International Journal of Multidisciplinary Research and Growth Evaluation.

Imparting practical engineering skills in the Nigerian university system

Emmanuel Osikhuemen Aluyor [1], Kevin Shegun Otoikhian [2*]
[1, 2] Edo University Iyamho, Edo State, Nigeria

* Corresponding Author: **Kevin Shegun Otoikhian**

Article Info

ISSN (online): 2582-7138
Volume: 03
Issue: 02
March-April 2022
Received: 23-03-2022;
Accepted: 12-04-2022
Page No: 570-574

Abstract
The modern-day engineer must be equipped to solve multifaceted technical challenges that require the efforts of interdisciplinary teams whilst managing social, environmental, and cultural issues as well. The skills required by the engineer have been categorized into technical skills, computer skills and soft skills. The increase in the demand for and deployment of these technologies in the engineering world will threaten many routine-based jobs and open the door for several others that are more dynamic and require original human intelligence and ingenuity. This paper therefore, using a strategic frame work of analysis unfolds the utility of impacting practical engineering skills in the Nigerian system by recommending that the challenging trend in the use of technologies in the engineering world will not necessarily lead to unemployment of engineering professionals if attempts are constantly being made to upgrade the acquisition of engineering skills. As a matter of fact, the conception of this paper is that the challenge is expected to provide more openings for engineers with an entrepreneurial outlook to adequately take advantage of the opportunities for innovations through the use of new technologies.

Keywords: Skills, framework, engineers, practical, technologies, entrepreneurial

1. Introduction

It is vital that engineering students are trained not just for the present but also for a future which may be significantly different from the present in a world of rapid technological advancement. Hence, the balance of emphasis must be tilted towards those fundamental skills as well as skills of emerging immense relevance necessary for progressive engineering in current and future times (National academy of Science 2012) [10]. With the rapid advances in science, technology and Information Technology (IT) comes the need for highly skilled engineers with the requisite competence to maximize these gains in delivering valuable solutions to the world's problems that are more effective, faster and/or cheaper. The present global work environment is significantly different from that of fifty (50) years ago, notably, it is almost unthinkable these days for any engineer to function effectively as required by the present work environment, without the aid of computers/ work stations running relevant software. In another fifty (50) years from now, the work environment will be significantly different than it is right now with certain skills of emerging relevance such as advanced computer and digital literacy, applications of machine learning, artificial intelligence and other disruptive technologies becoming essential skill requirements for many engineering professionals (Bakhshi *et al*. 2017) [2]. The engineering professionals will not have to be without jobs, but they will have to constantly upgrade their skill set (Fulgence 2015) [6]. There will also be a need for more engineers with an entrepreneurial outlook to adequately take advantage of the opportunities for innovation that these new technologies present. Furthermore, as the work environment and operations of even small firms and organizations goes global, there will be an increasing demand in soft skills such as communication, teamwork, leadership, time management, lifelong self-learning and so on (Chikumba 2011; Choudary 2014; Cukierman and Palmieri 2014) [3-5]. There has been a growing problem of skills mismatch of engineering graduates with Pitan and Adedeji, (2012) [12] reporting a skills mismatch of 60.6% with major weaknesses in soft skills. In the midst of all these, the ever relevant and fundamental engineering skills and requirements such as sound knowledge of the fundamental science principles as well concepts, techniques and principles of the specific engineering disciplines in addition to technical problem solving, critical

thinking, numeracy etc. will remain as relevant as they have always been. The question then is how can these ever-increasing demands for advanced computer skills and soft skills in addition to the fundamental technical skills and know-how be imbued in the teaching and training of the modern-day engineer?

2. Practical Engineering Skills for the 21st Century

Prior to presenting and discussing a strategy for imparting the practical engineering skills needed for the modern engineer, there is a need on some clarity about what these skills which are to be imparted are. These skills for the purpose of this paper are divided into three broad categories which are technical skills, computer skills and soft skills.

2.1 Technical Skills

These are traditional engineering skills that form the bedrock of the engineering discipline. The relevance of these skills will remain well in place. These skills include in-depth grasp of relevant science fundamentals, in-depth grasp of fundamentals and applications of disciplinary principles, capability for independent scientific research. Others are ability to prepare and interpret engineering drawings, engineering design, systems thinking and analysis.

