

Engineering and Related Programs' Teaching Methods in Nigeria

Terungwa Stephen Akor, Kamalularifin bin Subari, Hanifah binti Jambari, Muhammad Khair bin Noordin, Igogbe Regina Onyilo

Abstract: *The failure of engineering education in Nigeria has been blamed on many factors from various research findings. To have an in-depth view of some of the problems, this study reviewed research findings on the methods of teaching engineering and related programs in Nigerians institutions of learning. The study reviewed articles and theses on teaching methods in Nigeria, skills need of the 21st century and the 4th industrial revolution, and how the existing teaching methods impart the needed skills. The review showed that: the most popular teaching methods of teaching engineering and related programs in Nigeria are lecture method, laboratory experiment, field trip and final year practical project; the skills that the 21st century industry and 4IR demand are critical thinking, innovation and creativity, problem solving, teamwork, life-long learning, and communication skills; the teaching methods employed in Nigeria are not able to impart the needed skills. The researchers, therefore recommended innovative, students centered learning like problem based learning, project based learning, inquiry based learning and well as effective utilization of instructional resources like multimedia, simulations and virtual laboratory for the teaching and learning of engineering, science and technology programs.*

Index Terms: *Employability Skills, Engineering Education, Teaching Methods in Nigeria, Twenty-First Century Skills.*

I. INTRODUCTION

Engineering education, just like any form of education is aimed at preparing students who upon graduation should be able to solve the problem of their immediate as well as the wider society. To this effect, it is expected that the teaching and learning environment should be a replica of the working environment. The caliber of engineering students from Nigerian Universities and Polytechnics is a significant issue of concern from nearly all industries in Nigeria. Many industries complaint stem from insufficient skill necessity for many leading edge technology, confidence, and low practical knowledge. Most Nigerian engineering students are put through many retraining programs since the majority of the graduates are believed to be non-employable moving by the quality of instruction acquired from the various institutions of learning [1], [2]. The level of economic development of

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every nation depends on its level of human capital advancement, especially in engineering and science in addition to technical advancement and industrialization. Nigeria is far from going through some landmark in technical development towards industrialization because of bad infrastructural state despite the massive amount of students from different engineering faculties of universities and polytechnics who cannot impact favorably on the expansion of industries for financial emancipation and industrialization.

The National Universities Commission (NUC) report proved there are sixty five universities in Nigeria including twenty six federal universities, twenty four states colleges along with twenty three privately owned institutions [2]. There are also forty three polytechnics made up of seventeen federal and twenty six state owned polytechnics. Nevertheless, just approximately 10% of graduates from these different institutions employed annually. A number of research findings have queried the relevance of graduates as well as investigation benefits to the employer industries' thinking about the lower academic status and expertise acquired by item from different institutions [3]–[7]. This shows that the skills needs of the employer industry and the society are not being addressed by the by the training programs. According to [8], the conventional engineering pedagogy may be referred to as deep and narrow, with the students typically being taught isolated subjects utilizing linear progression model. A difference of guidance is actually necessary to shut up the widening gap with a period of time between the engineer -in-industry as well as the engineer-in- academia [8]. Change of focus is going to require the re orientation and perhaps the adaptation of the existing engineering instructional approach as well as education to satisfy the indigenous need and the 21st century skills need.

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Table I: Results of Retrieved Articles According to Keyword against the Database

	Engineering Teaching Methods in Nigeria	Employability Skills	21 st Century Skills	Total
Scopus	117	201	102	420
ERIC	112	178	96	386
Web of Science	98	181	112	391
Science Direct	105	193	123	421
Total	432	753	433	1,618

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Various research findings have been blamed lack of employable skills on inappropriate curricula and instructional approaches among the factors leading to the soaring youth unemployment in Nigeria. Analysts have argued that in Nigeria typically, the skills that acquired by graduates do not match the skills need of the 21st century employers. Based on them, the education system of Nigeria has its liberal bias that really over-supplies the labor market with graduates that do not have the abilities needed by companies. A number of students in Nigeria lack entrepreneurial skills to facilitate self-employment [9]–[11]. The Federal Government of Nigeria has made various efforts to resolve the alarming situation of employment with the establishment of notable agencies like the National Directorate of Employment (NDE) and National Poverty Eradication Program (NAPEP). These efforts however, have failed to make significant effect on the high rate of youth unemployment in the country [12].

