1. LINKS BETWEEN ENGINEERING TRAINING PROGRAMMES IN TERTIARY INSTITUTIONS AND GRADUATES' PRODUCTIVITY IN NIGERIA

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Abstract

To understand the linkages between engineering training programmes in tertiary institutions and graduates' productivity in Nigeria, researchers worked with 366 students, randomly selected from the University of Lagos (Unilag) and Yaba College of Technology (Yaba Tech) in the South, and Ahmadu Bello University (ABU) and Kaduna Polytechnic in the North. Data was collected on the levels of professional competencies of the students outside the classroom, in relation to participation in practical training. The study indicates that Nigerian engineering curricula are too loaded and rigid, and the content of training had little relevance to employment. This may not be surprising in a situation where there are hardly enough funds to maintain engineering laboratories and lectures are more theoretical than practical. In the light of the foregoing, authors recommended that 1/ student be exposed to more practical sessions to make them relevant to national development and 2/ tertiary institutions' engineering curricula be revisited to make them relevant to the labour market, thus easing access to employment for learners.

Key words: links, engineering training, tertiary institutions, and productivity.

Résumé

Pour comprendre les liens entre les programmes de formation d'ingénieur dans les institutions d'enseignement supérieur et la productivité des diplômés au Nigeria, les chercheurs ont travaillé avec 367 étudiants, sélectionnés au hasard à l'Université de Lagos (Unilag), à l'Institut universitaire de technologie de Yaba (Yaba Tech) dans le Sud, à l'Université Ahmadu Bello (ABU) et l'Ecole polytechnique de Kaduna au Nord. Les données ont été collectées par rapport aux compétences professionnelles des étudiants en dehors des classes, en relation avec leur participation à la formation pratique. L'étude a montré que le programme d'études des ingénieurs est surchargé et rigide. Par ailleurs, le contenu de la formation n'est pas suffisamment pertinent pour permettre une insertion professionnelle réussie. Ceci ne peut être surprenant dans un contexte où il n'y a pas de fonds pour assurer le maintien des laboratoires d'ingénieur et les cours sont donc plus théoriques que pratiques. A la lumière des faits suscités, les auteurs

recommandent que : 1/ les étudiants soient plus exposés aux sessions pratiques pour être indispensables au développement national et 2/ les programmes des institutions d'enseignement supérieur d'ingénieurs soient revus pour les rendre pertinents pour le marché du travail et faciliter ainsi l'accès des apprenants à l'emploi.

Mots clés : liens, formation d'ingénieurs, institution d'enseignement supérieur, productivité

Context and statement of the problem

Nigeria has a lot of natural and human resources and has invested significantly to set up institutions of higher learning and faculties of engineering. At present, Nigeria can boast of federal and state universities, colleges of technology and polytechnics. The last administration in Nigeria licensed private universities to complement state and federal efforts. Thus, 70 universities and colleges of technology and polytechnics in Nigeria (government and private owned) offer engineering courses and graduate 39 200 engineers annually.

In spite of the number of engineers produced annually, the country is yet to establish itself in engineering fields. Mechanical engineers in the country cannot produce an automobile. Electrical engineers have not been able to find lasting solutions to non-existent power supply in some areas and epileptic supply in others, after so many years of independence. Nigerian chemical engineers are unable to build, operate and maintain our oil refineries. The steel industry is in a comatose state. The country hardly has a fully indigenous construction company capable of building roads, bridges, high-rise buildings and so on. Expatriates continue to lead in the execution of most engineering works. These realities have adverse effects on economic development of communities and the entire nation.

Ideally, engineering education is to provide skilled manpower for economic and technological development of any nation (Mbanefoh, 1992; Oni, 1999b). However, in Nigeria when locally trained engineers are employed, they usually go through training within the company and outside the country before they are assigned any significant roles (Ogunbayo, 1995). Engineering graduates in other African countries also lack enough practical training to enable them to cope with economic and technological development. As a result, many are underemployed or unemployed. In Dar es Salaam for example, locally trained engineers have to go through retraining programmes before they are given technical assignments (Halfani, 1995). In Kenya, locally trained engineers also need to be retrained to be able to measure up to the standard of foreign trained ones (Otieno & Luti, 1995).

