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Innovative Approaches to the Teaching of Engineering Programmes in Nigerian Tertiary Institutions for Sustainable Economic Development

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ABS T RAC T

The Nigerian Tertiary education system has contributed to the development of the Nigerian economy for many years. With the current focus on sustainable economic recovery, it is important to ensure that the tertiary engineering programmes are being taught` in a manner that is both robust and innovative so as to facilitate the creation of graduates that are work ready. Therefore, this paper seeks to review the traditional approaches to teaching engineering programmes in Nigerian tertiary institutions and explore the need for innovation. In specific the paper provides an overview of engineering education in Nigeria, describes various stage of teaching/learning resources for engineering programmes, traditional approaches to the teaching of engineering programmes in Nigerian tertiary institutions, innovative approaches used in the teaching of engineering programmes, and at the end, the paper draw a conclusion towards the need for tertiary institutions to embrace the modern innovative approaches to the teaching of engineering programmes for the fact that, the knowledge and skills that will be developed in the individual learners will bring about sustainable economic development.

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INTRODUCTION

The term teaching simply refers to the process of imparting knowledge and skills to a learner (student) usually within a discipline (Bello, 1981). In other words, any activity that helps to increase the knowledge and skills of a learner is teaching and it comes from teachers. Teaching has existed for ages. In this 21st century, engineering programmes require modern innovative teaching approaches in order to make them meaningful and in tune with the real world. These innovative approaches are the strategies or methods used in imparting knowledge and skills.

The aim of innovative teaching approaches is to improve academic performance and address the real teaching problems (Thompson, 2023). Thus, the main aim of innovative teaching approaches in engineering is to promote the teaching-learning of engineering programmes with a view to producing a competent and ready to work graduates.

LITERATURE REVIEW

Therefore, this paper reviews engineering education in Nigeria, discusses the teaching/learning resources for engineering programmes, list the traditional approaches in the teaching of engineering programmes and explained some innovative approaches used in the teaching of engineering programmes.

METHODOLOGY

Overview of Engineering Education in Nigeria

Engineering education is being recognized as one of the keys to technological and economic development of any nation. Danko (cited in James, Ishola & Epeyong, 2020) defined engineering education as that type of education in which students learn about the process knowledge and skills related to engineering. As a field, it covers the human ability to change the physical world to meet the needs of the society by manipulating tools using technique. Engineering education includes an initial education (bachelor's degree and HND) and any other advanced or post-graduate degree typically accompanied by examinations and supervised training as part of the requirements for a professional license or membership. A variety of engineering courses are offered in Nigerian tertiary institutions, among them are; Chemical engineering, Civil engineering, Mechanical engineering, Industrial engineering, Computer engineering, Architectural engineering etc.

Okojie (2007) reported that, engineering education in Nigeria started at Yaba College of Technology in 1932. Thereafter, two monotechnic were established in 1977 as follows; Nautical College of Nigeria (now Maritime Academy of Nigeria), Oron and Nigerian College of Aviation Technology, Kaduna. In 1980, four Federal Universities of Technology in Owerri, Akure, Minna and Yola were established.

Prior to the establishment of these universities of technology, some old generation tertiary institutions in Nigeria have also ventured into offering engineering programmes. Among those institutions are; University of Ibadan,

Ahmadu Bello University, Zaria, University of Nigeria, Nsukka, Bayero University, Kano, University of Maiduguri, Abubakar Tafawa Balewa University, Bauchi, Obafemi Awolowo University, Ile-Ife, University of Benin, Benin City, University of Lagos, Kaduna Polytechnic, Federal Polytechnic Nekede, Federal Polytechnic, Ilaro, Federal Polytechnics Bauchi Mubi, Idah, Bida, Okwo etc. Also, in an attempt to promote engineering programmes, some state governments have established universities and polytechnics. In recent times, federal government has given licensed to individuals to establish universities, polytechnics and or monotechnic to promote engineering and science education.

Teaching/Learning Resources for Engineering Programmes

There are variety of resources used for the teaching of engineering programmes. Teaching resources simply refers to the materials that are designed to help facilitate learning and knowledge acquisition. These resources are categorized into two, namely, human and material resources. The human resources are the manpower or workforce used in the teaching of engineering programmes, whereas; the material resources refer to non-human items or things used in the teaching of engineering programmes (Sara & Musa, 2019). Examples of these resources are briefly described below:

a. Human Resources: These are the teaching staff, lab attendants and the entire students.
b. Material Resources: Material resources are classified into three, namely; the audio visual and audio-visual. The audio materials appeal to the sense of hearing only, and they include; radio, microphone, tape recorder etc. The visual materials are the instructional aids that appeal to the sense of seeing. According to Ogwo and Oranu (2006) they constitute the large percentage of instructional materials used in the teaching industry. They include, charts, models pictures, graphs etc. Whereas, the audio-visual materials are the instructional aids (items) that appealing to two senses, i.e., hearing and seeing. These materials combine the features of audio and visual senses, and they include; television, motion pictures, multimedia, applications, videos, software, platforms, v-sat, cell-phone and other electronic gadgets.