2.2 Computer Skills

In recent times, the importance of the computer in engineering practice has been on an exponential increase. Computer skills that are relevant for the modern-day engineer include computer aided design, modelling, simulation and control of systems, processes and devices, computer programming, data analytics, applications of artificial intelligence, and machine learning in engineering amongst others.

2.3 Soft Skills

Relevant soft skills required of professionals include lifelong self-learning, problem analysis and solving, analytical thinking, teamwork, communication amongst others. These skills are needed for a holistic engineering education (Cukierman and Palmieri 2014) [5].

3.0 A Strategic Framework for Imparting These Skills

As can be reasonably deduced, there is the need for a well-thought out strategy for delivering the skills outlined in the previous section within the engineering education system. Engineering education can no longer be business as usual and there is a need for innovation based on an effective strategy in the way engineering education is delivered in order to obtain engineers that are qualified for the modern day world and are globally competitive.

3.1 Aimed Strategic Framework

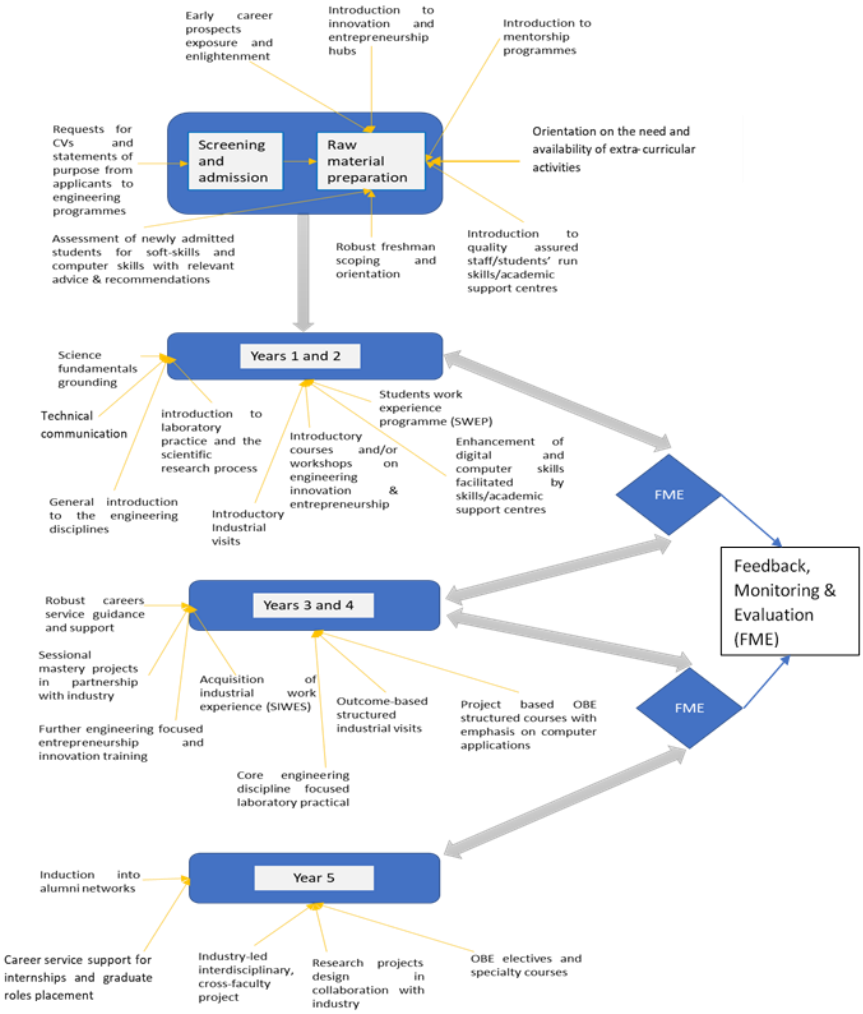

Fig 1: Aimed Strategic Framework for Imparting Practical Engineering Skills

Figure 1 shows a proposed strategic framework for imparting the technical, digital, and soft skills required of engineers in the 21st century. The framework consists of four stages represented by the four blue squares with curved edges as shown in figure 1. The four stages of the strategic framework are discussed below.

