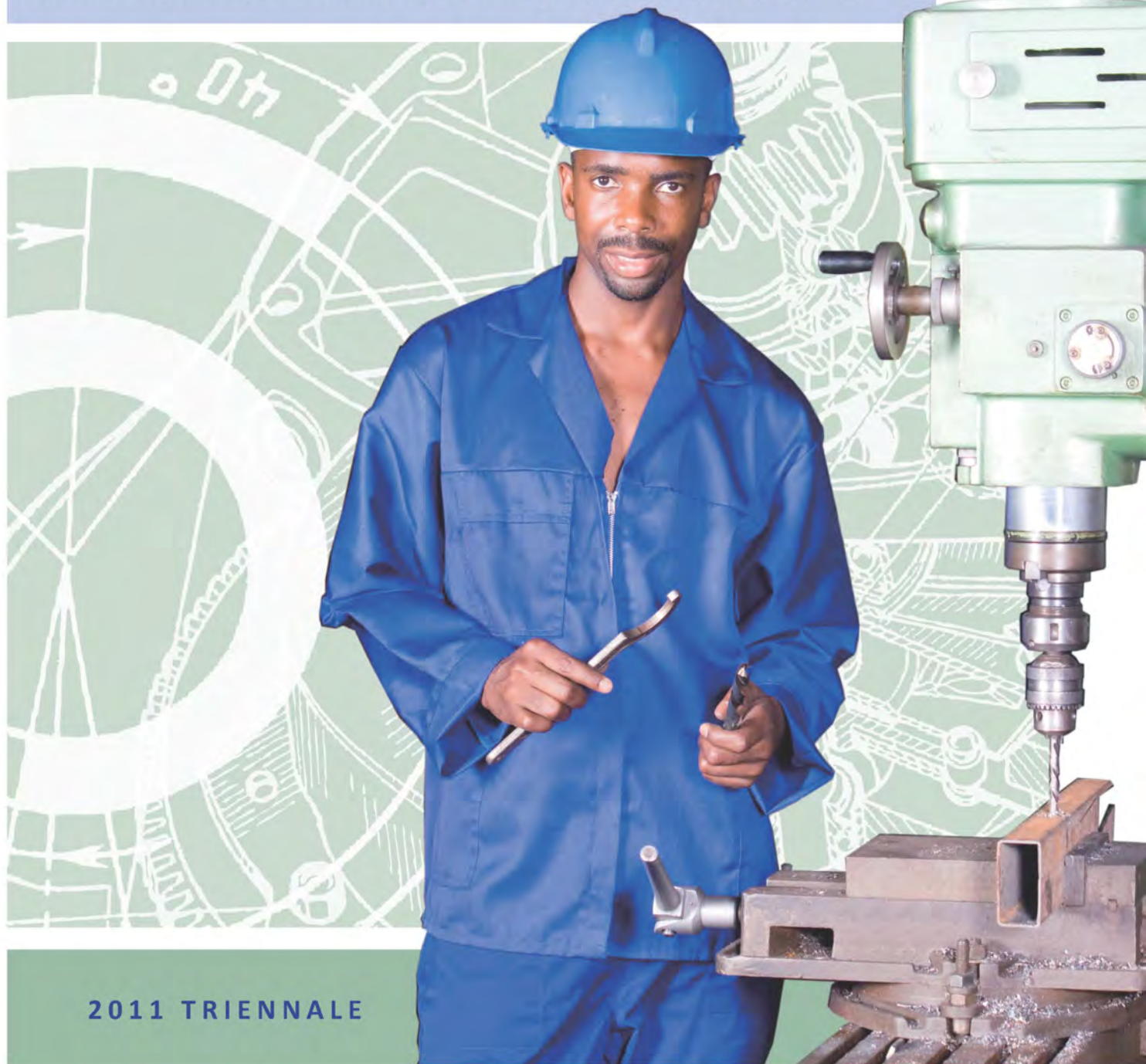


Invest in Science and Technology or Perish:

The Challenges facing African Colleges of Science and Technology, Schools of Engineering and Polytechnics in the Knowledge Economy

Cases of the University of Abuja School of Engineering, Kaduna Polytechnic and Yaba (Lagos) College of Technology in Nigeria



2011 TRIENNALE

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Ushirika wa Maendeleo ya Elimu Barani Afrika
الرابطة لأجل تطوير التربية في إفريقيا
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INTRODUCTION

The theme of the Association for the Development of Education in Africa (ADEA) 2012 Triennale *Promoting critical knowledge, skills and qualifications for sustainable development in Africa: how to design and implement an effective response by education and training systems?* is timely and relevant because of the global context characterized by the merge of the knowledge economy on one hand and the increasingly significant attention being paid to sustainable development by an ever increasing number of countries (policy makers), researchers and other concerned constituencies on the other hand around the world.