I. RESEARCH QUESTIONS

This meta-analysis was methodically structured by the researchers to examine the existing teaching and learning methods employed for the science, engineering and technology related programs in Nigeria. The study considered the teaching methods, employers' skills need, skills impact of the existing teaching methods and the possible way forward. In an explicit approach, the study seeks to answer the following questions:

- What are the contemporary teaching methods employed in the teaching and learning of engineering and related courses in Nigeria?
- What are the skills need of the industry and the society?
- How do the existing teaching methods impart the skills need of the industry and the society?

II. METHODOLOGY

This study systematically reviewed the existing literature to extract the relevant research studies to be considered. In

accordance with the title, the study seeks to identify the employability impact of teaching methods employed for the teaching and learning of engineering, science and technology programs in Nigeria. To this effect, four data bases namely: web of science, Scopus, science direct and ERIC were explored. The following keywords were used: Engineering teaching methods in Nigeria; employability skills; employability in Nigeria. A large number of materials was arrived at and in order to arrive at a manageable figure, the following criteria was used:

- The documents were restricted to articles and theses between 2008 and 2018
- Search was restricted to the title of the study.

Other than the criteria set above, the researchers did not limit the search the any subject area or journal type thus, producing the articles and theses shown in Table I.

As shown in Table I, the use of key words: Engineering teaching methods in Nigeria; employability skills; employability in Nigeria across the four data bases produced 432, 753, and 433 articles and theses, making a total of 1,618 results.

After the duplicates were removed by reading a comparing the titles based on the three (3) key words, the number was reduced to 1,113 articles and theses. The 1,113 articles and theses were further reduced to 483 after removing the irrelevant works that are not related to engineering and technology. The articles and theses were further narrowed down to senior secondary, technical colleges and tertiary institutions in Nigeria thus, arriving at 97 articles. At last only 48 articles and theses were considered for the review after removing the ones without clear teaching methods and effects. The study was limited to findings carried out between 2008 and 2018.

III. FINDINGS

Based on the reviewed literature, the findings obtained to answer the guiding research questions are as provided in this section.

A. Methods of Teaching Engineering and Related Courses in Nigeria

Various studies carried out on methods of teaching engineering and related courses in Nigeria indicate that, the traditional lecture method which has been the practice since independence remains popular despite the current advancement in technology [3], [13]–[16]. According to

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the studies, the traditional lecture method is normally supported by practical laboratory work, field trip to the industries, and final year project work [17]–[19].