3.1.1 Stage 1: Raw material selection and preparation

The quality of input into any process to a large extent affects the quality of outputs that can be obtained. The task of producing engineering graduates with the required skills for the 21st century requires a vital co-operation between the academia, students, alumni, and industry.

At the candidate screening and admission part of stage 1, it is recommended that another layer of screening requirement be added, in requesting that applicants submits CVs and statements of purpose in support of their application to be admitted on an engineering programme. This additional layer of screening requirement could go a long way in raising awareness and fostering efforts to develop some of the soft skills and basic computer skills required for an engineering degree by the applicants. A statement of purpose for example, will compel applicants to research, reflect upon and communicate why they want to study engineering. This singular exercise can prove vital to the rest of the students' engineering journey.

At the conclusion of the screening and admission phase of stage 1, the next phase is termed, raw material preparation, this is relatively a brief phase in terms of duration as it lasts only a couple of weeks, usually the first few weeks of the start of the engineering programme, its impact can be far-reaching. The major components and key activities of this phase are as highlighted in figure 1. One of the key activities is labelled, robust freshman scoping/orientation, this entails detailed orientations at the university, faculty and departmental levels of the purpose and aim of university education. The vision of the kind of graduates that are intended to be produced at the end of the engineering programme should be clearly communicated to the new students at this stage. Furthermore, the need for the students to take responsibility for their own learning and begin to cultivate the skill of lifelong self-learning should be communicated at this stage. This will serve to give an apt sense of purpose, focus and motivation to the students for their engineering education journey. The relevant skills that they are expected to acquire through their time in the university and how the university, faculty and department intends to impart these skills should be clearly spelt out. This will help to engender co-operation with the process amongst the students.

Entrepreneurship and innovation hubs, careers service units, skills/academic support centres, and mentorship programmes are key requirements that should be in place to enable the engineering programmes achieve its aim and objectives. These units, programmes and/or centres are to be established and operated via a synergy between academia, alumni, industry, and older students. Also, at this stage, an assessment of the computer and soft skills level of the newly admitted students is appropriate. This will serve to assess the level of support that these students need to thrive in their studies towards achieving the aim and objectives of the engineering programmes. It is probably superfluous to state here that an engineering undergraduate student in the 21st century would need a laptop or some regular access to a computer in order to develop the necessary computer and digital literacy skills intended. The students should be encouraged to participate in relevant clubs and societies and even aspire for positions of responsibility in these clubs and societies as this have been proven to improve soft skills and employers generally find such impressive (Lowden *et al*. 2011) [9].

3.1.2 Stage 2: Foundational Training

This stage is where foundational engineering competencies are imparted to the students. The core components and key activities of this stage are as shown in figure 1 which is quite self-explanatory. The Students Work Experience Programme (SWEP) which is a period of about 12 weeks workshop practice training as well as exposure to the various engineering disciplines serves to impact several technical skills such as; basic equipment handling, work environment health and safety skills, basic engineering drawing skills amongst others. The soft skills to be honed include teamwork, self-learning, communication, etc.

The use of multi-media technologies and learning management systems (LMS) is key for effective delivery of courses in the 21st century.

3.1.3 Stage 3: Core Engineering Training

This is the stage at which students are trained in their core engineering disciplines of choice. The principles and techniques of the core engineering disciplines are imparted to the students at this stage. Advanced discipline specific computer skills and applications are to be built into the delivery of the courses which should follow the prescription of the Outcome Based Education (OBE) curricula. As much as is feasible, assessed course projects should be included in the delivery of these courses, this will further serve to hone the technical, computer and soft skills of the students. The Student Industrial Work Experience Schemes (SIWES) should be strategically managed to ensure that the aim and objectives of the scheme are achieved. Industrial visits should be frequent at this stage with clearly defined outcomes for each visit. The attainment of these outcomes should be assessed, and the assessment scores be included in the grades for the SIWES programme.

