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Practical content of engineering education for entrepreneurship, innovation, safety, and sustainability: The perspectives of university of Nigeria's Students

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Abstract

This study investigates the practical content of engineering education in Nigeria, specifically focusing on its alignment with the demands for entrepreneurship, innovation, safety, and sustainability. Despite the vital role of engineering in sustainable nation development, concerns persist regarding the preparedness of Nigerian engineering graduates for the modern job market, a disparity underscored by existing literature. This research aims to explore and develop practical content within engineering curricula that better integrates these essential skills. Through a case study of the University of Nigeria, Nsukka (UNN), the study reviewed current engineering curricula to identify areas for improvement in promoting entrepreneurship, innovation, safety, and sustainability. Furthermore, it identifies and explores new teaching methods and approaches to enhance the practical relevance of engineering education. The effectiveness of any proposed curriculum enhancements and teaching methods will be assessed. This investigation utilizes a mixed-methods approach, relying on self-reported data from students, faculty, and industry experts at UNN. While the findings may not be generalizable to other institutions due to the confined scope and limited sample size, this study offers valuable insights into enhancing engineering education within the Nigerian context.

Keywords: Engineering Education; Entrepreneurship; Innovation; Safety; Sustainability; University of Nigeria

1. Introduction

The classification of Africa as a third world, or an underdeveloped continent, despite its rich, human, and material resources as noted by Siyum (2018), highlights the fact that there is a fundamental problem with the harnessing and utilization of the human and material resources in the continent. The Global Innovation Index (GII) 2014 surveyed 143 economies around the world, using 81 indicators to gauge both their innovation capabilities and measurable results. Mauritius, which tops the African countries in the ranking, came at the 40th position, followed by South Africa at 53rd and Tunisia at the 78th position. Nigeria was placed at the 110th position. The foregoing GII ranking has shown that in a global and dynamic world, the economies that can remain flexible, adaptive, and innovative will reap the benefits of world trade through educational sustainability. This is because the global competitiveness of any economy depends on its science, technology, and innovation (STI) capabilities (Krammer, 2017). In all ramifications of economic development, technology-dependent economies surpass economies dependent on their natural resources. However, there remain challenges to the diffusion of technology in Nigeria (Alhannom, & Mushabeb, 2021).

The impact of educational development on the natural environment has been a cause of increasing concern in recent years (Onyia, 2024; Onyilo et al. 2019; The Royal Academy of Engineering, 2012). An important outcome of these deliberations about the environment is sustainable development in education as a result of innovation, which aims to reconcile economic growth and environmental protection (Onyia, 2024). Engineering has been implicated in sustainability crises, including climate change, pollution and resource depletion. Sustainable engineering arose as a

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strategy to deliver positive engineering solutions and systems to benefit the environment, economy and society. Guiding it, is a sustainability worldview which also necessitates sustainability education (Karlberg, & Bezzina, 2022).

Undeniably, education is an essential tool for national development. It plays a vital role in promoting sustainable development by imparting fundamental knowledge and essential skills necessary for technological breakthrough and socio-political progress, which in turn, accelerates economic growth. To develop a knowledge-based educational system that is both structured and functional, there is a need to incorporate entrepreneurship education. This would ensure that students are equipped with the necessary entrepreneurial skills to create jobs, stimulate innovation and contribute to national development (Josephine and Doris, 2019). The strength, creativity, and innovativeness of young adults form the fundamental basis of any nation, and as a result, various governments at the local, state, and national levels, along with industry, have made concerted efforts to promote economic empowerment, prosperity, security, and safety for both present and future generations of youth.

