Disruptive Innovation as a Panacea for Sustainable Engineering Education in Nigeria

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Abstract **- The pace of globalization in the world has brought about tremendous shifts and changes in every sector of the economy. This is also evident in the educational sector which has evolved over time from the traditional method of teaching experience to embracing of different technological advancement to create a teacher-learner friendly environment. However, much of these has not been experienced in the engineering education in Nigeria as students are still regimented to the traditional approach of learning experience as such, cannot compete effectively in the global market. It is due to this aforementioned that this study examined the role of disruptive innovation as a panacea for sustainable engineering education in Nigeria. A qualitative analysis approach was used to query engineering education in Nigeria and its readiness in embracing technological innovation for a cutting-edge teacher-learner experience. The diffusion of innovation theory model was utilized to understudy how individuals respond/react to innovation when the adopters lack information or its potential benefits to them. The study therefore concluded that in order for engineering education in Nigeria to compete with global standards, there will be a need to invest heavily in research and development. It will also become imperative to learn, re-learn and adapt to innovative culture across boards. The study also recommends that manpower should be trained and taught the innovation processes and changes.**

Keywords **-Disruptive innovation, Engineering education, Nigeria, Technology, Student/Learner approach**

I. INTRODUCTION

The global industry has witnessed a period of unprecedented change which has also impacted the pace of engineering education sporadically. The future of engineering education is being framed by the constant and competitive global forces which transcend national boundaries such as the impact of globalization, rapid technology advances, climate change and inequality (Parashara & Parasharb, 2012). Hence, disruptive innovation has therefore become a fundamental issue in the development of engineering education in the new global economy as it is seen as the best adaptive profile for engineering students/technicians. The concept of disruptive innovation is directly concerned with 'technological core' or 'technological advancement' in a particular field which brings about fundamental breakthroughs. As such, technological innovation has recently been nurtured in novel engineering curricular and educational models as a driver that necessitate the integration of foundational, science, technical, and socio-economic aspects connected with engineering and engineering learning.

Most foreign institutions specifically European countries have introduced the concept of innovation and design in the first year of their engineering programs, and in multidisciplinary activities/courses/degrees in novel engineering curricular and education models (Higgins et al., 2012). According to Hamad et al (2013), the increasing complexity and interdisciplinary nature of the engineering profession requires equipping engineering undergraduates with a set of non-technical skills such as communication, decision making, management, leadership, emotional intelligence, cultural awareness, and social ethics which will allow smooth business negotiation.Technological and scientific revolutions especially at the interface of advanced computing, biology and physics has led to the exponential growth of innovation which has opened a world of new possibilities and markets (Kamp, 2016).

Engineering education in tertiary institution needs to constantly strive to keep pace with these advancements and in particular the contribution of engineering to these global opportunities and challenges (Luo et al., 2014). Tertiary institutions need to prepare future engineers with the unique skills and technical knowhow which will be required to manage rapid change, uncertainty and complexity. This method is concerned with the ability to tailor engineering solutions to the local social, economic, political, cultural and environmental context and to understand the impact of local action on the wider world. Although there is a global dimension within all subject areas, engineering and technology has unique importance in addressing global challenges, delivering environmental sustainability, international poverty reduction and economic growth(Luo et al., 2014).

Contemporary research in engineering education focuses not only on learning processes and individual versusteam learning, but also on educational techniques for use in the classroom setting (Litzinger et al., 2011). Innovative tertiary institutions are adopting courses that will equip graduates with the skills, knowledge and attitudes that are necessary to maximize the positive and far-reaching impact of engineering in the society. Notably, there is often a myriad of knowledge of global issues amongst teaching staff and resistance as some of this teaching faculty described it as a 'dilution' of core

engineering content. The research function of academia remains a major source of knowledge and innovation atnational, regional and international levels. Engineers apply knowledge and create technology as most innovations are derive from engineering (Metclafe, 2009).