Since their inception as a human activity, education and training have played a key role in promoting knowledge, skills and qualifications all over the world. However, with specific reference to Africa and due to historical, political, social, cultural and economic reasons, the continent's contribution to the production of a critical mass of scientific and technological competencies, knowledge, skills and qualifications necessary to propel its economic development has been quite limited. For example, Africa's contribution to Research and Development (R & D) that is the amount of knowledge generated by research over the past decade has been estimated at only .75 percent of the total amount currently produced in the world (Science with Africa, 2009).

Furthermore, the Triennale's sub-theme *Lifelong development of scientific and technological skills for the successful integration of Africa into the context of globalization* reflects a shared vision around the continent that scientific and technological skills so crucial for Africa's sustainable development are in short supply implying that the institutions and entities whose primary mission is to produce this knowledge and develop these skills do not have the desired capability (human, financial and material) to perform in an optimum manner to generate knowledge, develop skills, and confer qualifications to sustain Africa's development in the 21st Century. It is generally recognized that underinvestment in these institutions significantly limits their capability to produce scientific and technological skills and induce innovation, all elements that are critical to Africa's development.

Background and Setting

Universities of Technology, Faculties of Science, Schools of Engineering and Colleges of Technology are all an integral part of tertiary education in Nigeria that encompasses all organized learning activities. The National Policy on Education (1998) defines tertiary education to include the universities, polytechnics, monotechnics, and colleges of education in Nigeria. The goals of tertiary, as specified in the National Policy (2004) are to:

- ◆ Contribute to national development through relevant high-level manpower training,
- ◆ Develop and inculcate proper values for the survival of society,
- ◆ Develop the intellectual capability of individuals to understand and appreciate their local and external environments,

- ◆ Acquire both physical and intellectual skills which will enable individuals to be self-reliant and useful members of the society,
- ◆ Promote and encourage scholarship and community services,
- ◆ Forge and cement national unity
- ◆ Promote national and international understanding and institutions.

According to ESA (2007) in Nigeria, higher education is available in four main types of institutions:

- ◆ The universities, whose number totals 110 in 2011
- ◆ Polytechnics, originally intended for middle and high level technical/professional education
- ◆ Colleges of education, intended for high-level non-graduate teacher education, but some of which have since become degree-granting institutions, with emphasis on bachelors' degrees in education
- ◆ Monotechnics which are higher education institutions (HEIs) that offer courses in specific professional area: nursing, agriculture, veterinary studies, etc.

Presentation of the Three Institutions

The three institutions selected are a university, a polytechnic and a college of technology. They were chosen because of their specific identify and mandate as institutions of higher education offering academic as well as practical courses, and being both teaching and research institutions. This uniqueness of mandate highlights their ability to produce knowledge, develop skills and promote qualifications. They are representatives of a wide range of higher education institutions not only in Nigeria but across the whole African continent. Not all the respondents provide the same amount of information on all of these institutions. Whereas the information provided on the University of Abuja was relatively scanty and fragmented in this part of the instrument, enough information was available on Yaba College of Technology and even more information was available on Kaduna Polytechnic.

a) The University of Abuja

The University of Abuja also known as UniAbuja is a specialized institution in technology that was established in 1988 as a dual-mode university with the mandate to run conventional and distance learning programs in the federal capital. The University of Abuja is the first institution of this type in Nigeria to assume such a dual mandate. The UniAbuja is thus committed to and seeks academic excellence while ensuring equal education access to a diverse constituency, thus preparing its students for productive roles in the society. UniAbuja is a specific institution that offers undergraduate and graduate programs in fields such as science, technology and engineering as well as pre-service and in-service teacher training especially in science and technology. Its strategic location on the federal capital territory

makes it one the universities of technology that experiences a rapid growth and that also has a bright future in store.

b) Kaduna Polytechnic

Kaduna Polytechnic was established during the colonial period in 1956, long before the emergence of universities whose mission is to train high level technical manpower in a variety of technical and professional fields. As one of the oldest polytechnics in Nigeria, Kaduna Polytechnic has trained a significant number of technicians and professionals who are performing in both public and private enterprises in Nigeria and outside the country. The Polytechnic offers undergraduate courses in 39 fields of studies ranging from science laboratory technology to computer science and fashion design. Table 1 provides basic information about Kaduna Polytechnic.

