ENHANCING TECHNOLOGICAL DEVELOPMENT THROUGH DYNAMIC, INNOVATIVE AND CREATIVE ACADEMIC CURRICULA

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Abstract

As the nations all over the world manage the impact of the COVID-19 pandemic outbreak, the need to look inward and become self-reliant in the face of global isolation became evident. To tackle the challenges facing today's world requires pragmatic solutions employing innovations and creativity. Technical and Vocational Education and Training (TVET) is expected to produce personnel that would rise up to challenge in times of need. Such innovations and creativity would be needed to be adopted into educational curriculum to bring up individuals that would achieve the much needed innovations and creativity. Educational institutions must produce graduates that possess the technical skills of their disciplines to carry out innovation. This study proposes a 30:30:40 ratio for curriculum delivery and assessment in a 3-tier approach to curriculum delivery. Tier-1 comprises the theoretical concepts that give the background knowledge of the course being taught. In tier-2, the learner is made to undergo practical exercise related to the course of study. The third tier involves developing the creative abilities of the learner to innovatively conceive something original or unusual and implement it. The proposed model has potential to ensure that the objectives of the curriculum delivery has been fully achieved. When educators deliver the curriculum based on the proposed 3-tier curriculum delivery approach, it is expected that TVET learners in Nigeria would be better off than with the current system. Students will not only have theoretical knowledge but also acquire necessary skills to create devices that meet societal needs.

Keywords: Bloom's Taxonomy, Creativity and Innovation, Curriculum Delivery, Professional Skills, Technological Development, TVET.

Introduction

As the nations all over the world manage the impact of the COVID-19 pandemic outbreak, the need to look inward and become self-reliant in the face of global isolation became evident. This is because the global coronavirus pandemic has fundamentally changed the way of living in the new normal. Quarantines and closures have changed the way of doing things. The path forward is difficult, but modern technology through innovation and creativity will be the last option. During the lockdown, professionals across the world are working from various angles to combat the impact of the virus from the health sector to education. During this time of crisis, first and foremost the health and safety of everyone should be priority number one. The survival instinct is inherent in man and necessity is the mother of invention always. This was amply demonstrated during the pandemic with many innovations and inventions from every angle across the globe.

Education must promote the natural ability of the mind to set and to solve problems and by inter-relation to stimulate the full usage of general intelligence (Brito, 2013). The COVID-19 outbreak is disrupting markets and consumer behaviour in unpredictable ways, and those businesses that are most able to adapt will survive and thrive as recovery begins. To that end, educational institutions should employ proactive strategies to address low skill among the students through innovative and creative curricula able to meet the needs of the hours (OECD, 2016). Technical and Vocational Education and Training (TVET) is expected to produce personnel that would rise to challenge in times of need. Real innovation means bringing something new to the market. At its most fundamental level, this might be a new product or service but could be a change of business model, customer experience or a new approach for delivery of products or services that already exist. A disrupted and changing world creates a lot of new opportunities

and challenges to be solved. Educational and technical institutions need to innovate more than ever to remain relevant with cutting edge technology.

For the comprehensive adaptation of engineering education to the post-COVID-19 situation, the challenges of the pre-COVID-19 era must be considered. To tackle the challenges facing today's world requires pragmatic solutions employing innovations and creativity. Such innovations and creativity would be needed to be adopted into the educational curriculum to bring up individuals that would achieve much-needed innovations and creativity. This requires a holistic review of education necessitating the need for effective curriculum delivery. Further, an interdisciplinary approach to education is essential to achieve solutions to challenging contemporary problems. Such an interdisciplinary approach is depicted in Figure 1. Interdisciplinary and transdisciplinary methods in education are integral parts of the technological innovation cycles and they bridge the gap between research, industry and education (Ehlen, 2015).

Educational institutions must produce graduates with not only the technical skills of their disciplines. They must also impart a wider range of transferable professional skills, an understanding of the societal context of engineering and most importantly, an understanding of how to transfer such skills when in the industry(Mitchell, Nyamapfene, Roach, & Tilley, 2019).