Transformation of engineering education is partly a political process, and as such may encounter resistance and barriers to change(Marjoram, 2013). Most universities and academics usually concentrate on research rather than education. Consequently, some of these academics are conservative and resist change, and have a culture and spacefor lecturing, rather than learning. Furthermore, tertiary institution focus on staff performance in terms ofpapers published and grants won and give higher rewards for researchers than effective educators. Also, there are constraints and barriers relating to accrediting authorities, who tend to be conventional, slow to change, often averse to an output-oriented, graduate attribute approach. This approach often does not effectively enforce attribute achievement at the individual student level(Marjoram, 2013).

Engineering is portrayed as the most radical profession in terms of technological, social, economic and cultural change; however, engineering is also conservative as engineering education has itself changed very little over the last 50 years. This is therefore one of factors that has resulted in the decline of interest, enrolment and retention of young people in engineering and reported shortages of engineers in many countries. As such, this is an avenue for a sporadic global challenge for engineering in facilitating a "greener", sustainable use of resources, in mitigating the effects of and adapting to climate change, and in humanitarian engineering and development, especially poverty reduction.

II. LITERATURE REVIEW

The term 'disruptive innovation' was coined by Clayton Christensen in 1995.According to Christensen (1997), a disruptive technology is an innovation that results in worse product performance and sustaining such innovations happen within an existing market. Sustaining innovations typically solve problems using new technologies without creating a new market. However, disruptive technologies have the ability to cause radical changes due to their availability outside of existing markets and their simplistic learning curve for consumers. Given that disruptive technologies start small and with a segment of the market that is generally overlooked, they have the ability to be constantly improved upon, until they are able to overtake an existing market.

The term 'innovation' was first introduced by the Nobel Prize Laureate in Economics, Joseph Schumpeter in 1930s. Schumpeter posits that innovation is an important process in business and economy. Corroboratively, Kotsemir et al (2013) stated that innovation is not only concerned with novelty but also in radical change and efficiency in terms of market conquest and fast promotion of new products. Congruently, iinnovation is based on technical and engineering research, as well as in other fieldincluding in education that involves with new system and method of learning, teaching and management. Innovation has been divided into radical and incremental. Radical innovation is concerned with scientific ideas that has a major impact to the society. However, the best example for incremental or upgraded innovation is smartphone with new models based on new features. Azhar (2004) further outlined the types of innovation intofour; radical, incremental, modular and design. According to Christensen and Raynor (2003), the internet is described as the 'mother of all disruption'.

2.1 Student/Learner Centered Approach

The center of all learning and teaching evolves around the student/learner as such, it would be catastrophic if the teaching method fails to recognize the central position of the student/learner. In the teaching of engineering in tertiary institution, the student/learner should be considered foremost and all their interests should be served. The student/learner teaching approach recognizes the needs, values and importance of the student/learner as the center post of all teaching. This is a new perspective in the teaching of engineering which is different from the old/traditional method of teaching in which the teacher was seen as the most important person in the teaching and learning process. The student/learner-centered innovative methods consist of; planed discussion, advisory approach, panel discussion, small group discussion, seminar, debate, committee and group work, problem solving research, case study (Ezeano, 2013). Several innovative teaching strategies which adopts student/learner centered approach have been developed to bring about improvements in teaching and learning of engineering in tertiary institutions in Nigeria(Neboh, 2012).The student/learner-centred strategies include the use of analogy, constructivism, learning activity package, concept mapping, cooperative learning, individualised instruction, computer-aided instructions, programmed instructions, multimedia instructional approach, information and communication technology ICT approach.

2.2 Disruptive Innovation as a Panacea for Engineering Education

Engineering education is of fundamental importance to the development around the world since the physical infrastructure are designed, built and maintained by engineers (Bruyckere et al., 2015). It is therefore expedient for tertiary institutions engaged in engineering education to undertake a review of existing courses and also considers the extent to which the global dimension is adequately reflected in the course content. Engineering education research represents a unique component of education and research. Engineering education in tertiary institution should not only be dependent on research and discovery, but also on reforms and implementation(Janssen et al., 2016). Globally, engineering education research is on the agenda for the improvement of higher engineering education and the development of

strategies for solving important issues for the future of engineering education, such as recruitment, the need for new competences and the ability to deal with new types of interdisciplinary and complex knowledge. In order to meet up with global standards, engineering education research should be characterized by a unique interdisciplinary approach where engineering education researchers do have various backgrounds in engineering, science, social science and educational psychology investigating higher engineering education. Research in engineering education is highly interdisciplinary and lies at the intersection of engineering, education and the learning sciences. Engineering education research must draw upon innovations and advances in the fields of education and learning sciences to strengthen the research.