Table 1: Basic information about Kaduna Polytechnic -Academic year 2009-2010

Age of institution	55
Number of academic staff	1,377
Number of students enrolled	14,109
Number of fields of studies	39

The Kaduna Polytechnic’s total academic faculty member number (all ranks combined) and total student enrolment for the 2009-2010 academic year was respectively 1,377 and 14,109. It should be noted that students are enrolled in 39 fields of studies at the Polytechnic that is described as both a teaching and research institution.

c) Yaba College of Technology

Yaba College of Technology is one of the oldest institutions in Nigeria. Table 2 provides basic information about the College. As may be observed from the table student enrolment at Yaba College of Technology, in the 2009-2010 academic year was 9,138 students whereas

Table 2: Basic information about Kaduna Polytechnic –Academic year 2009-2010

Age of institution	64
Number of academic staff	586
Number of students enrolled	9138
Number of fields of studies	38

there were 9,138 academic staff members. It is interesting to note that Yaba College of Technology also offers a wide range of undergraduate programs ranging from food science to electrical engineering to urban planning and the like. As a technical and professional institution, its mandate in the production of knowledge may not be very articulated but its mandate as a teaching institution is well established and well recognized.

Problem Statement

In fact, the fundamental contribution science and technology as well as higher education make to the promotion of economic development in Africa and the increasingly important role they play in the knowledge economy have not been adequately documented by scholars and researchers across the continent. It is not well perceived in Africa that the accumulation of scientific knowledge and technological innovations and their practical application are a key driving force behind the significant increase in a country's economic growth. The reason African economies are not making significant progress in this direction is because of their extremely weak capability to create a critical mass of knowledge and technological innovations of all kinds that enterprises and businesses can utilize in order to develop by rationalizing their processes. Without this critical mass of knowledge Africa's economic growth will not gain impetus and the pace of its development will not in any way be optimal.

Purpose

The overall purpose of this study is to investigate how the inadequate funding of the scientific and technological institutions of higher education (faculties of science and technology, schools of engineering and polytechnics) constitutes a major impediment to the production of scientific knowledge and technological skills by these institutions.

A second purpose of this study is to bridge the gap in knowledge that exists in the exploration of the nature of the relationship that might exist between the weak volume of scientific stock institutions have developed over time and the level of financial investment made by governments and funding agencies to support knowledge production in these institutions of higher learning.

A third purpose is to raise awareness of policy makers about the importance of investing massively in scientific and technological institutions of higher education as they constitute the key driving force behind the production of knowledge, the development of skills and qualifications so critical in promoting Africa's economic growth.

Research Questions

Because of the exploratory nature of the study, research questions rather than formal hypotheses are utilized to guide the research. Thus, the section that follows includes the basic research questions guiding this study.

1. Do Faculties of Science and Technology, Schools of Engineering and Polytechnics enjoy a comfortable situation in Nigeria's higher education system with regards to infrastructures, laboratory equipment, instructional materials, adequate library resources and facilities as well as academic faculty supply and productivity, among others, that enable them to generate scientific knowledge, develop skills and promote qualifications that are required to promote the sustainable development of Nigeria?
2. Are budgets allocated by the Federal Government and other layers of authority as well as the total financial investment in this sub-sector adequate for these institutions to achieve their mission of knowledge production, skills development and the like?
3. Besides the financial constraints faced by these institutions, are there other key factors that hinder their ability to fulfil their role of knowledge production, skills development and qualifications conferral?
4. What are the possible solutions to be formulated and the strategies to be developed that enable these institutions to play their role of knowledge production and skills development among other things?

LITERATURE REVIEW

The literature regarding the development of scientific and technological skills as well as sustainable development is extensive. The flurry of scholarly works since the beginning of the 20th Century has been supplemented by a continuing flow of research. Many researchers and institutions (Bloom et al. 2006; Mugabe, 2009; the World Bank, 2009; Oladapo et al. 2010; and the United Nations, Educational, Scientific, and Cultural Organization UNESCO, 2010) have attempted to better understand the nature of science and technology, scientific and technological skills, knowledge as well as qualifications and how they relate to economic development in general. Furthermore, sustainable development has been extensively dissected in the Brundtland Report (1987) that examines its nature, constituent pillars, impact and implications for the development of Africa. Other researchers Jallow (2010), Diarra (2010), Nair-Bedouelle (2010) attempted to establish the linkage between education on one hand as well as science and sustainable development on the other hand. It is interesting to note that very few of these researchers have established the link between the development of skills and sustainable development and this exploratory study is a step in the right direction.

Knowledge production, skills development and the acquisition of qualifications are among the key mission of education as a system. Furthermore, the role and responsibilities of each level and type of education are clearly defined in the education production function. First, post primary, secondary, technical education and vocational training play a major role in the development of skills and the acquisition of middle level qualifications. Second, knowledge production, skills development and the acquisition of qualifications are among the key mission of higher education and research institutions. Third, “the key to economic success in a globalized world lies increasingly in how higher education and research institutions in the continent can significantly contribute in the production of knowledge and how effectively Africa can assimilate the available knowledge and build comparative advantage in selective areas with good growth prospects, and how it can enlarge the comparative advantage by pushing the frontiers of technology through innovation” World Bank (2008).