Furthermore, the laboratory practical sessions at this stage should be highly focused and directly linked to the principles taught in the classroom. It is recommended that the lecturers who teach the various courses should be responsible for designing and supervising laboratory practical sessions that are directly aligned to the course principles taught in class. It is also recommended that this should be done in collaboration with industry partners. This will further help to ensure the engineering programme laboratory practicum is relevant to industrial practice.

The engineering entrepreneurship and innovation trainings by the entrepreneurship and innovation hubs should be much more discipline focused at this stage and should be facilitated by seasoned engineering entrepreneurs and innovators; persons who have led and/or are leading entrepreneurial initiatives and/or have made several engineering innovations. These resource persons may be within the staff base of the various departments or maybe guest lecturers/facilitators outside the full-time employ of the university. The key point here is that those who seek to impart entrepreneurial and innovation skills to engineering students must themselves be entrepreneurs and innovators. The management of the engineering programmes will have to seek out and engage qualified personnel among its staff, alumni, and industry

partners as well as other personnel, if need be, across the length and breadth of the country, for such task.

A notable component included in the proposed framework in figure 1 which is not common in the Nigerian university system is termed 'sessional mastery projects' and should be administered with input from industry partners. It is a well-known fact that a key requirement for mastery is practice. The proposed sessional mastery projects are team-based projects that will require the students to draw on all the technical, computer and soft skills that they have garnered in a given academic year to solve a real-world problem, probably posed by industry partners.

Furthermore, at this stage, there should be concentrated effort by the career services units to provide necessary support and training to students to help them secure internships, graduate positions, and jobs during studies and upon graduation.

3.1.4 Stage 4: Specialisation and Finishing

At this final stage, students usually have the option of offering several electives in line with the aspects of the discipline they intend to focus on. The final year research project at this stage should be tailored towards solving real-world problems which have the potential to result in profitable spin-out companies if the research is successful. These research projects should be designed in consultation with industry partners.

Furthermore, a recommendation is made for a final engineering design project which should be industry led, cross-faculty and interdisciplinary. The idea is to draw students from the various departments within the faculty of engineering into teams that will then tackle a problem presented by industry. This will help to simulate a typical inter-disciplinary work situation which is the norm in an industrial work environment. None of the engineering disciplines is an island of itself, expertise from the various engineering disciplines are usually needed to deliver any major engineering project. A project-based learning approach is vital in developing soft skills alongside technical and/or computer skills (Harmer 2014; Kabouridis, Giannopoulos, and Tsirkas 2014) [7, 8].

At this stage, the careers services unit as well as the entrepreneurship and innovation hubs should be actively involved in providing necessary support to the fresh graduates in securing graduate placements, internships, and/or starting their own businesses. Furthermore, these fresh graduates should be duly inducted into functional alumni networks for continuous professional development support. These alumni networks are in turn very beneficial to the university in terms of serving as a source of additional funding, providing mentorship to undergraduates, and serving as links between the higher education institution (HEI) and the industry in which they work amongst other benefits.

A notable and very important component of this strategic framework is the feedback, monitoring and evaluation Feedback Monitoring and Evaluation (FME) component. Quality control and assurance is key to ensuring qualitative engineering education (Oloyede, Ajimotokan, and Faruk 2018) [11]. Regular assessment of the attainment levels of the technical skills, digital/computer skills and soft skills of would-be engineers and an assessment of the overall satisfaction of all major partners in the engineering education project is vital to the success of the proposed strategic framework.

3.2 Additional Notes

In implementing the presented strategic framework above, there are several salient points that should be taken note of. First of all, the management and members of the engineering academia may need to commit to continuous training and professional development in keeping with current best practices and developments in their areas of specialty. Academics who are expected to impart advanced computer application skills and soft skills to would-be engineers must be highly competent in these skills. Furthermore, there is need for regular curriculum updates in keeping pace with global trends and developments (Aluyor *et al.*, 2019) [1].

