

A Learning Model for Effective Teaching of Entrepreneurship Engineering Using Workshop Technology As A Case Study

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Abstract: For over a decade that Entrepreneurship education was introduced to the curriculum of tertiary institutions in Nigeria, majority of engineering students only acquired the skill but lacked the entrepreneurial spirit to initiate their personal engineering based ventures. This attitude could be traced to the structure of the curriculum of entrepreneurship education which is generic in nature that could hardly bring out the technical entrepreneurship values that were embedded in engineering education. To close this gap, there is the need to integrate entrepreneurship education into the engineering curriculum without sacrificing the technical and professional objectives of the course. This study developed a learning model based on the course outline of Workshop Technology and the behavioural objectives of Introduction to Entrepreneurship to develop an Entrepreneurial induced version of Workshop Technology which adopted modular-based pedagogy for effective learning. The model aimed to produce entrepreneurial minded engineering graduates that will willingly prefer to create engineering ventures after graduation. The model was given a prima facial evaluation by the experts in engineering and entrepreneurship and was adjudged to be appropriate for its purpose.

Keywords: Entrepreneurship, Engineering, Education, mindset, pedagogies, curriculum

1. Introduction

Entrepreneurship is considered to be the hope for the developing economies and a realistic solution to youth unemployment (Abdul Karim, 2016). The bulk of unempl-oyed youths in Nigeria are the graduates from tertiary institutions (Ogunbanjo et al., 2017) and by the virtue of their educational attainments, most of these graduates expect jobs from either public or private enterprises. The Federal Government has been using different methods as palliative to offer temporary jobs for these graduates. Most recent among these palliative measures are Graduate Assistance Programme (GAP), N-Power and the 774,000 Federal Government's Special Public Works Programme but the effects of these programmes are either short lived or insignificant when compared with the annual turn out of graduates from tertiary institutions.

Current records show that not less than 25 million graduates in Nigeria are unemployed (Babalobi, 2019). The major cause of this unemployment is often attributed to the education system which was structured towards securing white collar jobs without requisite skills and zeal for entrepreneurial pursuit (Nkechi, et al., 2012, Ojeifo, 2012, Chris, 2015). Entrepreneurship is the ability to identify opportunities regardless of available resources. It is associated with economic growth at global level and

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countries with high levels of entrepreneurial activity have their economic performance at above average growth rate (Lumsdaine and Bink, 2003; Timmons, 2004).

Entrepreneurship education is all kinds of experiences that give ability and vision of how to access and transform opportunities of different kinds to goods and services. It is a specialized training given to the students to acquire skills, ideas and managerial abilities and capabilities for self-employment (Enombo et al., 2015). Entrepreneurship education is considered to be an attitude, and innovative mentality rather than business acumen. A training that will equip an individual to turn ideas into action through creativity, innovation and risk taking, as well as the ability to plan, execute and manage projects in order to achieve objectives which encompass much more than the traditional desire to obtain monetary wealth (United Nation, 2011. Shaw, 2004; and Bashir et al., 2012). Any nation that desire development through better quality of education and human resources must strengthen their entrepreneurship education curriculum to be able to catch up with the realities of the globalized world.

The Federal Government of Nigeria through National Universities Commission (NUC) in 2007 directed all universities to mount entrepreneurship education to solve the problem of unemployed graduates. Despite this effort, it is on record that graduates unemployment is increasing and the conscious attitude towards self-employment is not encouraging (Idris and Adeyemi, 2018). Failure of entrepreneurship education to achieve its objectives in Nigeria most especially among the engineering graduates could be traced to the teaching and learning methods adopted to teach entrepreneurship (Ahmad et al., 2004). Some of these institutions commonly present entrepreneurship education in the context of vocational training or managerial/administrative skills rather than developing the spirit of entrepreneurship that will stimulate entrepreneurship activities embedded in students' disciplines. Lumsdaine and Binks (2003) opines that instilling entrepreneurship mindset into engineering students could only be achieved through delivery of entrepreneurship courses as part of or integrated into the engineering course.

The relevance of entrepreneurial education, most especially in engineering, cannot be overstressed,

because if engineers could understand business principles along with mindset of engineering entrepreneurship, it could lead to a greater number of technological innovations which will eventually create employments and promote national prosperity (Bashir, et al, 2012). Despite the fact that engineers are the originator of most of the product ideas, students of engineering most often than not, show indifference in creating their own businesses after graduation (Ahmad and Abd Rahman, 2004). To change this situation, engineering students need to be taught on how to identify problems that have market values and consider their product or design from the customer's point of view and as well, develop entrepreneurial interest in engineering which could only be achieved through innovative teaching that will integrate entrepreneurial objectives with the engineering principles, concepts and fundamentals. To the best of knowledge of the authors of this paper, this effort has not been given its due attention in Nigeria.