Table II: Observed Engineering Teaching Methods & Study Focus

Citation	Observed Teaching Methods	Study Focus
Hamilton-Ekeke & Mbachu(2015)	Lecture method	Information and communication Technology (ICT)
Akpan, (2012)	Lecture, laboratory work and field trip	Employable skills
Olorunfemi & Ashaolu (2014)	Lecture, lab work, and final year project	Teaching methods and industry partnership
Mahmud, Ismail, & Taib (2012)	Lecture method	Engineering Education and Product Design
Amaechi et al. (2016)	Traditional lecture method	Strategies of Effective Teaching and Learning Practical Skills
Nkang (2013)	Traditional method	Education For Employment and Poverty Alleviation
Akani (2015)	Traditional, lab work, field trip and project work	Laboratory Teaching: Implication On Students' Achievement In Chemistry
Pitan (2016)	Traditional method	University Graduate Employability in Nigeria
onyekachukwu & Umurhurhu (2016)	Traditional method	Effective Skill Development in Nigeria Tertiary Institution
Ogundola (2017)	Lecture method	Effects of Peer Tutoring Strategy on Academic Achievement
Nwezeh (2010)	Traditional method	Use of ICT in Nigerian Universities
Okoye (2010)	Traditional method	Enhancing Quality in Educational Practice and Instructional Delivery
Agbatogun (2013)	Traditional methods	Interactive digital technologies' use
Adejimi (2008)	Traditional methods	Distance Learning in Nigerian Universities
Rufai (2014)	Traditional methods	Employability Skills
Peter, Abiodun, & Jonathan (2010)	Traditional methods	Teaching Practical Skills to Mechanical Related Trade Students
Longe (2012)	Conventional methods	Effects of video compact disc (VCD) based instructions on students' learning outcomes
Olatoye & Adekoya (2010)	Traditional methods	Effect of Project-Based , Demonstration and Lecture Teaching Strategies
Aremu & Efuwape (2013)	Traditional methods	A Microsoft Learning Content Development System (LCDS) Based Learning Package for Electrical and Electronics Technology
Olutola & Olatoye (2015)	Traditional methods	E-Learning Technologies in Nigerian University Education
Laleye (2015)	Traditional methods	Effective Service Delivery in Educational Training and Research
Saba, Ma 'aji, & Tsado (2013)	Lecture method	Pedagogical Skills in Teaching of Electrical and Electronics Engineering
Etuk (2015)	Traditional methods	Innovations in Nigerian Universities: Perspectives of An Insider from A "Fourth Generation
Onyesolu (2009)	Traditional methods	Virtual reality laboratories

Table II shows various studies on engineering teaching methods in Nigeria was well



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as the recommended alternative methods

As can be observed in Table II, various research findings have revealed that, the old conventional methods of teaching engineering remain popular in Nigerian institutions of learning. Among the identified methods are the traditional method (lecture method), practical laboratory work, field trip to industries, and practical final year project work. The various studies have identified and recommended various

instructional methods that could meet the needs of the 21st century employers, 4th industrial revolution and the contemporary society. This is indicative of the fact that, the traditional methods as being practiced in Nigeria have failed to impart the necessary skills as demanded by the contemporary modern society.

Table III: 21st Century Employability skills and Competencies

Employability Skills	Competencies
Creativity and innovation	The ability to create new ways of thinking and be able to find solutions to new problems by being innovative enough to build new products and services
Critical thinking and problem-solving	The ability to apply higher order thinking to new problems and issues, use appropriate reasoning to analyze problems and be able to make appropriate decisions needed to solve problems (non-routine problem solving using critical thinking).
Communication	The ability to communicate effectively in a wide variety of forms and contexts for a wide range of purposes by using multimodal communications and technologies
Collaboration	The ability to work in teams where they are able to effectively generate, share and use ideas.
Information literacy	The ability to access, evaluate, synthesize and share information from multi-disciplinary/interdisciplinary sources
Technology usage	The ability to identify appropriate technology tools and use them efficiently, ethically, and effectively
Career/Life Skills	The ability to become self-directed and independent learners who can adapt to change, manage projects, take responsibility for their work, lead others and produce results.
Personal/Social responsibility	The ability to develop cultural competence in working with others by recognizing and respecting cultural differences while working on diverse cultural and social backgrounds.

A. The Skills Need of the 21st Century and the 4th Industrial Revolution

The dynamic nature of the society and its increasing complexity has made it necessary for continuous improvement of knowledge and skills to meet the changing needs and demands of the society. This can be seen in the eminent changes and effects that the various industrial revolutions brought to society [39]. The skills need as demanded by the 21st century and the 4th Industrial Revolution are: Creativity and Innovation, Critical thinking and problem solving, communication, collaboration, information literacy, technology usage and application, Career and life-long learning, personal and social responsibility [40]–[42]. Table III shows the skills need of the 21st century and the 4th industrial revolution

IV. IMPACT OF NIGERIAN CONVENTIONAL TEACHING METHODS ON THE 21ST CENTURY SKILLS

Various research findings have shown that the traditional methods being practiced in Nigerian institutions of learning are obsolete and far from meeting the skills need of the 21st century, 4th industrial revolution and the needs of the present society [41], [43], [44].