Specifically, engineering education serves as a cornerstone for economic growth and national development, particularly in developing nations like Nigeria (Onyia, 2024). It is responsible for cultivating the technical expertise and problem-solving capabilities essential for industrial advancement, infrastructure development, and technological innovation. However, a growing concern within Nigeria's educational landscape is the perceived disconnect between the theoretical knowledge imparted in engineering programs and the practical competencies required by industries (Onyia, 2024; Onyilo et al. 2019; The Royal Academy of Engineering, 2012). This significant disparity exists between the quality of training received by Nigerian engineering graduates and the expectations of employers in the business and industrial sectors, despite the nation's vast resources (Idris & Rajuddin, 2012). This gap suggests that current curricula may not be adequately preparing students for the dynamic realities of the contemporary job market, which increasingly demands skills beyond traditional technical proficiency. Engineering education plays a significant role in preparing future engineers for the complex and ever-changing technological landscape. However, there is a need to rethink and update the curriculum of engineering education to ensure that graduates are equipped with the necessary skills and knowledge to succeed in the 21st-century workplace (Benedict et al. 2016). Meanwhile, there has been an effort by the Nigerian Universities Commission (NUC), in collaboration with COREN and some engineering stakeholders, which has reviewed the former Benchmark Minimum Academic Standards (BMAS) and published and are implementing the new Core Curriculum and Minimum Academic Standards (CCMAS) for Nigerian Universities (Abubakar2023; NUC, 2023).

The modern global economy places a premium on entrepreneurship, innovation, safety, and sustainability (Régnier, 2023). These areas are no longer supplementary but are fundamental to the success of engineering professionals and the overall development of any nation. Engineers are expected not only to design and build but also to identify opportunities, create novel solutions, ensure the well-being of all stakeholders, and contribute to environmentally responsible practices (Burleson et al. 2023). As a result, the traditional focus of engineering education, often heavily theoretical, requires re-evaluation to integrate these critical practical dimensions which NUC (2023) and COREN's outcome based education (Abubakar, 2023) is designed to address. This research aims to complement this critical issue by empirically investigating the practical content of engineering education within the Nigerian context, with a specific focus on the University of Nigeria, Nsukka (UNN), to explore how its engineering curriculum can be enhanced to better foster these indispensable skills.

2. Literature Review

2.1. Engineering Education in Nigeria

Nigeria has a diverse range of engineering institutions, including universities, polytechnics, and technical colleges. Several studies have highlighted the challenges faced by engineering education in Nigeria, such as outdated curricula, lack of practical training, inadequate infrastructure, and limited resources. These challenges hinder the development of skills necessary for entrepreneurship, innovation, safety, and sustainability in engineering. (Adeoye & Aladejebi, 2018)

2.1.1. Entrepreneurship in Engineering Education

Entrepreneurial learning is described as recognizing and creating opportunities, acting on those opportunities in innovative and even opportunistic ways, moving between ideas and activities, interacting socially, using imaginative technologies to create multiple forms of value, and managing organizations (Rae, 2003). The educational system faces a formidable task of equipping young adult students with skills for future jobs that are yet to exist. One of the challenges is identifying and educating students who possess an entrepreneurial mindset or have the potential to become entrepreneurs in the future. In this context, entrepreneurial education is crucial in identifying and nurturing such individuals who could bring about transformative change in the present and future. Entrepreneurship education within

engineering programs is gaining recognition worldwide. In Nigeria, as noted by Onyia and Madueme (2025), incorporating entrepreneurship in engineering education has the potential to foster an entrepreneurial mindset and enable graduates to create jobs rather than seeking employment. The literature emphasizes the need to integrate entrepreneurship education, including business management, finance, and marketing, into engineering programs to nurture entrepreneurial skills among engineering students (Edem, Rikhardsson & Aggestam, 2017). Arogundade (2011) meticulously highlights the importance of entrepreneurship skills in sustainable development in Nigeria. The study discusses the problems facing the country ranging from youth and graduate unemployment; high rate of poverty; over-dependence on foreign technology and goods; Low economic development and growth; among others. The study argues that entrepreneurship education will equip (engineering) students with the relevant skills for self-reliance and recommended that all (engineering) educational programmes at all levels should be made relevant to provide the youth with the needed entrepreneurial skills to practice. It further recommends that the government should give adequate attention to entrepreneurial development in the country through the provision of an enabling environment. The aftermath of this is projection of increased output through innovations, generation of employment, efficient utilization of available resources and the facilitation in the transfer of technological advancement to mention a few. However, this is still far from reality of the current Nigerian situation.