The questions that arise are as follows: What is actually wrong with engineering training in Nigeria? Why are we not making tangible marks in engineering in Africa even with our population that accounts for about a quarter of the continent's total? Where are we missing it? Does it mean our curricula are more theoretical than practical? Do we need to retrain our engineering lecturers? Are there enough funds to carry out such modifications effectively?

Is there a gap between engineering training programmes in Nigerian tertiary institutions and graduates' professional competencies vis-à-vis their relevance in the employment market? There has been and still is great controversy regarding the level of practical development of engineering students in Nigeria. Many believe that Nigerian engineering students do not posses enough practical skills to make them functional enough to take up a job upon leaving school.

This study is aimed at ascertaining the scientific basis for these speculations and proffering solutions where necessary, by carrying out an empirical assessment of the relationship between engineering students' practical exposure and their productivity outside the classroom.

Research questions

The study was guided by the following research questions:

1. Are the present engineering curricula in Nigerian tertiary institutions suitable for students' productivity?

2. Do Nigerian engineering students have enough practical sessions to allow for effective productivity in relevant engineering activity outside the classroom?

Research hypotheses

1. The number of laboratory practical sessions provided for engineering students in Nigerian tertiary institutions will not significantly influence their productivity outside the classroom.

2. The present engineering curricula in Nigerian tertiary institutions will not significantly influence the productivity of learners outside the classroom.

Theoretical framework and literature review

Our analysis is based on the premise that learning lasts longer when it appeals to the senses of the students. According to Kidd (1977), students who are able to 'practicalize' learning are more productive than those exposed only to theoretical learning. Thus, we infer that engineering training will be more effective when learners are more engaged in practical exercises.

The role of engineering and technology as agents of societal development in Africa in general and in Nigeria in particular cannot be underestimated (Dahlman, 1989). Oboho (2001) identifies university and technology education as the formal routes at the tertiary level to training of engineering manpower. However, scholars observe that engineering education in Nigeria does little to impart the qualities required of a good engineer (Akintunde, 1994; Oboho, 2001; Oluwande, 1997). According to them, the training of engineers in Nigerian tertiary institutions is saddled with a lot of problems such as poor foundations for engineering education, poor funding, lopsided admission requirements, poor curriculum, poor academic leadership, and deficient industrial training programmes, among others. These problems inhibit the training and actual performance of Nigerian engineers.

Thus, an average engineer trained in a Nigerian university has to undergo re-training within or outside Nigeria for better employment in engineering firms (Dalbalen et al., quoted in Oni, 1999b). As a result, an average engineering firm usually prefers foreign trained engineers to indigenous trained ones, making the latter under-utilized (World Bank, 1996). This under-utilization has caused Nigeria to remain underdeveloped (Oni, 1999a).

Oni's (1999b) study revealed that Nigeria requires proper and comprehensive technical and engineering training capacity for the global competition of the twenty-first century. The Nigerian government recognizes the development of science, technology and engineering as a matter of national policy. However, the existing research centres and university engineering and technological departments face problems that affect their performance. Oni identified some of the problems as lack of funds, "brain drain," lack of technological development and more importantly lack of practical experience. This also explains why most Nigerian trained engineers are less productive than their foreign counterparts.

Oni (1999b) suggested that for Nigerian trained engineers to be productive; there is need for an appropriately designed institutional framework and policy environment where university laboratories and private sectors are encouraged to build a network of information and personnel exchanges.

There is no doubt that Nigeria has the resources for industrialization. However, poor managerial capacity and weak technological institutions constitute major constraints. Nigeria's revision of educational policy has not been so effective in engineering departments in Nigerian universities owing to governmental bureaucracy, which usually results in well-intentioned policies by government though, producing undesired outputs (Dahlman, 1989).

One of the main ways by which universities contribute to national development is through production of a corps of highly skilled personnel in engineering, sufficiently exposed to scientific research to generate new knowledge and innovations to solve national problems (Oni, 1999b).

Research methodology

Our study employed survey techniques to gather data to assess the level of productivity of engineering students in Nigeria.