Contemporary research in engineering education focuses not only on learning processes and individual versus team learning, but also on educational techniques for use in the classroom setting(Beanland & Hadgraft, 2010).Innovative tertiary institutions are adapting courses to equip graduates with the skills, knowledge and attitudes that are necessary to maximize the positive and far-reaching impact of engineering on society. Importantly, there is often a lack of knowledge of global issues amongst teaching staff and resistance to what is seen by some as a 'dilution' of core engineering content. The research function of academia remains a prime source of knowledge and innovation at national, regional and international levels (Sujatha, 2017).

Engineers are problem-solvers and innovators hence, there is a need to change the trajectory of engineering education toward a curriculum focused on project and problem-based learning, with particular reference to global issues, greener engineering and technology which is beneficial in the social, economic, environmental and cultural context(Marjoram, 2013). The curricula should reflect formal and informal learning trends, especially the use of ICT resources for student-centred learning, with limited lectures and staff acting more in a role of learning facilitators. According to Beenland (2012), there should be a focus on development and the assessment of graduate attributes, and the provision of suitable learning and work space to facilitate student interaction.

Educational system goes through various developments and changes viz-a-viz curriculum issues. Thus, selection and organization of curriculum content, curriculum implementation and evaluation, the development, distribution and use of teaching materials, and the relevance of the curriculum is what is needed today. Teachers are the most influential factor in the Education change. A curriculum considers the learners and their interaction with each other, the teacher and thematerials.

III. THEORETICAL FRAMEWORK

Everett M. Rogers (2000) diffusion of innovation theory is a useful approach to studying organizational innovation, culture, and change. Rogers defines innovations as new ideas, and diffusion as all the activities surrounding the spread of such new ideas. Most notably, diffusion involves communicating information about an innovation to reduce perceptions of uncertainty and risk in adopting the innovation. Individuals largely base their decisions to adopt or reject an innovation on their perceptions of five key attributes. Relative advantage, one of the most influential attributes, is "a ratio of the expected benefits and costs of adoption of an innovation. Sub dimensions of relative advantage include economic profitability, low initial cost, a decrease in discomfort, social prestige, a saving of time and effort, and immediacy of reward. Compatibility involves the innovation's alignment with an individual's values and needs: "An innovation can be compatible or incompatible with (1) sociocultural values and beliefs, (2) previously introduced ideas, and/or (3) client needs for the innovation. Not surprisingly, the more relative advantage and compatibility an individual perceives with an innovation, the more likely he or she is to adopt that innovation. Furthermore, complexity is the level of difficulty the individual perceives in adopting the innovation, trial ability refers to an individual's opportunity to experiment with the innovation prior to full adoption, and observability is the individual's ability to observe others using the innovation prior to adoption. Logically, the greater the complexity of an innovation, the less likely an individual is to adopt it. However, trial ability and observability may mitigate an innovation's complexity, resulting in increased likelihood of its adoption. These five attributes affect innovation-decisions at not only the individual level but also the organizational level.

IV. CONCLUSION AND RECOMMENDATION

This study concluded that it is important to rrecognizee, promote and support the transformation of engineering education to universities, government, through innovative research. Also, tertiary institutions engaging in engineering education need to partner with experts in the industry on projects and leverage on their professional experience in order to facilitate transformational and come up with novel solutions. The accreditation authorities and universities in Nigeria need to implement professional competencies development programs for their staff members and ensure their student course contents meets up with industry needs.

Additionally, disruptive innovation in engineering education is required to attract and retain young people in engineering, to address the increasing shortages of skilled engineers reported globally. The transformation of engineering education needs to be student-centred, with a focus on graduate attributes, professional competencies and relevance. Other professions, such as medicine, have transformed toward 'patient-based' learning, when there was noenrolment need to do so, whereas engineering has enrolment and retention issues that the transformation will address. This transformation will not only benefit engineering students and professionals, but also universities, professional industries and the wider public.

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