2.1.2. Innovation in Engineering Education

Innovation is the practical implementation of ideas that result in the introduction of new goods or services or improvement in offering goods or services (Tidd, 2023). ISO TC 279 in the standard ISO 56000:2020 defines innovation as "a new or changed entity realizing or redistributing value". Others have different definitions; a common element in the definitions is a focus on newness, improvement, and spread of ideas or technologies (Tidd, 2023). Innovation often takes place through the development of more-effective processes, products, services, technologies, art works or business models that innovators make available to markets, governments and society (Wikipedia 2023). Tomorrow's innovations will need engineers who thoroughly understand how to apply their knowledge and skills to designing products and processes that did not exist before. Engineering education provides an academic learning ground for industrial and technological pressures faced by future engineers that aims to influence technological advances and enhance the quality of life in society (Berglund, 2013). Innovation remains the key driver of economic growth and competitiveness. The literature reveals the significance of integrating innovation education into engineering programs to foster creative thinking, problem-solving skills for technology development. Various studies discuss the implementation of innovation pedagogies, such as project-based learning, design thinking, and interdisciplinary approaches, to enhance the innovation capabilities of engineering students (Jian & Pang, 2023).

2.1.3. Safety in Engineering Education

The International Labour Organizational (2025) Article 23 of Law No. 23/1992 on health states that "every workplace shall provide health services, especially the ones having a great health risk." This provision aims to protect the workers from dangers and diseases that may cause them and their communities harm, as well as creating decent work and optimum productivity as stated in the regulation of worker protection (Blustein et al. 2023). The implementation of operational safety and health (OSH) is a must in this globalization era, so it should be conducted in every area including the educational field where practical courses are conducted in order to minimize the risks of accidents and work-related diseases. Additionally, OSH should be implemented to improve comfort and safety of the students, lecturer, and people around them. (Munir et al., 2018). Engineering practices must prioritize safety to prevent accidents, protect human lives, and preserve the environment. The literature highlights the importance of incorporating safety education into engineering curricula. This includes topics such as risk assessment, safety regulations, hazard identification, and safety management systems. Integrating safety principles within engineering education prepares students to design and implement safe engineering solutions (Ohwofadjeke, 2020).

2.1.4. Sustainability in Engineering Education

As global concerns about environmental degradation and resource depletion are on the rise, sustainability has become a crucial aspect of engineering education (Mihelcic et al. 2006). Previous studies emphasize the need to incorporate sustainability principles, including sustainable design, renewable energy, waste management, and environmental impact assessment, into engineering curricula (Mihelcic & Zimmerman, 2021). By equipping students with knowledge of sustainable practices, engineering education can contribute to building a more environmentally conscious society (Gutierrez-Bucheli et al. 2022). In a conference of Students in Free Enterprise (SIFE), and after examining the Benchmark Minimum Academic Standards (BMAS) for undergraduate engineering programmes in Nigeria, a document published by COREN, Akeel et al. (2017) disclosed that 30 engineering programs did not explicitly incorporate sustainability education. This presentation wonders why a country that is angling for infrastructural developments, such as road construction and development of its Ajaokuta steel plant and refineries lacks a clear sustainability agenda.

Consequently, they emphasized the importance of integrating sustainability into engineering education in Nigeria. The areas of cooperation that have been identified include improving the industrial work experience scheme for students, setting up institutional factories and industries, establishing postgraduate engineering schools to enhance practical training, industry-academia collaboration on research and development initiatives like organizing joint conferences and workshops to increase impact, maintaining regular industrial visits and adhoc industry-based lectures, and funding research projects by industries through universities as presented by Onyia et al. (2023) and Achebe et al. (2022). To ensure the sustainability of engineering education and practice, Vijayan et al. (2018) proposed the concept of learning factories as a means of promoting engineering knowledge creation. The study described learning factories as platforms for exchanging knowledge, innovations and ideas among students, academics, and industry practitioners. Furthermore, Trevelyan (2010) emphasized the significance of expanding the scope of engineering education beyond technical problem-solving and design to improve engineering practice. The examination of contemporary engineering education curricula revealed that almost all formal instruction focuses on engineering science, with limited attention on business aspects and social culture. Ozor and Mbohwa (2019) emphasized the need to restructure the training path and environment for engineers to produce high-quality world-class professionals capable of transforming Nigeria both technologically and economically.