For purposes of the study, Nigeria was divided into three zones according to her ethnic groups and dominant languages. The three zones were the northern zone, the south-western zone and the south-eastern zone. Universities and colleges of technology in these zones were to be equally involved in the study. Necessary letters of introduction and acceptance had already been obtained for their involvement before the national strike of academic staff of universities that was sympathetically joined later by the academic staff of Nigerian polytechnics. The students were away from school for five months as a result of the strike. This greatly affected the collection of data for the study.

However, the strike did not start at the same time in all the institutions. The northern zone and southwestern zone were involved in the study because of their late involvement in the strike, while the Southeast could not be reached at all because they joined the strike earlier. The researchers had to involve research assistants to hasten the collection of data before the open institutions eventually joined the national strike and this increased the financial obligations pertaining to the study, limiting the number of institutions involved.

Population

Nigeria has 19 federal universities, three federal universities of agriculture, six federal universities of technology and 26 state universities. Of all these, 37 offer engineering courses and 33 private universities also offer engineering courses. The target population for the study comprised all engineering students.

Sampling

The stratified random sampling technique was used to select 366 engineering undergraduate students (267 males and 99 females) from universities and polytechnics. Though the research was meant for the three dominant ethnic groups in Nigeria, namely the North, Southwest and Southeast, only universities in the Southwest and the northern states were

involved because of the national strike of academic staff at universities mentioned earlier. On the whole, two universities and two polytechnics from the north and southwest Nigeria were involved in the study. These included the University of Lagos; Ahmadu Bello University, Zaria; Kaduna Polytechnic; and Yaba College of Technology, Akoka. See table 1 for the number of students selected per institution.

The lists of names of students from relevant departments were collected from their Heads of Departments (HODs). Names of all male students on odd numbers were randomly selected from the lists. It was difficult to randomly select the female students because they were very few. So, all the female students were involved in the study except at University of Lagos where the last two names on the list were dropped because those students were not present on the day the researcher visited their school.

Table 1: Number of students selected per institution

Institution	Number of students selected
University of Lagos	139 (38%)
Ahmadu Bello University	81 (22%)
Yaba College of Technology	87 (24%)
Kaduna Polytechnic	60 (16%)
Total	**365**

The study focused on the third and fourth year students in the department of Electrical Electronics and Food Technology only. Students in the third and fourth year were involved because of their level of maturity in the course and their compulsory participation in Industrial Training (ITA) programmes. The researchers intended to involve chemical engineering students but the five-month national strike of academic university staff in which students were sent home made this impossible.

The universities that were involved in the study were consulted shortly before they decided to join the strike. The selected polytechnic and college were actively in session.

Data collection

Structured interview questions were developed, validated by experts at the Faculty of Education, University of Lagos, and heads of departments were asked to ascertain the status of the target faculties in terms of their accreditation and available facilities. Questionnaires were administered to students.

Students' productivity was measured in the way they handled their professional engagements during their compulsory Industrial Training (ITA) programme. Students were treated like professionals during the training programme and were assigned activities to measure their productivity.

Results

The data collected from the study was analysed using quantitative approaches and descriptive statistics. The X2 was used to ascertain the degree of influence of students' involvement in practical exercises and curricula relevance on students' productivity outside the classroom.

The results obtained are presented in tables 2 through 4. On the productivity criterion, students who were able to handle relevant engineering assignments outside the classroom during industrial training (ITA) were classified as highly productive. Those who attended retraining courses for about two weeks before they could handle their assignments were regarded as being averagely productive, while those who had to undergo retraining courses for at least two months (out of their six months of industrial training) before handling relevant assignments were regarded as having low productivity.

In the same vein, respondents' level of laboratory and practical participation were measured in terms of how many times they attended practical sessions in a week. Once per week attendance was low, 2 to 3 times a week was average, and four times and above a week was considered high participation.

Table 2 : Students' level of participation in engineering laboratory practical in tertiary institutions and their level of productivity outside the classroom

Participation in practical	Students' productivity Outside the class			Total
	Low	Average	High	
Low level of participation	151	81	18	250 (69%)
Average level of participation	41	31	16	88 (24%)
High level of participation	8	10	7	25 (7%)
Total	200 (55%)	122 (34%)	41 (11%)	363

A close look at the data presented in table 2 shows that 69% of student respondents claimed low-level participation in laboratory practical during training while only 7% claimed high-level participation. Outside the

classroom, 55% of students had low productivity while only 11% were highly productive, indicating some relationship between participation in practical sessions and productivity outside the classroom.