Innovative teaching methods that will instill entrepreneurial mindset into the training of engineers have been adopted by some foreign institutions in the recent time, notable among them are documented in Gross (2000), Kriewell and Mekemson (2010), Reid and Ferguson (2011), Holzmann, et al (2018), Rayess (2016), Wang (2017), and George (2019). A well trained entrepreneurial minded engineer is naturally motivated to translate engineering concepts to value-added products and processes not because he/she could not secure a paid job, but for the interest in self-employment and the passion to create. By virtue of training, engineers possess entrepreneurial qualities of applying scientific principles to create products and services. However, Shaw (2004) and Hsiao (2013) observed that most engineering graduates lack entrepreneurial mindset because the concept and objectives of entrepreneurship are not integrated into the engineering curriculum to facilitate the application of their creativity and technical skills to develop a business strategy for technology-based ideas.

Imparting entrepreneurship into the future engineers goes beyond imparting mere entrepreneurial skills or vocational skills but it involves motivation to acquire the skills and the readiness to translate it to job creation even when there are opportunities to secure paid jobs. Imparting entrepreneurial mindset into engineering students according to Weaver and Rayess (2011) is to raise the

interest level among the students, make them aware of the significance in entrepreneurship and most importantly relate entrepreneurship to their knowledge of specific engineering topics that could be utilised to create engineering business ventures.

In response to the need to instill entrepreneurial mindset into the engineering students in Nigeria through the use of core engineering courses to teach engineering entrepreneurship, this study selected a first-year course, Workshop Technology as a case study. The study integrated entrepreneurial mindset learning modules into the existing course content of "Workshop Technology I" which is a general course for all fresh students of the faculty of engineering.

The rest of the paper is organized as follows. First, the existing course content of "Workshop Technology I" is presented followed by the discussion on how the objectives of Entrepreneurship course were integrated into the learning outcomes of the course. An Entrepreneurial Engineering Workshop Technology learning model was developed, its evaluation results were discussed and then followed by conclusion.

2. Development of Entrepreneurial Engineering Workshop Technology

A. Workshop Technology I (MEE 104)

Workshop Technology I is a general and compulsory course for engineering students in Nigeria (NUC, 2015). The course is taken by fresh students in all the departments of Engineering at the Osun State University, Osogbo, Nigeria. It is a two-units course domiciled in the Department of Mechanical Engineering with course code MEE 104. It is generally taken by the students during the rain semester, it has an hour class lecture, and three (3) hours workshop practical. The learning content of the course is five. These are;

- Introduction to workshop practice.
- Types of machine: Lathe, milling machine, shaper, drill, folding machine, shear, press, etc; their uses and associated tools.
- Safety in workshop; Organization of the workshop;
- Introduction to methods and tools for producing thread, holes, slots, tapers, etc.

- Introduction to wood workshop tools, properties of wood and their influence on the detailed design of wooden structures and components, e.g wood fasteners, and preservation measures (UNIOSUN, 2017).

B. Integrating Entrepreneurial Objectives with Workshop Technology I

In order to expose the students to entrepreneurship education, Introduction to Entrepreneurship (GNS 201) was made compulsory for all the engineering students in the Faculty of Engineering, Osun State University, Osogbo, Nigeria. The behavioural objectives of the course are to:

- acquaint students with history of successful entrepreneur so as to develop the can do spirit in them;
- guide students to identify marketable skills in their environment;
- develop identified skills into Business ideas;
- conduct feasibility studies and writing feasibility report and;
- start and manage a business (UNIOSUN, 2017).

These five objectives were integrated with the learning content of Workshop Technology I as follows;

Objective I: Three successful entrepreneurs and an engineering career motivator will be invited to discuss the gains and the path to success in engineering entrepreneurship. The guest entrepreneurs will include; Metal/ Machine Design Fabrication Entrepreneur, Electrical Entrepreneur, Building Construction Entrepreneur and Engineering Career motivator.

Objective II: Students will be grouped into manageable sizes and each group will be directed to identify marketable products in their immediate community through market surveys with aim to produce these items which could be through reverse engineering, redesign or traditional engineering system of production.