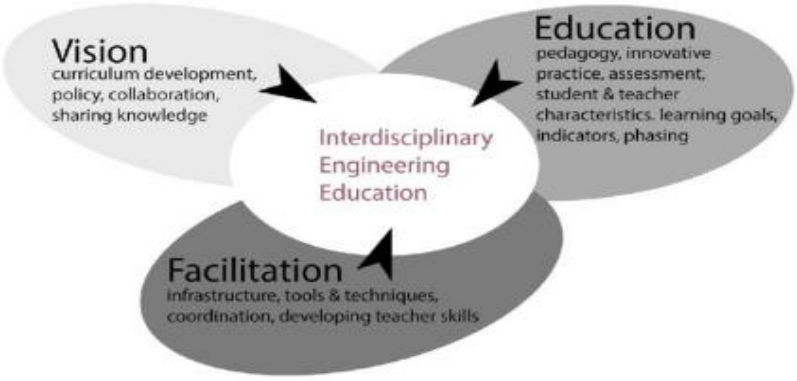

Fig. 1: Structural components of interdisciplinary education (Van den Beemt, A. & van de Ven, 2016)

To achieve a productive review of the curriculum, it is necessary to consider the students' experience. The students' experience of teaching and learning in science engineering and what they take from it should be a central consideration of all pedagogical considerations necessitating a curriculum review (Mitchell, Nyamapfene, Roach, & Tilley, 2019). Moreover, a demand-led curriculum is imperative in the 21st century in for technical education to ensure better learning opportunities and production of quality graduates with the right skills to perform in the workplace (Oloyo, 201a 9). Such curriculum will ensure that polytechnics graduates' performance at the workplace and in the field of research and development is at pal with expectations and technology acquisition and innovations will be a lot easier. In other words, the curriculum should lay more emphasis on knowledge and skills acquisition rather than an emphasis on unbridled crave for certification without the quest for knowledge or skill.

Teachers have to be involved in curriculum development and for this reason, the teacher should be provided with appropriate knowledge and skills needed to effectively contribute to curriculum development. The knowledge, and use, of ICT and the Internet, is a necessity for all teachers to guarantee the relevance of the system and its products in the 21st century but there is insufficiency in knowledge among teachers in the use of ICT in a globalizing world (Ogunyinka, Okeke, & Adedoyin, 2015). Further, to achieve a time-responsive technical education curriculum delivery, the impacts of ICT must not be ignored. Researchers hold the view that older educators should be saddled largely with the responsibility of curriculum review, design, development and revision (Jegede, 2009). However, asserted by Adetona, Okeke, & Igbabini (2010) asserted that younger educators are at the forefront of ICT in Nigeria while Yushau & Nannim, (2020) found out that older educators use ICT more in some educational institutions(Yushau & Nannim, 2020). Thus younger educators should have a contribution to curriculum development in technical education especially on the adoption of ICT in curriculum delivery.

Concept of Curriculum Development and Review for Technical Education

Curricula are developed as guidelines for educators to impart knowledge into learners. How effective and up to date a technical education curriculum is, depends on many factors including the delivery and time and advancements in technology. An effective curriculum should be hinged on the philosophy, goals and objectives; learning experiences and instructional resources, and assessments that comprise a specific educational program as it represents an articulation of what students should know and be able to do. (Bureau of Curriculum and Instruction, 2006)Developing a curriculum must be a living document that is in constant flux, adaptable to changes in the educational community, and cannot be stagnant (Alsubaie, 2016).

Because of their experience in imparting knowledge to students, teachers are most knowledgeable about the practice of teaching and are responsible for introducing the curriculum in the classroom. Thus, teachers should be involved in curriculum development (Alsubaie, 2016; Baş & Şentürk, 2019; Jadhav & Pratibha S. Patankar, 2013). Their opinions and ideas should be incorporated into the curriculum for development. Hence, teacher involvement is important for successful and meaningful curriculum development. Indeed teachers are among the collective developers of the curriculum. Other developers include curriculum coordinators state agencies, curriculum development organizations and textbook publishers(National Research Council, 2012). Thus teachers play an invaluable role in developing, updating, implementing and upholding the curriculum.

The curriculum development for any course of study involves one or more of the following processes (Oloyo, 2019):

i. Adoption with or without modification of curriculum in use in an established similar institution;
ii. Collation of ideas from a group of teaching staff believed to have long-standing teaching experience in the field of teaching/specialization; or
iii. Results of a survey conducted to study the job functions and the scientific and technical skills required of the graduates to be produced from the training programme.