A. Traditional (Lecture) Method

The lecture method of teaching, also known as traditional teaching method is the most common approach for instructional delivery in Nigeria and most parts of the world. This instructional technique involves the teacher delivering the message through the “chalk-and-talk” or with the use of projectors. This instructional model which has its roots from the behavioral learning is passive and learners play less role in the process of learning [45]–[47]. This method has some advantages of: enthusiastic communicating of subject intrinsic interest; meeting the needs of particular audience; ability to present large amount of information to large audiences; allowing maximum control of learning outcomes by instructor; little risk to students; appealing to those who learn by listening [48].

The traditional method however, has some disadvantages that makes it not suitable for the acquisition of 21st century engineering skills. According to [11], [13]:

- i. It fails provide feedback to instructors on students' achievement
- ii. Does not actively engage students in the learning process thus, making them passive learners
- iii. The attention of students quickly wanes within 15 to 25 minute minutes
- iv. It presumes that all the learners have the same space of learning

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- v. Not suitable for high order thinking thus, inhibiting creativity and innovation skills
- vi. Does not enhance students' complex reasoning
- vii. Only suitable for teachers who are effective speakers
- viii. It emphasizes learning by listening thus, ignoring students with other learning styles.

B. Laboratory Experiments

Laboratory practical experiments are used to support the lecture methods in Nigerian institutions especially in science and engineering programs [23]. It is a suitable means for the establishment of cause and effect because of the deliberate variables manipulation that is involved thus, enhancing the acquisition of practical (technical) skills. The replicable potentials of experiments allows for the standardization of procedures and confidence in the test of theories [49]. Laboratory experiments which is favored by the learning pyramid also helps for the quantitative data collection analyzable through inferential statistics thus, permitting conclusions on chance occurrences.

The laboratory experiments however, has some limitations which include:

- i. Artificiality where the experiments are not real-life typical and students perform bizarre tasks that are not natural thus, resulting to distortion of behavior. This makes the generalization of findings difficult due to the ecological invalidity.
- ii. It creates a narrow range of behaviour due to the precise control of situations.
- iii. There no flow between lectures and laboratory experiments, a result of which affect the applicability of the lab experience in solving real-life problems.

C. Field Trip

A field trip is learning journey taken outside the classroom to get immediate experience from an all-natural environment. It is structured to enhance students' interest in learning, for gathering information, objects or materials for classroom courses also as to look at phenomena or objects not feasible to deliver inside the classroom. The field trip is a planned workout going on outside of the 4 walls of the classroom. It provides a chance for learners getting first-hand info on folks, things and places for the permanency of learning experiences [50]. A field trip is a trip designed by the instructor to help the learning process of the students and is designed for learners to experience principle in practice.

The utilization of field trip as a technique of instructing helps you to result in a good learning of engineering, science and technology courses. It is of huge advantage since it improves the observation of learning experiences in the area of engineering works wherein engineering resources like clear plastic, rubber, ceramics, wood and metals are used. Field trips are an active technique of teaching giving students of both genders equal chance to widen their cultural and practical experience through a variation in the learning environment.

The field trip method according to [51], has some limitations which include:

- i. The loss of time for safeguarding written content.
- ii. The loss of some control of what goes on.
- iii. Right trips call for effort to create and this should be done very well ahead of time.
- iv. Long distance trips can be time consuming, and as such arrangements has be made to makeup the lost day.
- v. Excursions from campus cost money and also usually the professor must locate an "angel" to coat the price.
- vi. Most of the students take the field trip for granted since it is not covered on the test items.