Objective III & IV: Students will be taught on how

to carry out feasibility studies, presentation and development of these results into business ideas.

Objective V: Students will be allowed to use the workshop facilities under the supervision of the course lecturer and the workshop technicians to produce some of the identified items and present them for sale at the end of semester trade fair.

C. Development of Entrepreneurial Engineering Workshop Technology Teaching Modules

This study adapted a modular pattern of instruction to facilitate effective teaching and learning of Entrepreneurial Engineering Workshop Technology. Modular pattern of learning instruction was chosen being one of the relevant media in the teaching and learning process of entrepreneurship courses (Yulastri et al, 2017). Basically, it contains objectives, materials, methods and evaluation which are systematically arranged and structured in such a way that could be used independently (Hasanah et al, 2016).

1) Engineering Entrepreneurial Workshop Technology: Objectives: Considering the learning content of “Workshop Technology I” as enumerated earlier, the under listed objectives were formulated for Entrepreneurial Engineering Workshop Technology, thus; upon successful completion of this course, students should be able to:

- Describe and identify the likely causes of accident in the workshops and their economic and social implications;
- Prescribed safety precautions to the major accidents that could occurred in the workshops;
- Identify problems, opportunities, and proffer engineering entrepreneurship solutions in terms of value creation;
- Identify and use basic machine and hand tools in the workshop for the production of market valued items and
- Identify business processes starting from recognition of needs and ending with production processes that will lead to creation of prototype or a real market valued product(s)/service(s).

2) Engineering Entrepreneurial Workshop Technology: Materials: Materials are the instructional facilities that need to be put in place to aid teaching and learning to achieve targeted objectives. Instructional facilities needed for this course include;

- Mechanical Workshop with Lathe, milling machine, drilling machine, grinding machine, welding machine, workshop benches and basic workshop hand tools.
- Audio visual facilities.
- Engineering materials like mild steel (sheet, rod, tube of different grades), wood (different sizes).
- Consumables (mechanical, electrical and civil related), and
- Guests speakers: Successful engineering entrepreneurs.

3) Engineering Entrepreneurial Workshop Technology: Methods: The following methods would be adopted to deliver the course;

- Direct teaching-learning methods (Class lecturing, speeches from guest speakers, seminars, videos, and entrepreneurship mentoring talk)
- Interactive teaching-learning methods (Problem-oriented learning, process-oriented learning, interviewing entrepreneurs, group discussion, market survey, paper presentations and trade fair)
- Demonstration teaching-learning methods (Workshop practice and training, visitations to sites, practical projects and weekends internship)

4) Engineering Entrepreneurial Workshop Technology: The Learning Modules: The learning modules for Engineering Entrepreneurship Workshop Technology were presented below based on the topics to be covered:

Topic I: Introduction to Workshop Practice: The content and the general objectives of the course will be discussed. The importance of workshop practice to the development of technology and its job creation potentials will be fully enumerated.

- **Topic II: Accidents and Safety in Workshop:** Types of workshop-layout and their functions will be discussed. Common accidents in the workshops, safety ethics to prevent such accidents will be treated. Economic impact of non-availability of manpower and machine as a result of accidents in the workshop will be highlighted. Video of recorded and animation of causes of accidents in the workshops will be presented to aid the learning. Workshop as a place where market valued products could be produced rather than a place solely meant for training exercises will be emphasized.

- **Topic III: Engineering and Engineering Entrepreneurship:** This topic is to instill into the mind of students the relationship that exists between engineering and entrepreneurship and how this relationship could be transformed into engineering entrepreneurship. Engineering entrepreneurship which is the process of harnessing the business opportunities in engineering and turning it into commercially viable innovation can only be understood and appreciated when the students are equipped with the knowledge of technological innovations and the basic knowledge of marketing, accounting, business operations and managerial skills.

- **Topic IV: Hand Tools in Workshops: Uses and Maintenance:** The objective of this topic is to acquaint students with the basic workshop hand tools; such as measuring tools, holding tools, striking tools, cutting tools, etc. The students will also be taught on how to use and maintain these tools. This will involve real practical exposures, demonstrations and video shows to teach the students on how to use and maintain these tools.

- **Topic V: Workshop Machines: Uses and Maintenance:** This topic will introduce students to the basic machine tools that are useful for the production of engineering products. Their features, uses and maintenance will be succinctly highlighted and described. The class will be conducted through demonstrations, video shows and visitation to sites where these machines are used to produce items for commercial purposes.