The need for a synergy between academia, industry, alumni networks, and students have been highlighted throughout this paper. In order for this strategic framework to be successful, the importance of such a synergy cannot be over-emphasized. Possible challenges to implementing some of the recommendations presented herein include; the natural inertia to change, inadequate levels of advanced computer application and digital literacy amongst engineering academia, challenge of establishing and sustaining strategic links and partnerships with industry, certain restrictive policies of regulatory bodies, funding, amongst others. These challenges can however be duly overcome if all parties involved catch the vision of the overwhelming benefits that are available to all parties and the society at large if engineering graduates from the Nigerian university system possess the practical engineering skills to make them thrive and be globally competitive in this 21st century. A good measure of grit and sustained motivation is needed by all parties involved if the engineering education in Nigeria is to be reformed to enable it produce engineering graduates of high calibre, through a robust and rigorous implementation of the Outcome Based Education (OBE) curricula;

4.0 The Edo University Example

Edo University Iyamho is one of the few universities in Nigeria that has adopted to a large extent several of the recommendations presented in this paper to ensure her engineering graduates are well equipped and prepared to excel in the modern world. The engineering programmes enjoy a full implementation of the outcome-based education (OBE) curricula with a good emphasis on computer applications in engineering. There is a well-established entrepreneurship centre which offers courses to students on entrepreneurship. Edo University is well equipped with multimedia teaching facilities in all the classrooms and 24/7 teaching and learning is supported by the institutional learning management system which made it possible for Edo University to carry on with her academic calendar and successfully conclude the 2019/2020 academic session with students writing exams remotely. The laboratories are reasonably equipped, and the university maintains close links with industry and other HEIs within and outside the country. There is a robust FME mechanism in place to ensure students satisfaction and quality assurance.

5.0 Conclusion

The skills needed by the 21st century engineer and a strategic framework for imparting these skills have been presented. There may be several challenges associated with implementing the recommendations presented herein, these challenges are surmountable. The recommendations presented in this paper are practicable and if implemented

will ensure that the engineering graduates from the Nigerian university system is equipped with relevant and practical skills for both modern-day and future relevance in a global work environment.

6.0 References

1. Aluyor EO, Otoikhian SK, Agbodekhe B. A Chemical Engineering Curriculum- Meeting the Nigerian Need" Journal of the Nigerian Society of Chemical Engineers JNSChE) NSChE Journal of. 2019; 34:1.
2. Bakhshi, Hasan, Jonathan M Downing, Michael A Osborne, Philippe Schneider. The Future of Skills: Employment in 2030. United Kingdom: Pearson, 2017.
3. Chikumba, Steadyman. Development of Soft Engineering Skills For Industrial Engineering Technologists Through Effective Mentoring, 2011, 17.
4. Choudary, Daggubati Vasanth. The Importance of Training Engineering Students In Soft-Skills, 2014, 5.
5. Cukierman, Uriel Ruben, Juan Maria Palmieri. Soft Skills in Engineering Education: A Practical Experience in an Undergraduate Course, 2014, 237-42 in 2014 International Conference on Interactive Collaborative Learning (ICL). Dubai, United Arab Emirates: IEEE.
6. Fulgence, Katherine. Employability of Higher Education Institutions Graduates: Exploring the Influence of Entrepreneurship Education and Employability Skills Development Program Activities in Tanzania, 2015, 281.
7. Harmer, Nichola. Project-Based Learning, 2014, 34.
8. Kabouridis, George, Georgios I Giannopoulos, Sotirios A Tsirkas. Improving the Skills and Employability of Mechanical Engineering Students via Practical Exercise, 2014, 8.
9. Lowden, Kevin. University of Glasgow, Faculty of Education, SCRE Centre, and Edge Foundation. Employers' Perceptions of the Employability Skills of New Graduates: Research Commissioned by the Edge Foundation. London: Edge Foundation, 2011.
10. National academy of Science. Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century. Washington, D.C.: National Academies Press, 2012.
11. Oloyede AA, Ajimotokan HA, Faruk N. Embracing the Future of Engineering Education in Nigeria: Teaching and Learning Challenges." Nigerian Journal of Technology. 2018; 36(4):991. doi: 10.4314/njt.v36i4.1.
12. Pitan, Oluyomi, SO Adedeji. Skills Mismatch Among University Graduates in the Nigeria Labor Market." US-China Education Review A. 2012; 1:90-98.