The science and engineering curricula in use in polytechnics in Nigerian are quite old. Some have been reviewed only once in the last 17 years. Each of the authors of this paper has been involved in the delivery of these old curricula for more than a decade and they have observed certain deficiencies in the curricula. Thus this work follows the second approach above to propose a review of the curricula. As educators in TVET, their teaching wealth of experience is brought to bear in this study.

Poor education schemes and implementation have resulted in an undue emphasis on certification without corresponding knowledge. Due to the high level of unbridled crave for certification without the quest for knowledge or skill, many today go about with high-grade certificates without adequate skills relevant to the society. Hence, it is not uncommon to see very brilliant students faltering in the labour market. In the theory of learning, according to Bloom's taxonomy (American Society of Civil Engineers, 2012; Sisson & George, 2019) shown in Figure 2, there are six levels of cognitive development namely knowledge, comprehension, application, analysis, synthesis and evaluation. After the comprehension level, the four other levels seem to be missing in rote learning in our educational system where memorization (upload, download and forget) is the usual practice, Even with the practical

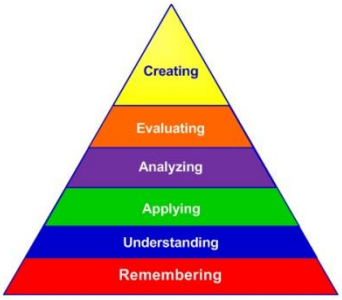

Fig. 2: Bloom' Taxonomy of education (The Peak Performance Center, 2020)

class, there exists a limitation because the practical exercises are more or less developed procedures followed by the student to carry out the experimentation. There is need therefore to develop a better model to reinforce learning. The application of the proposed model will address the problems by not only reinforcing the theoretical learning but also

enable the learner to think (in the process of analyzing, synthesizing and evaluating) independently thereby helping to grasp the concepts better.

Methodology

To correct the anomalies observed in the existing curricula in science and engineering, a 3-tier approach to curriculum delivery methodology is proposed in this paper. This proposed model will then be compared with some criteria such as Bloom's Taxonomy for evaluation. Figure 3 shows the 3-tier approach proposed by this paper as a means of enhancing curriculum delivery in tertiary institutions.

Tier-1: Theoretical Concept/Conceptual Theory

Tier-1: This refers to the theoretical concepts that give the background knowledge of the course being taught. The existing semester-based curriculum can be adapted to fit into this model. The modular nature when completed is expected to produce necessary basic understanding required to be productive. The three main components of General Studies/Education (15%), Foundation Courses (10-15%) and Professional Courses accounting for the rest 60-70% where theoretical foundations are laid can be adapted to fit into this model.

Tier-2: Practical demonstration of course content

In this level, the learner is made to undergo laboratory ad workshop practical exercise related to the course of study. Practical exercise through effective and adequate laboratories/workshops programme is geared to complement the theory already taught. This involves laboratory experimentation and workshop practice on theoretical knowledge previously acquired in the classroom. To further enhance this, the Students Industrial Work Experience Scheme (SIWES) and the Industrial Training should be strengthened.

Tier-3: Creative Innovation

In this study, a third facet is introduced into the existing structure to ensure that the knowledge acquired is transformed into productivity capable of meeting the societal needs. As illustrated in Figure 3, the third tier is aimed at developing the learner beyond the laboratory experiments. The essence is to develop the creative abilities of the learner to conceive something original or unusual and implement it innovatively. This unique aspect when implemented will encourage inventions, resulting in the emergence of new products.