The teaching resources described above provide the basis for what students will experience and learn. They hold the power to either engage or demotivate learners. Therefore, they must be carefully planned, selected, organized, refined and used in order to bring about meaningful teaching-learning of the engineering programmes.

RESULTS AND DISCUSSION

Traditional Approaches in Teaching Engineering Programmes in Nigeria

There are six basic methods used in teaching engineering and engineering related programmes. These methods or approaches are lecture, demonstration, discussion, activity-based learning (ABL), assignment (Delton),

project methods (Ogwo & Oranu, 2006). However, these approaches are not adequate enough to cater for this 21st century engineering and technology. Hence the need for new teaching approaches.

Innovative Approaches Used in the Teaching of Engineering Programmes

Teaching 21st century students need innovative approaches (methods) prove to work effectively with today's tech-smart students. There are certain approaches used across the globe that bring in the desired academic results in a quicker time when compared with the traditional teaching approaches. These modern approaches are listed and explained as follows:

1. Flipped classroom
2. Cooperative learning (Team work)
3. Design thinking
4. Teleconferencing
5. The Khan Academy approach
6. Simulation
7. Guest speaker approach

Flipped Classroom

This is a modern pedagogy that has gained popularity among educators most especially during Covid 19 era. It is a blended learning strategy which allows students to be self-dependent learners at home or outside the classroom and test what they have learnt in the classroom with a live problem session. The proponent of flipped classroom are Jonathan Bergemann and Aaron Sams. They used teacher created video to teach Chemistry in 2007 and since then, it has gained wider acceptance among educators globally.

In the traditional teaching methods, teachers present lessons to students and then assign class work or home work. Whereas, in the flipped classroom approach, the students watch prepared videos or online lectures, collaborate in online discussions or carry out research at home, while actively engaging concepts in the classroom, with the teacher serving as facilitator.

The flipped classroom intentionally shifts instruction to a learner-centered model, in which students are often intentionally introduced to new topics outside the school, freeing up classroom time for exploration of topics in greater depth and creating meaningful learning opportunities. The approach is structured around the idea that lecture or direct instruction is not the best use of class time. Instead, students received learning materials before class and then freeing class time for activities that involve higher thinking (Bhat & Bhat, 2018).

Cooperative Learning (Team Work)

This is also known as small group learning approach and it is an instructional approach in which students work in small groups to accomplish a common learning objective under the guidance of a teacher (Rigacci, 2020). The approach is based on the theory and philosophy of John Dewey, (an education reformer) that; tell me and I forget. Teach me and remember. Involve me and I learn.

Cooperative learning offers students the work together, brainstorm to learn both content and collaboration skills (soft skills), such as communication, conflict management, leadership, accountability and decision making while strengthening their commitment to group goals. The approach also allows the teacher to work on the competencies of the students on soft skills towards realizing the objectives of a lesson. It arranges and mixes students of different level of ability and learning into groups for the success of the group rather than the individual. Every learner helps, and actively participate for the success of his group.

Design Thinking Approach

Design thinking approach is both an ideology and a process concerned with solving complex problems in a highly user-centric way. Stevens (2023) simply defined design thinking as an approach used based heavily on the methods and processes designers use (hence the name). The approach evolved not only in engineering, but all fields of endeavour. For instance; architecture business and commerce etc. Design thinking is extremely user-centric. That is, it focuses on human first and foremost. It seeks to understand people's needs and come up with effective solutions to meet the needs. It is often called solution-based problem-solving approach.

Design thinking process (approach) are broken down into five steps or phases namely; empathize, define, ideate, prototype, and test. Empathize step provide a starting point for design thinking. At this stage, the designer or engineer observes the psychological an emotional feeling of potential user of the intended project. The second step is defined. At this stage, the designer defines the 'problem' from the information gathered in step one (empathize), and at the end of it come up with problem statement. Step three (ideate) is about brainstorming and mind mapping in an attempt to come up with a single and clear idea on the project. Step four (prototype) is about experimentation and turning ideas into tangible products. Step five (test) is about testing the product. In reality, the result of the testing phase will often lead one back for fine turning until perfection is achieved. It is important to understand that, design thinking approach (PBL) differs from the traditional problem-based learning approach (PBL) in the sense that, the later (PBL) is defined by the teacher, whereas, for the design thinking approach, the instructors do not define the problem, they only define the scope of the problem.