The building of a vibrant system of higher education geared toward the promotion of a strong knowledge base and of scientific and technological skills requires significant commitment and adequate investment in the sector as well as in scientific research by African governments in order to push the frontiers of knowledge and technological innovation. Thus, knowledge production, skills development and qualifications acquisitions become pivotal in the development process of the continent.

Africa has been dragging its feet in science policy formulation and implementation in all areas and at all levels of education. This is the reason why a remarkable imbalance exists between science and arts and humanities tracks in African educational systems. Data show that only one third (34 percent) of enrolments in Africa secondary schools are in science, technology, and mathematics (STEM) whereas two thirds (66 percent) are in the Arts, Humanities and Social Sciences (UNESCO, 2010). Furthermore, the contribution of Africa, for instance, in the area of Research and Development (R&D) that is 0so critical for creating tangible conditions for sustainable development and propelling Africa in the knowledge economy has been minimal.

Along those lines, it should be noted that faculties of science and technology, schools of engineering and polytechnics, key structures in and pillars of tertiary education are underfunded, understaffed and under resourced in the overwhelming majority of African countries even in some with a relatively strong economy. In this respect, Nigeria is a good example. As a matter of facts, Africa’s integration into the world economy depends, to a large extent, on its ability, determination and commitment to adequately invest in science and technology. Furthermore, tertiary education that constitutes the pedestal of the promotion of science and technology especially through faculties of science and technology, schools fo engineering and polytechnics has to get a reasonable amount of investment. The human capital formation is at this cost and at this cost only.

RESEARCH DESIGN/METHODOLOGY/PROCEDURES

Research Design and Methodology

The research is part of the transnational case study of Nigeria. It focuses on how the funding bottlenecks of her Universities of Technology Schools of Engineering and Polytechnics impede on the development of science and technology in these institutions. The study used a triangulation of methodology. The first phase consisted of a quantitative methodology namely

a survey questionnaire that was used to collect quantitative data including cost. As for the second phase it used a qualitative approach to collect data through interviews of the institutions' administrators in order to elicit their views, opinions and reflections about the state of science and technology in their respective institutions and the challenges they face regarding the promotion of science, technology and engineering in their faculties, schools and polytechnics. It should be noted that because of time constraints the qualitative phase of the study did not materialize as it was planned by the researcher. Nonetheless, email exchanges and phone conversations complemented, to a large extent, the limitations of the survey instrument that was administered to the sample of the Directors of the institutions.

Instrumentation and Measurement

An instrument, the Higher Education Stakeholders' Survey (HESS) was developed in November 2011 to collect data from the heads of the concerned institutions in Nigeria. It was emailed to the heads of institutions who were instructed to fill it in and return it to the researcher within a period of two weeks. This operation was not readily done and the submission of the filled questionnaire dragged on till early December for the Kaduna Polytechnic and Yaba College of Technology and mid early January 2012 for the University of Abuja's School of Engineering. Contacts with the Dean of the School of Engineering of the University of Abuja were unsuccessful and the Vice-Chancellor of this institution has to step in as a last minute resort in order to complete the survey questionnaire and submit it at last. This situation considerably delayed the completion of the study within the specified deadline.

In developing HESS, items relative to the institution's profile, student body, faculty number and productivity, availability of equipment and instructional materials, funding and other factors impeding the production of scientific and technological knowledge were identified and selected in a multi-stage process. The first stage was conceptualization. Second, an initial pool of twenty items was selected. These twenty items were those which, in the researcher's judgment and following extensive reviews and synthesis of pertinent literature best represented the relevant features about various dimensions of the production of scientific knowledge, technological skills and qualifications in Higher Education Institutions (HEIs). Third, the HESS is included as Appendix A. The question format for each of the questionnaire item although open ended produced, strikingly, uniformed responses across all three respondents. I should be noted that this state of affairs considerably facilitated data analysis.

Data Collection procedures

The research procedures are a critical stage in undertaking the study in Nigeria. In this respect, as a matter of principle, the endorsement of the education authorities of Nigeria to carry out the research was sought. A letter describing the major objectives of the study, its significance for the educational systems of Nigeria and the ADEA Triennale was drafted by the ADEA Executive Secretary and dispatched to the Nigerian Federal Minister of Education through the Federal Ministry of Education Director for Tertiary Education. The basic purpose of this letter was to secure cooperation from the Nigerian officials at all levels and gain their endorsement of the study. In her response dated October 2011, the Federal Minister of Education officially endorsed the case study through an endorsement letter that was sent to the ADEA Executive Secretary. This endorsement enabled the researcher to establish preliminary contacts with the Director of the National Board of Technical Education (NBTE) and head of the Kaduna Polytechnic as well as a senior staff member of the Nigeria National Universities' Commission (NUC).