D. Final Year Practical Project

The core aim of final year project is to provide the graduating class the opportunity to apply the acquired knowledge in solving problems through a practical, physical project design and construction. According to [8], "they are an essential tool in developing judgement via critical evaluation and reflection, and provide students with the opportunity to apply and reinforce their acquired knowledge in a design context". In Nigeria, like any other nation, engineering students are expected to conduct a research and develop a practical project at the end of the program. The aims of this project is to enable the students to link theory with practice by conducting a research and coming out with an innovative solution to a problems in their area. This involves the application of the cognitive and psychomotor skills. Although this method is favored by the learning pyramid as shown in Figure 1and has the advantages of enhancing the technical skills, creativity, innovation and critical thinking, it has some limitations which include:

- i. Lack of team work and collaboration skills
- ii. Lack of leadership skills
- iii. Lack of communication skills
- iv. Sometimes the project is just an academic exercise without addressing the problems of the society

V. DISCUSSION

As can be seen in the existing literature on teaching methods in Nigerian institutions of learning, the conventional methods employed in the teaching of engineering and related programs are far from meeting the needs of the contemporary industry and society. The findings agree with that of Ragupathi (2015), that, "traditional engineering education practices like lectures and lab sessions are inadequate in preparing engineering students for being effective professionals". For instance, the lecture method which is the most popular method of teaching is seen as teacher centered and fails in vital learning components like: lack of proper feedback on students' achievement; lack of students' participation and activity; waning of students' attention within few minutes; forces students to learn at same pace; inhibits high order thinking, creativity and innovation; only suitable for teachers with good speaking skills; and limits learning to hearing.

The laboratory experiments which support the lecture method has the advantages of enabling the students to put what they have been thought into practice. It is a suitable

means for the establishment of cause and effect because of the deliberate variables manipulation that is involved thus, enhancing the acquisition of practical (technical) skills. Although this method is 75% favored by the learning triangle, it fails to meet the needs of the contemporary society because: where the experiments are not real-life typical and students perform bizarre tasks that are not natural thus, resulting to distortion of behavior as well as makes the generalization of findings difficult due to the ecological invalidity; creates a narrow; range of behavior due to the precise control of situations; no flow between lectures and laboratory experiments, a result of which affect the applicability of the lab experience in solving real-life problems.

As earlier mentioned, the field trip is structured to enhance students' interest in learning, for gathering information, objects or materials for classroom courses also as to look at phenomena or objects not feasible to deliver inside the classroom. It also provides a chance for learners getting first-hand info on folks, things and places for the permanency of learning experiences. However, the method is not without its limitations which include: loss of time for safeguarding written content; loss of some control of what goes on; difficulty in linking the industrial environment and experience to the class learning; and lack of commitment from students if they are not to be tested on the visit and moreover, some of them copy their reports from fellow class mates.

The final year practical project which is usually carried out by the graduating class is aimed at providing the graduating class the opportunity to apply the acquired knowledge in solving problems through a practical, physical project design and construction. Although this methods favors some of the employability skills like creativity and critical thinking, it has some limitations like: lack of team work and collaboration skills since most of the students carryout the project individually; lack of leadership skills; lack of communication skills; and in most cases, the project is just carried out to fulfil the requirement, problem solving skills are lacking.

VI. CONCLUSION AND RECOMMENDATIONS

As can be seen from the literature and conclusion, the conventional methods of teaching engineering and related courses in Nigeria are far from meeting the societal and industrial needs. Although each of the methods has their individual merits, they have their limitations in terms of the components, processes and approaches. This calls for the utilization of teaching methods that favor the skills need of the century as well as meet the needs of the 4th industrial revolution. The researchers therefore recommend innovative and student centered teaching methods that like problem based learning, project based learning, inquiry based learning as well as effective utilization of modern instructional resources like multimedia, simulations and virtual laboratories in the teaching and learning of engineering, science and technology programs in Nigerian institutions. It is expected that the effective utilization of the right teaching methods in Nigerian institutions of learning could lead to the production of employable graduates

capable of gaining self and paid employment as well as solving the problems of the nation.

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