Teleconferencing

This is another modern teaching approach that can be used for teach engineering programmes. Teleconferencing is the use of telecommunication device to communicate between two or more individuals. It includes a conference call over the phone or through the use of video software (www.indeed.com).

Three types of teleconferencing are widely used, namely; audio teleconferencing, video teleconferencing and audio-visual teleconferencing.

Audio teleconferencing utilizes learning aids only. e.g., radio, telephone and mobile calls. The video teleconferencing uses visual devices only i.e., devices that use pictures and graphics only e.g., photographs, screen share etc, whereas, audiovisual teleconferencing material involves the use of both hearing and imaging devices, e.g. television, iPhone etc.

The Khan Academy Approach

The Khan academy is an American non-profit educational organization created in 2006 by Sal Khan a graduate of MIT and Harvard Business School. The mission of the organization is to provide a free world class education for anyone and anywhere. The academy has a website which provide a free online collection of more than 3,300 micro lectures via video tutorials on various science and art courses (Maduewesi, 2013).

Mr. Khan started the academy by remotely tutoring his cousin's interactively using yahoo, doodle images. Based on feedback from his cousin, additional cousins began to take advantage of the method. In an attempt to make better use of his time, Khan transitioned to YouTube video tutorials. All the videos hosted on YouTube are available through Khan Academy website. It has the features of measuring learning abilities, practice exercises and many more. Logging into the site is done through Google, YouTube and Facebook accounts.

Global classroom students learn through this medium at their own pace on every single day. The lessons taught through the facility are translated in more than 35 languages in addition to English, French, Portuguese and Brazilian. The academy is funded through donations by philanthropists and some organizations such as Bill and Melinda Gate foundation and Google.

Simulation

Simulation is a teaching approach in which students are tasked to solve problems in controlled environments through replicated 'real life scenarios' (Lateef, 2010). Simulation creates a true-to-life learning environment that mirrors real-life work and scenarios. In simulation, trainees (students) put real knowledge and skills into practice, not just by reading books and listening to lectures, but through physical, hands- on activity.

Simulation based approach is highly effective far the fact that it transfers key skills to trainees (students) in a cost-effective manner, and also provides the basic needs of kinaesthetic students who flourish through practical activities.

Simulation teaching approach can be applied across so many fields of endeavour. For instance, in business area; such as project management and customer service; the medical field, allowing for practical work in a life-saving situations; in the military drone plotting; in aeronautic engineering, students can be taught how to fly in a life like scenario, etc.

Guest Speaker Approach

This is an advanced teaching approach in which certain personalities are invited to give talk on certain issues on a topic area (Sara & Musa, 2018). The

personalities are most of the time, subject experts and therefore role models in their areas of specialization.

Field Trip

Field trip a.k.an excursion, is an organized visit to a place (organization) with the sole purpose of getting a first-hand information in an area of interest (Ogwo & Oranu, 2006). This approach acquaints students with concrete and direct learning experiences on the knowledge of a subject matter. This type of learning takes place in an informal way and student are directed to focus on what they are there for. After the trip, the teacher arranges for a group discussion in order to evaluate the students' learning outcome.

CONCLUSIONS AND RECOMMENDATIONS

The paper has made an overview of engineering education in Nigeria with the sole aim of understanding its context and its place in promoting sustainable economic development. Also, the paper has defined and categorized teaching resources into two, namely; human and material resources. Furthermore, it splatted the material resources into; audio, visual and audio-visual. The paper listed some methods of teaching as traditional (fundamental), among them are; lecture, discussion, demonstration, assignment (Delton method), Activity-Based Learning (ABL).

In an attempt to improve the teaching/learning of engineering programmes; the paper introduced and explained the following concepts as innovative approaches; flipped classroom, cooperative learning, design thinking, teleconferencing, the Khan Academy approach, simulation, guest speaker approach and field-trip.

Therefore, it is now left for the government, private individuals and organizations to see to it that adequate teaching resources are provided in their tertiary institutions that are offering engineering programmes. It is also a challenge to teachers (lecturers) to select the most appropriate modern teaching approach(es), based on the available instructional resources, in order to make the teaching-learning of engineering programmes more simple, interesting and effective for better sustainable economic development.

FURTHER STUDY

This research still has limitations so further research needs to be done on this topic "Innovative Approaches to the Teaching of Engineering Programmes in Nigerian Tertiary Institutions for Sustainable Economic Development".

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