchy of computer literacy standards</td>
<td>Standards exist</td>
<td>NBTE</td>
<td>The concept of a qualifications framework is agreed</td>
<td>115</td>
</tr>
<tr>
<td>3.13 Provide computer literacy training for in-service teachers as part of INSET programs and for HEI lecturers - Some of the cost may be recovered from the trainees</td>
<td>Number of teachers and lecturers who receive training</td>
<td>FME, NUC, NCCE, NBTE</td>
<td>Trainers and training facilities and venues exist Recurrent costs are met</td>
<td>114</td>
</tr>
</tbody>
</table>

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<thead>
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</thead>
<tbody>
<tr>
<td>3.14 Initiate an ongoing process of re-developing curricula and instructional materials to capitalize on the teaching and learning opportunities offered by ICT - Provide necessary training to curriculum developers</td>
<td>ICT opportunities added to curriculum documents ICT-based teaching and learning resources developed</td>
<td>FME, NERDC, NUC, NBTE, NCCE and HEIs, Professional associations</td>
<td>Expertise exists to initiate the program and to provide the necessary training Recurrent costs will be met</td>
<td>108</td>
</tr>
<tr>
<td>3.15 e-Learning capability is developed within individual HEIs taking advantage of experience gained by existing examples of good practice</td>
<td>New digitized courses coming online each year; number of institutions offering them increasing yearly</td>
<td>NUC, NBTE, NCCE, HEIs</td>
<td>Institutions already offering e-learning programs willing and able to offer advice and training and share software and digitized materials</td>
<td>118</td>
</tr>
<tr>
<td>3.16 Led by NOUN, institutions offering ODL program should initiate a process of digitizing courses and making them available online through a national network of shared e-learning centers</td>
<td>Some ODL programs offered in e-learning mode Network of online centers exists and expanding</td>
<td>NOUN, HEIs with e-learning capability</td>
<td>Physical infrastructure exists and mechanisms for financing are developed to maintain it</td>
<td>117</td>
</tr>
<tr>
<td>3.17 Establish S&amp;T education portals to support both teaching and learning</td>
<td>Portals exist and developing</td>
<td>Schoolnet, professional institutions, HEIs</td>
<td>Necessary skilled personnel exist to maintain portals Necessary infrastructure is in place</td>
<td>108ff</td>
</tr>
</tbody>
</table>

3.9 The use of open source software in developing learning platforms, databases, etc. will eliminate long-term annual license fees and contribute to the evolution of a healthy local software industry

Open source software in use in HEIs

HEIs, Schoolnet, NITDA

Expertise can be identified, possibly from abroad, to initiate developments

104ff
### 6.2.4 Financing Trends and Expenditure Patterns

#### Area 1: Data constraints

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<tr>
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<tbody>
<tr>
<td>4.1 Designate one federal ministry or parastatal organization to collect and track financial data on STEPB across all ministries, institutions and parastatal organizations</td>
<td>Organization identified and empowered</td>
<td>FMF to take the lead, FME, NUC, NBTE, NCCE</td>
<td>Strong leadership from the FMF</td>
<td>122ff</td>
</tr>
</tbody>
</table>

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>4.2 Improve financial data management capacity in post-basic institutions, and introduce regular reporting requirements in order to build a M&amp;E culture in institutions. For example, institutions could be required to produce a Facts and Figures report annually for reporting at a stakeholders consultative meeting held yearly</td>
<td>Reliable financial data available within STEPB institutions and the umbrella organizations (NUC, NBTE, NCCE)</td>
<td>Designated organization</td>
<td>122ff</td>
<td></td>
</tr>
<tr>
<td>4.3 Institute mechanisms for monitoring the impact (in terms of indicators such as graduate employment rates, increase in access to post-basic programs, etc) of education financing trends</td>
<td>Data collected</td>
<td>FME</td>
<td>122ff</td>
<td></td>
</tr>
</tbody>
</table>

#### Area 2: Federal Education Expenditure

<table>
<thead>
<tr>
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<th>Para</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4 Conduct a study on the efficiency of Nigeria’s STEPB institutions to explain observed wide variations in unit costs</td>
<td>Study Report</td>
<td>FME, NUC, NBTE, NCCE</td>
<td>Institutions are willing to disclose all sources of funding</td>
<td>134</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>4.5 Put in place a funding policy that encourages efficiency improvement (e.g. matching funds for cost reduction) and mobilizes a greater input from the private sector</td>
<td>Funding policy in place and operational</td>
<td>FME, NUC, NBTE, NCCE</td>
<td>STEPB institutions are willing to cooperate with Government to improve efficiency</td>
<td>139</td>
</tr>
</tbody>
</table>

#### Area 3: Funding Policy

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>4.6 Use funding policies to encourage the emergence of, on the one hand, a small numbers of centers of excellence operating at the cutting edge of both instruction and research and, on the other, institutions offering a less rigorous, and less costly training than is currently offered</td>
<td>Decrease in unit costs across many HEIs Emergence of identified centers of excellence</td>
<td>FME, NUC, NBTE</td>
<td>147</td>
<td></td>
</tr>
</tbody>
</table>
Annex A

STEP-B Research Reports

Acknowledgements

The STEP-B research process has been a highly consultative activity, in the course of which a wide array of stakeholders made valuable inputs. The research team hereby expresses its deep appreciation for the contributions of these stakeholders in deepening its understanding of the Nigeria situation and in helping to build large scale consensus around the entire STEPB project, and would like to acknowledge in particular the contribution of the following persons for facilitating the participatory research process of this study.

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