Table 3 : Load of Nigerian engineering curricula in tertiary institutions and students' level of productivity outside the classroom

Relevance of engineering curriculum load	**Students' productivity Outside the class**			**Total**
	Low	**Average**	**High**	
Irrelevantly loaded	122	96	32	250 (69%)
Relevantly loaded	78	26	9	113 (31%)
Total	**200 (55%)**	**122 (34%)**	**41 (11%)**	363

Table 3 shows that 250 or 69% of student respondents claimed that their training curricula were irrelevantly loaded. Out of these, 122 (49 percent) had low productivity, 96 (38 percent) demonstrated average productivity, and 32 (13 percent) were highly productive.

Also, 113 or 31% of student respondents claimed that the curricula were relevantly loaded. Out of this number, 78 (69 percent) had low productivity, 26 (23 percent) demonstrated average productivity, and 9 (8 percent) were highly productively.

Test of the hypotheses

The hypotheses postulated in the study were tested using 2 statistics. Two null hypotheses were postulated for the study. The results are summarized in table 4 below.

Table 4 : Association between learners' productivity and two other variables

Variable compared	χ^2 Calculated	Critical value	Df	P < 0.05	Significance
Participation of students in laboratory practical	19.2	9.488	4	0.05	Significant
Relevance and load of engineering curricula in Nigerian tertiary institutions	12.04	5.911	2	0.05	Significant

The result presented in table 4 shows that the two hypotheses were very significant because the values of the computed □2 of 19.2 with the critical value of 9.488 and 12.04 with critical value of 5.911 were significant, so the hypotheses were rejected.

The hypotheses rejected were:

1. The number of laboratory sessions provided for engineering students in Nigerian tertiary institutions will not significantly influence their productivity outside the classroom.

2. The present engineering curricula in Nigerian tertiary institutions will not significantly influence the productivity of learners outside the classroom.

The rejection of these hypotheses means that the number of laboratory practical sessions provided for engineering students as well as the relevance of engineering curricula do significantly influence students' productivity outside the classroom later. Many of the students recorded low productivity because they had low participation in practical sessions.

Discussion of findings

Of the 7% of respondents who claimed that they had high level of participation in laboratory practical sessions in their training, 28% demonstrated high productivity during their industrial training. Out of the 69% percent of respondents with low-level participation in practical, only 7% demonstrated high productivity. Of those who claimed low-level participation in practical, 60% also recorded low productivity, while only

32% of those who claimed high -level participation in practical recorded low productivity.

The study suggests that students' level of participation in practical training influences their productivity, thus confirming Oboho's (2001) study, which mentions that the lack of practical training in technical and engineering departments is one of the major problems facing Nigerian research centres and universities.

The study confirms Oni's findings (1999b) that argued that the revision of Nigeria's educational policy has not positively impacted engineering departments in Nigerian universities. This is mainly due to governmental bureaucracy and bottlenecks regarding university curricula.

On the whole, most Nigerian trained engineers' questioned (55 percent) demonstrate low levels of productivity outside the classroom and most of them (69 percent) had participated about once a week in laboratory practical. Indeed, owing to the high number of students in a class, they are usually divided into five groups for practical and each group is expected to participate in practical exercises in the laboratory, once a week.

From all indications, Nigeria needs more effective engineering curricula and training for effective participation in developing national and global technology.

Recommendations

The study established that engineering students generally recorded low productivity in handling engineering activities outside of the classroom, because of their low participation in practical sessions during training. Therefore, it is recommended that the Nigeria National University Commission (NUC) make it mandatory for every engineering department to engage their students in laboratory practical, at least four times a week. The Nigeria's engineering curricula are usually irrelevantly loaded, so NUC needs to really involve all stakeholders (university lecturers, engineering firms, students, etc.) in developing more results-oriented curricula that would be useful for developing the entire nation.

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