- **Topic VI: Wood and Its Uses in the Workshop:** Basic wood workshop hand tools and machines will be introduced to the students. They will also learn how to use and maintain these tools and equipment.

Properties, treatment and uses of common wood will also be discussed. Lecturing, demonstration, and video shows methods will be used to teach this topic.

To facilitate easy implementation of these learning modules, the modules are presented in table 1.

3. Evaluation of Entrepreneurial Engineering Workshop Technology Teaching Modules

The model was given a prima facie evaluation by selected delegates that attended the 2018 Annual Conference of the School of Engineering & Engineering Technology (SEET), The Federal University of Technology, Akure, Nigeria. The conference with theme “Need-Driven Engineering Research for Entrepreneurial Development in Developing Countries” was held between 17th and 19th July, 2018. Twenty five (25) delegates were selected and requested to respond to these basic questions;

- Is the model meeting the expected goals?
- Is the model relevant to the intended learners?
- Could the students able to perform adequately base on this model?
- Is the scheduling of topics reasonable?
- Are there any topics that should be deleted?
- Is the model attainable considering the time and resources? (Adapted from[30])
- What are your observations and recommendations?

Their responses to questions number 1 to number 6 were analysed and discussed.

4. Results and Discussion

The result as presented in figure 1, shows that out of 25 respondents, 19(76%) of them considered the model suitable to meet the expected goals while 4(16%) considered it not suitable and 2(8%) could not decide. On its relevance to the intended learners, majority of the respondents, 23 (92%), considered it to be relevant while the remaining 2(8%) considered it not relevant.

Eighteen (18, 72%) respondents agreed that the students could perform adequately if the model is effectively used, while 5(20%) and 2(8%) did not agree and could not decide respectively. Twenty two (88%) respondents agreed with the manner at which the topics were scheduled while 1(4%) could not decide and 2(8%) recommended that the topics should be rescheduled.

Sixteen (64%) respondents considered all the topics to be relevant and appropriate while 4(16%) considered some topics as irrelevant while 5(20%) could not decide. Only 10(40%) of the respondents agreed that the model is attainable considering the time and available resources for the course while 12(48%) considered it not attainable and 3(12%) could not decide.

Summarily, the result indicates that the model has adequate and appropriate topics that could be used to teach Workshop Technology, in such a way that the students will imbibe the spirit of engineering entrepreneurship, motivate them to produce market valued products and prepared them for future entrepreneurial challenges. However, the time allotted for the model could be adjusted where possible.

5. Conclusion

This study has successfully elucidated the need for engineering entrepreneurship education to be embedded into the engineering curriculum, it further developed a learning model for effective teaching of entrepreneurship engineering using Workshop

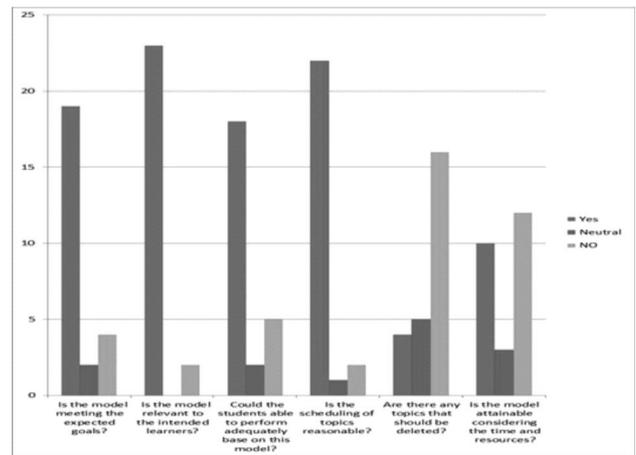


Fig.1: Evaluation Result of Engineering Entrepreneurial Workshop Technology Learning Model

Technology as a case study. The model integrated the curriculum of Workshop Technology, a foundation course in the faculty of engineering, with the basic requirements from entrepreneurship education to create an integrated curriculum that will stimulate and instill entrepreneurial mindset into the engineering students. This will dissuade them from pursuing white collar jobs rather encourage and build their interest in creating jobs through their professional learning in engineering. The students would be creating goods and services effortlessly while doing what they have learnt, and invariably solving and developing technological products in the community. The model was evaluated through the respondents from and their responds in favor of the model show positivity and encourage its usage and as well adapting the model into some other engineering courses learnt in the university.