It should be noted that the Director of Tertiary Education played a pivotal coordination and facilitation role between the researcher and the institutions' representatives. Because of serious communication issues no formal contact could be established with the Dean of the School of Engineering of the University of Abuja. Therefore, the Vice-Chancellor of this institution has to step in for his institution. He readily played the role of a focal point and helped his institution come on board even if this initiative was taken at a very late stage of the process that is January 2012. Nonetheless, his involvement facilitated, to a great extent, the processing of the survey questionnaire and led this institution as a science and technology school to be now part of the study sample.

The second phase of the study was a field visit to Nigeria. Because of time constraints linked to various holidays' celebrations especially the Moslem Eid El Adha, it was not possible to schedule campus visits of the School of Engineering of the University of Abuja as well as the Kaduna Polytechnic and Yaba College of Technology. This situation neither constituted a major handicap nor affected the data collection procedures in a negative way. Meetings were instead called with the Head of the NBTE (as well as Director of the Kaduna Polytechnic), the representatives of the NUC and the Federal Ministry of Education. All these meetings were held in Abuja. Furthermore, meaningful interactions took place through email exchanges and phone calls between the researcher and all the parties involved in the study. These channels of communication were very effective and considerably smoothed out the study implementation process. The quality and the frequency of the interactions whenever I was in Abuja were good but a lot of time was eventually lost in the process. This negatively impacted the completion of the study within the scheduled period of time and created some tensions between the researcher and the thematic coordinator.

Sample

The initial sample of the Nigeria case study consisted of two institutions: The School of Engineering of the University of Abuja and the Kaduna Polytechnic. It also comprised their heads. The reason why the School of Engineering of the University of Abuja was selected is because the combination of a highly academic institution with a practical type of institution notably a Polytechnic would be the best way for addressing the issue of knowledge production and skills development by HEIs at hand. Incidentally, Yaba College of Technology in Lagos, the oldest institution of this type in the country, was selected by the NBTE Director with the consent of the researcher and added to the study sample. Therefore, the final sample size of the study comprised one school of engineering, one polytechnic and one college of technology. It should be noted that no formal contact was established with the head of the Yaba College of Technology in Lagos.

As for the sample size of the institutions' administrators, it consisted of the Vice-Chancellor of the University of Abuja representing the Dean of the School of Engineering of his institution, the Director of the NBTE and head of Kaduna Polytechnic. Thus, in the final analysis, it should be noted that the total sample size of the study increased to three as the Director of Yaba College of Technology was added to the two heads of institutions. The study was conducted in December 2011 and January 2012. Furthermore, the bulk of the study data collection took place between December 2011 and January 2012 in Nigeria.

DATA ANALYSIS TECHNIQUES

Appropriate quantitative data analysis techniques were used to analyze the data collected. These analysis techniques were consistent with the cost analysis techniques commonly used (examination of budgets allocated to the institutions). For quantitative data analysis, descriptive statistical analysis was utilized. Simple percentages, means and frequency counts were sometime produced because of the specific nature of the research undertaken. It should be noted that the study is primarily an exploration research about the funding bottlenecks of the colleges of science and technology, schools of engineering and polytechnics in Nigeria as an impediment to the production of scientific and technological knowledge in Nigeria. As no formal interviews were conducted with Directors of institutions, no particular qualitative data analysis techniques were utilized to analyze the data. However, whenever this was deemed necessary, opinions, points of views and observations of the stakeholders were taken into consideration and included in the study findings. The bulk of the results/findings of the study are based on the information provided by the respondents in the survey questionnaires. This does not make the study an entirely quantitative piece of research but reinforces, nonetheless, this notion.

RESULTS

This section deals with the results of the case study that are exclusively based on the information provided by the respondents in the survey questionnaire. It comprises the survey return rates, the item response rates as well as the results of the research questions that were part of the survey questionnaire.

Survey and Item Response Rates

The survey response rate was 100 percent. All three heads of the institutions selected provided a filled survey questionnaire. However, it should be pointed out that not all the three heads of institutions provided complete and adequate responses to all the questionnaire items. Whereas this response rate was 99.95 percent for the Kaduna Polytechnic, it was 60 percent for Yaba college of Technology and the University of Abuja's School of Engineering respectively. These figures are acceptable and do not affect the validity of the study as the percentage of questionnaire items' responded is reasonable to draw valid conclusions from the study. The limit accepted to validate a study based on this level of response rate is generally 50 percent.

Research Questions

Four research questions were formulated to guide the analyses in the study. The first research question focused on the critical assessment of the enabling environment (capability) in which these Nigerian scientific and technological institutions operate that constitutes a basic prerequisite for them in the achievement of their mission of knowledge production, skills development and qualifications provision. Research question two focused on the relationship that may exist between the level of investment especially budgetary allocations made in this sub-sector of higher education and its intended consequences on knowledge production, skills development and qualifications provision in Nigeria. Research question three focused on the

identification of other potential factors along with underinvestment in the sub-sector that are also important explaining factors for the inability of these institutions to achieve their objectives of knowledge production and skills development in Nigeria. Finally research question four focused on the identification of the solutions to the various issues as well as the formulation of strategies in order to tackle the key issues identified as hurdles to overcome. The results of the analysis for each research question are presented below.