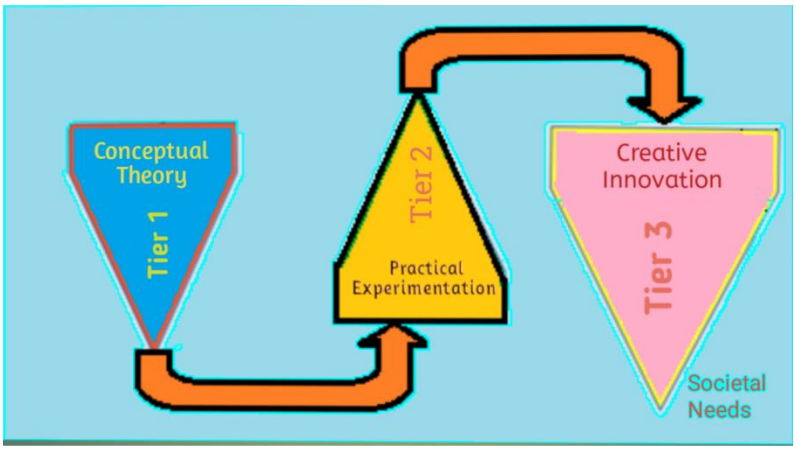

Fig. 1: Three tier approach model to curriculum delivery

When the learner carries out a real-life project on a course taught to a standard specification of the industry, such knowledge and practical implementation to transform the acquired skills into meeting the market and consumer requirements will go a long way to enforce learning. To ensure the learner is well motivated and prepared ahead, the list of related products made in the past can be given to him at the beginning of the course. The existing curriculum delivery system stipulates that theory-practical ratio is expected to be 50:50. This paper proposes a 30:30:40 ratio for curriculum delivery and assessment for tier-1:tier-2:tier-3.

Results and Discussion

Table 1 shows the comparison of the proposed model with the existing model. The proposed model has the potential of transforming technical education if well applied. The new model will guarantee full exploration of Bloom's taxonomy in areas where the old model has limitations. Innovation and creativity will ensure that the objective of the curriculum delivery has been fully achieved. For a learner to produce a product, it implies such learner has not only grasped the concept but has an in-depth understanding that will enable analysis, synthesis and evaluation of the subject at hand. The effectiveness of the proposed system requires keeping track of the technological market. This new model will ensure a constant review of curricula for relevance that meets up with market demand. By adopting a dynamic review mechanism/synergy between market demand and curricula, the innovative ability and creativity of the learners are enhanced. The old model, which is certificate-driven, makes a learner focus only on passing examinations by all means. The new model however will be innovation-driven and lay emphasis on skills acquisition. Unlike the other skill acquisition programmes such as entrepreneurship development run as a semester-based programme, the new model will be discipline-based and reinforced learning.

Table 1: Comparison of the new model with the old model

		Old Model	New Model
i.	Remembering	√	√
ii.	Understanding	√	√
iii.	Applying	√	√
iv.	Analysing		√
v.	Evaluating		√
vi.	Creating		√
vii.	Content of the curricula		√
viii.	The relevance of the curricula		√
ix.	Practical content	√	√
x.	SIWES	√	√
xi.	Industrial training	√	√
xii.	Innovation & creativity	-	√

Conclusion

This study has examined the state of curricula in the face of emerging technologies and the need for innovation. A 3-tier model approach was introduced and discussed in this paper. Tier-1 refers to the theoretical and conceptual framework. This was rated to be 30% of the curriculum delivery process. Practical exercise of the course content was regarded as tier-2 and rated to be 30%. The proposed tier-3, the creative innovation was rated to 40% of curriculum delivery and assessment.

When educators deliver the curriculum based on the proposed 3-tier approach to curriculum delivery, it is expected that TVET learners in Nigeria would be better off than with the current system. Students will not only have theoretical knowledge but also acquire the necessary skills to create devices that meet societal needs. The creative acumen of the learners that is otherwise hidden will be revealed and honed and thus they will be able to put the acquired knowledge in their respective fields into use to solve immediate problems in their environment.

Recommendations

To realize the benefits of the proposed model, some action plans are needed. More awareness and planning are required. Funding by government and industries is necessary for smooth implementation. Also, learners should be encouraged by giving adequate rewards to novel and outstanding innovations. Seamless transition to commercial value through industries- institution partnership is needed as well. Ban on importation of foreign goods and products with local substitutes will go a long way to promote the use of local content through innovation and creativity. This will also ensure less dependency on foreign culture. The lifespan of any curriculum should be less than 5 years to ensure time responsiveness. This will also necessitate the training and retraining of educators so that they can implement the new approach to curriculum delivery. There should be more emphasis on innovation and

creativity than the reigning culture of learning by rote. An industry-academic partnership can provide needed synergy and financial muscle in achieving the set goals. TVET institutions should ensure that research products do not end up in archives.

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