PROGRAMME: B.Eng. (Mechanical Engineering)	
COURSE TITLE/CODE: ENGINEERING ENTREPRENEURSHIP WORKSHOP TECHNOLOGY (MEE 104)	CONTACT HOURS: 1 hour (Lecture), 3 hours (Practical) /Week
GENERAL OBJECTIVES: On completion of this course, the students should be able to:	
<ol style="list-style-type: none"> 1. Describe and identify the likely causes of accident in the workshops and their economic and social implications; 2. Prescribed safety precautions to the major accidents that could occurred in the workshops; 3. Define problems, opportunities, and proffer engineering entrepreneurship solutions in terms of value creation; 4. Identify and use basic machine and hand tools in the workshop; 5. Identify some economic values of engineering materials in their environment; and 6. Carry out business processes starting from recognition of needs and ending with production processes that will lead to creation of prototype or a real market valued product(s)/service(s). 	

Topic 1: Introduction to workshop practice.			
Week	Specific Learning Outcome:	Relevant Case Studies	Resources
1	1.1 Explain the meaning and scope of workshop practice. 1.2 Discuss the content and the objectives of the course. 1.3 Discuss the roles of workshop in manufacturing processes. 1.4 Relate manufacturing processes to job creation. 1.5 Discuss the socio - economy importance of job creation.	Exhibition of products produced in the workshop.	Visits to small scale metal, electrical, foundry, forging or wood workshops
Topic 2: Accidents and Safety in Workshop			
Week	Specific Learning Outcome:	Relevant Case Studies	Resources
2	2.1 Describe different types of workshop - layout, their functions and peculiarities. 2.2 List and explain common accidents that could occur in the workshops. 2.3 Prescribe safety ethics and protective gadgets that can prevent accidents in the workshops. 2.4 Discuss the health and socio -economic impacts of accidents in the workshops.	Production of charts and pictures of safety rules and regulations in the workshops.	Video of causes of accidents in the workshops.
Topic 3: Engineering and Engineering Entrepreneurship			
Week	Specific Learning Outcome:	Relevant Case Studies	Resources
3, 4 & 5	3.1 Explain the meaning and roles of engineering in the society. 3.2 Explain the meaning of entrepreneurship and its relevance to an individual and nation's economy. 3.3 Explain the differences between Engineering Entrepreneurship and the General Entrepreneurship. 3.4 Discuss the contributions of notable entrepreneur engineers in the society. 3.5 Explain the concept and principles of market survey and feasibility studies. 3.6 Discuss financing and insurance schemes for small scale industries.	Production of Seminar papers on topics like; i. Prospects and Challenges of Small Scale Engineering Industries. ii. Strategies for identification of society needs. iii. Production Pattern: Types and Applications iv. Indigenous Technology: Prospects and Challenges, etc.	1 st and 2 nd visits of Entrepreneur Engineers as guest speakers
Topic 4: Hand Tools in Workshops: Uses and Maintenance:			
Week	Specific Learning Outcome:	Relevant Case Studies	Resources
6 & 7	1.1 Describe the features and uses of common hand tools in the workshops. Such as measuring tools, holding tools, striking tools, cutting tools etc. 1.2 Explain the maintenance steps for these tools.	Demonstration projects of how to use these tools.	Video shows and practice in the workshop Market survey to identify the needs of the society.
Topic 5: Workshop Machines: Uses and Maintenance.			
Week	Specific Learning Outcome:	Relevant Case Studies	Resources
8, 9 & 10	2.1 Describe the basic features and functions of common machine tools in the workshops. Such as lathe, milling machine, shaping machine, drilling machine, grinding machine and folding machine. 2.2 Explain the general maintenance principles of these machines.	Reports of the market survey conducted Production of basic items using workshop's equipment.	Video shows and practice in the workshop 3 rd and 4 th visits of Entrepreneur Engineers.

Topic 6: Wood and Its Uses in the Workshop			
Week	Specific Learning Outcome:		Relevant Case Studies
11	3.1	Explain common wood and their properties	Production of basic items using workshops' equipment.
	3.2	Explain the effects of wood properties on their engineering applications.	
	3.3	Identify basic wood workshop tools and equipment	
	3.4	Explain basic wooden structures and components	
	Topic 7: Exhibition and Trade Fair		
Week	Specific Learning Outcome:		Relevant Case Studies
12 & 13	4.1	End of Semester Quiz	Projects produced by different groups
	4.2	Exhibition and Trade Fair for students to show case and sell their projects to interested members of the community.	
			Members of the University community

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