Research Question # 1:

Research question # 1 asks, Do Faculties of Science and Technology, Schools of Engineering and Polytechnics enjoy a comfortable situation in Nigeria's higher education system with regard to infrastructures, laboratory equipment, instructional materials, adequate library resources and facilities as well as academic faculty supply and publications, among others, that enable them to generate scientific knowledge, develop skills and promote qualifications required to boost the sustainable development of Nigeria?

The analysis of the data provided demonstrates that no definite conclusions can be drawn for the College of Engineering of the University of Abuja and Yaba College of Technology because the respondents (heads of institutions) did not provide, for some reason, answers to the majority of questionnaire items in this part of the survey instrument. However, regarding the academic faculty's degree of involvement in knowledge production activities measured by the number of annual publications (books and journal articles) and presentations at conferences both national and international conferences, the figures are impressive. Table 3 provides data about the faculty's level of productivity at Yaba College of Technology. Data regarding, the number of patents from the same institution, are not available. A total of 73 books and 672 journal articles were produced in the 2010-2011 academic year. This gives an average of .12 book and 1.15 journal article per faculty member and per year. As for conference paper presentation, 626 papers were presented in 2010-2011, that is an average of 1.07 participation per faculty member.

Table 3: Basic information about Yaba College of Technology Academic Faculty Level of Productivity for the 2010-2011 Academic Year

Type	Books	Conference Paper	Journal Article	Patent	Academic Faculty Staff
Number	73	626	672	N/A	586

Regarding Kaduna Polytechnic, the answers provided suggest that this institution does not fulfil its knowledge production and skills development mission even if the situation is better as far as promoting qualifications. Data provided show that Kaduna Polytechnic's annual academic publications totals only seven (7) and that it did not produce any patent for the 2010 academic year. Besides, data further reveal that no enabling knowledge production environment exists as the lack of in-house training through workshop and seminars, and inadequate library facilities such as e-library, inadequate quantity and quality of books and journals, and obsolete equipment are cited as negative factors the institution is faced with.

Research Question # 2:

Research question # 2 asks, are the budgets allocated to these institutions as well as the total financial investment made in this sub-sector that deemed adequate to effectively achieve their mission of knowledge production, skills development and the like?

With regard to budgetary allocations and financial investment, all three respondents (heads of institutions) provided information that is usable. Table 2 provides data that show the total budgetary allocations for the three institutions. Data further reveal that these budgetary allocations encompass three categories of expenditure: personnel, overheads and capital outlay for three consecutive years: 2010, 2009 and 2008.

As may be observed in Table 4, data demonstrate that budgetary allocations to the institutions significantly increased from 2008 to 2010 in nominal terms for all the institutions with the exception of the University of Abuja whose allocation decreased in 2009 as compared to 2008. The most significant change occurred at Kaduna Polytechnic whose budget rose from 3.9 million US Dollars in 2008 to nearly 412 million US Dollars in 2010, nearly a fourteen fold increase over just a three year period of time. There are variations between institutions regardless of their type, mission, student body and academic faculty number as well as within institution disparities relative to type of expenditure (personnel, overhead and capital outlay) for the three year period under review. For example, with the exception of Yaba College of Technology, the variations within the two other institutions are quite significant. An examination of the data in subsequent tables relative to institutions considered separately provides the appropriate answers to the interrogations one may have about the budget allocation issues.

Table 4: Budgetary allocations to the Three Selected Institutions for 2010, 2009 and 2008 (in US Dollars) *

Institution	Abuja University	Kaduna Polytechnic	Yaba College
Year			
2010	23,008,598	41,706,963	19,088,233
2009	17,981,659	6,427,880	19,194,383
2008	22,5489,610	3,903,392	20,113,196

* The official exchange rates used are 130 N for 2008, 140N for 2009 and 150 N to the US Dollar for 2010

As may be observed from Table 5, the budget allocated to the University of Abuja declined sharply in 2009 and increased significantly in 2010. Due to the lack of consistent data, it is difficult to explain the reasons for this significant decline in 2009. Further research is warranted in order to better grasp the causes of this situation. It should be noted that this budget comprises the recurrent expenditure and capital outlay and does not take into account the overhead costs.

Table 5: Breakdown of budgetary allocations to University of Abuja for 2010, 2009 and 2008 by expenditure purpose (in US Dollars)

Type of expenditure	Personnel	Overheads	Capital Outlays	Total
Year				
2010	Inclu in the total	N/A	Indu in the total	23,008,598
2009	Inclu in the total	N/A	Indu in the total	17,981,659
2008	Inclu in the total	N/A	Indu in the total	22,5489,610

As data provided in Table 6 show, Kaduna Polytechnic's total annual budgetary allocations rose from 3.9 million US Dollars in 2008 to nearly 42 million US Dollars in 2010. The key factor driving the budget up is personnel costs that increased from only 340,879 USD in 2008 to nearly 40 million USD in 2010. As for the institution's capital outlay budget, it steadily decreased from over 2 million USD in 2008 to only 678,707 USD in 2010, a 34 percent decrease over a three year period of time. As for the overhead costs, they have remained fairly stable over time at Kaduna Polytechnic although a slight decline was observed in their amount in 2010. It should be pointed out that Kaduna Polytechnic is a big institution with a significant student body and academic faculty size. This factor may have come into play in allocating funds to the institution.

Table 6: Breakdown of budgetary allocations to Kaduna Polytechnic for 2010, 2009 and 2008 by expenditure purpose (in US Dollars)

Type of expenditure	Personnel	Overheads	Capital Outlays	Total
Year				
2010	39,581,549	1,446,707	678,707	41,706,963
2009	3,736,036	1,565,700	1,126,143	6,427,880
2008	340,879	1,557,215	2,005,298	3,903,392

The data in Table 7 suggest that the budgetary allocation to Yaba College of Technology has slightly declined from 20 million USD in 2008 to 19 million USD in 2010. With the exception of personnel costs that increased from 17 million in 2008 to nearly 19 million in 2010, capital outlay declined dramatically and overhead costs also observed a slight decline over the period of time under consideration.

Table 7: Breakdown of budgetary allocations to Yaba College of Technology for 2008, 2009 and 2010 by expenditure purpose (in US Dollars)

Type of expenditure	Personnel	Overheads	Capital Outlays	Total
Year				
2010	18,881,958	1,141,119	859,255	19,088,233
2009	17,607,463	1,111,480	475,440	19,194,383
2008	17,117,729	1,273,901	1,721,566	20,113,196

Despite these allocations that seem very high, it should be noted that all the respondents agree that funding is a key impediment in the production of knowledge, development of skills and promotion of qualifications. They all unanimously proposed that current budgetary allocations to their respective institutions be increased by at least 50 percent to adequately meet the real cost of undertaking knowledge production activities in their institution; For example, one head of institution ever suggested that a total amount of 40, million US Dollars be allocated to his institution on a yearly basis.

As a whole, concerning the three science and technology institutions under study in Nigeria, there is need, in order to get to a better understanding of funding as a key impediment to the production of scientific knowledge, the development of skills and the conferral of qualifications to take this investigation to another level as a future direction for research. Thus, more research is needed to further unveil the relationship between underinvestment and under financing of scientific institutions and the level of production of scientific knowledge.

Research question # 3:

Research question # 3 asks, Besides the financial constraints faced by these institutions, are there other key factors that hinder their ability to fulfil their role of knowledge producers, skills developers and qualifications promoters?

Findings suggest a striking convergence of the answers provided by all three respondents to this research question. This convergence strongly shows the great communalities between issues in most of these types of institutions across Nigeria. The following factors were identified and rank ordered by importance by the respondents as major impediments to the production of knowledge, development of skills and conferral of qualification in their institutions.

- a) Inadequate structures and facilities like electricity and ICT
- b) Political interference and inconsistent educational policies and strategies
- c) Inadequate human capacity
- d) Space constraints
- e) Power outage
- f) Obsolete equipment and laboratories

Research questions #4 asks, what are the possible solutions that can be formulated and the strategies to be developed that enable these institutions to play their role of knowledge production and skills development among other things?

Among the solutions and strategies identified by the respondents the following were cited as the most crucial ones:

- a) Provision of adequate budgetary allocation to the institution
- b) Provision of adequate fund for research in science and technology
- c) Diversification of funding sources

- d) Provision of adequate modern e-libraries, laboratories, machines and equipment
- e) Development of human capacity by implementing professional development initiatives such as workshops, participation in international conferences and presentation of research papers at these gatherings
- f) Provision of enabling and conducive working environment to motivate staff and enhance productivity
- g) Resuscitation/intensification of sponsorship/funding of both national and international seminars
- h) Encouragement of staff to get more involved in exchange programs between institutions and related industries both within and outside the country
- i) Develop further the public-private partnership that should enhance the collaboration between business and academia and push them to work closely in an effort to initiate together innovative programs.

It was pointed out that since the solution to these issues hinges virtually on the need for adequate financing for the institutions and especially their knowledge production and skills development tools and equipment, and given the public nature of these selected institutions the Federal Government of the Nigeria should resolve to commit the UNESCO and the African Union recommended 25 percent of its national budget and at least 5 percent of its Gross Domestic Product (GDP) to the funding of education. As for the private sector, it should intensify its contribution to the financing and development of skills and competencies. The bottom line is that all hands must be on deck. Attitudinal change concerning increased responsibility in the financing of education in Nigeria is needed on the part of all stakeholders. It is a fundamental belief that the funding of education is the primary responsibility of the government but it is also true that all the various stakeholders, the private sector, the communities, the students and the households should contribute to the effort of financing education. This type of concerted effort is the fundamental condition for the success of this type of operation.

CONCLUSIONS/DISCUSSIONS/IMPLCIATIONS

At a time when the world is increasingly becoming globalized, the wealth of nations does no longer depend on the quantity of physical capital available in a country but rather on the quality of the “capacity skills” such as higher quality cognitive, mechanical, industrial, technical, technological, communication, team, and organizational that tertiary education inculcates in people. This stock of knowledge, skills and qualifications is built by training institutions of science and technology, schools of engineering and polytechnics in Africa.

The study makes a strong case that underinvestment in science and technology institutions, schools of engineering and polytechnics in African countries is a major cause of the impediment to knowledge production and skills development that are so instrumental for sustainable development. It also makes a strong case that if this investment is not adequate Nigeria, knowledge production will be limited and the country’s quick integration into the knowledge economy will be in jeopardy. In the final analysis, the study attempts to investigate the funding situation of science, technology and engineering in Nigeria to better

explore the relationship between underfunding of science and technology and sustainable development from both a theoretical and practical standpoint.

From the perspective of the respondents, the gap in funding of the scientific institutions of higher education in Nigeria affects the level of knowledge production and skills development on these institutions in the following way:

- ◆ Shortage of funds serves as impediment for the provision of laboratory/workshop equipment and machines for students practicum
- ◆ It thwarts the training of staff within and outside the country
- ◆ It serves as an impediment to the dissemination of knowledge and research findings in the institution
- ◆ It hinders the provision of adequate Information and Communication Technology (ICT) facilities
- ◆ It reduces the chances of the provision of recreational facilities which affect the psycho motive activities of both staff and students

Discussions of Findings

The research impetus of this study centered around the perceived need for an increased investment in institutions of science, technology, schools of engineering and colleges of technology in Nigeria whose contribution to the knowledge economy is crucial. More investment in higher education means more provision of quantity and improved quality of services including those relative to science and technology.

Second, it appears that more investment in science and technology institutions puts them in a better position to produce the type of quantity and quality knowledge, develop skills and others that are so critical to the sustainable development of Nigeria and in propelling her in the knowledge economy. Moreover it equips her to be more competitive in a globalized 21st century world.

Third, the government may want to make tough choices between a massive investment in higher education and especially the sub-sector of science, technology and engineering and the country security which is gradually becoming a paramount national policy issue given the fact that the biggest chunk of the 2012 federal budget is allocated to security and the debt service at the expense of education and other social services for instance.

Four, the study demonstrates how underinvestment in science, technology and engineering negatively impacts knowledge production and thwarts skills development and the promotion of scientific and technological skills in Nigerian HEIs resulting in a significant delay in achieving the objectives of sustainable development.

Five, the study is both a theoretical and practical contribution in expanding the nomological network (that is our knowledge base) of the relationship between knowledge production, skills development, scientific and technological skills and sustainable development in Nigeria.

Finally, the study may also help raise decision makers' awareness about the importance and relevance of investing more in STE to enable African countries in general and Nigeria in

particular to build a critical mass of scientists, engineers, and mid-level professionals to stimulate innovation, promote the diversification of products and services, and maximize returns from capital assets through more efficient allocation and management that will constitute a boost to sustainable development and therefore to economic growth and a better integration of Africa into the knowledge economy.

Implications of Findings

The results of this study when viewed within existing literature on knowledge production, skills development along with sustainable development suggest a number of important implications both for theory and practice that need to be further considered in future studies of the financing of higher education as an impediment to knowledge production and skills development in science and technology institutions in Africa in general but in Nigeria in particular.

First, from a theoretical perspective, it is possible to examine the linkage between financing, knowledge production and skills development within a conceptual framework to understand the nature of this relationship.

Second, from a practical perspective, the usefulness of examining the financing of higher education as an impediment to knowledge production and skills development provides a powerful cadre for better resources allocations policies and strategies as well as their optimal utilization for achieving both the objectives of higher education science and technology institutions as well as those of the sub-sector as a whole.

Third and finally there is need to rethink higher education financing in Nigeria and consider a formula that allocates more resources to the institutions of science, technology and engineering with the view of ensuring that they fulfil their critical mission of knowledge production and skills development to further propel the economic development of the country and reverse the trend of humanities, arts and social science students outnumbering those of science, technology, engineering and mathematics in African schools and colleges and universities for the production of a critical mass of scientists who will boost the development of the African continent.

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