2.2. Practical Engineering Education in Nigeria and Policy Failures

The education system with regards to the western educational system in Nigeria can be traced to the arrival of colonialism and scholars highlight the policy of education during that era was structured to serve the interest of the colonial masters with regards to supply of man-power for the administration of the Nigerian colony (Fabunmi, 2005). The policy as such was structured and targeted at graduating Nigerians who had the capacity and ability to read and write in order to become inspectors, interpreters and clerks while failing to equip them with the necessary entrepreneurial skills that enable them to identify business opportunities in order to establish their own ventures (Aja-Okorie & Adali, 2013). According to Garba (2010) during this era the development of entrepreneurship was largely ignored particularly at the "micro-level" as the educational policy of colonial and the immediate post-colonial administrations focused on meeting the standards of "white collar jobs". Coincidentally, obtaining these jobs was not the challenge then due to the fact that various opportunities for employment awaited yet to be graduated Nigerian students (Chete et al. 2014).

However, the future of any nation depends not only on the natural resources available to it, but on its ability to harness these natural resources through specialized engineering skills acquired by its engineering graduates (Booth, 2004). As stated by Ajimotokan (2009), the Nigerian government from the mid 80's made frenetic efforts to promote engineering education in Nigeria. The government has diversified and specialized the universities with a goal of increasing their scientific, technological and agricultural contribution to the transformation of the country. As a component of its Millennium Development Goals, the aim is to promote economic growth and development. To achieve this objective, engineering education in Nigeria can be formally obtained through two distinctive routes. First is the trade apprenticeship education where the graduates of the local trade program study to advance their practical and hypothetical comprehension of their various trades (Idris & Rajuddin, 2012). This mode of education is usually obtainable from technical colleges in Nigeria awarding ordinary national diploma (OND) and higher national diploma (HND) in engineering. The second route can be traced through the colleges and universities awarding bachelors of engineering degrees. Either route, the federal government through the ministry of education instituted regulatory bodies to ensure quality and standardization of engineering graduates in Nigeria. The National Universities Commission (NUC) a regulatory agency, is in charge of accreditation and delivery of quality for all university education in Nigeria, while the Council for the Regulation of Engineering in Nigeria, (COREN) is in charge of accreditation and delivery of quality for only engineering education and its practice in Nigeria. However, both are responsible for planning, organizing, managing, monitoring and supervising the activities and development of engineering education in Nigeria to ensure an efficient control of Nigerian engineering education. (Nkemakonam et al. 2019). Hence, they are jointly responsible and have initiated a new curriculum (NUC, 2023) for the urgent and massive overhaul of the practical content of engineering education to solve the present challenge of poorly skilled engineering graduates. Evidently, practical engineering education plays a crucial role in preparing engineering students for real-world challenges and equipping them with the necessary skills to succeed in their professional careers (Onyia, 2024).

2.3. A Comparison Between Foreign and Local Engineering Practices

2.3.1. Foreign Practices

Emphasis on Experiential Learning: Many foreign engineering education systems place a strong emphasis on experiential learning which involves hands-on projects, internships, co-operative education programs, and industry

collaborations to provide students with practical exposure and real-world application of engineering concepts (Tembrevilla et al. 2024).

State-of-the-Art Facilities: Foreign engineering institutions often have well-equipped laboratories and workshops with advanced technology and equipment. These facilities allow students to gain hands-on experience in conducting experiments, building prototypes, and solving engineering problems using the latest tools and techniques (Borrego et al. 2015).

Project-Based Learning: Project-based learning is a common practice in foreign engineering education. Students work on real or simulated projects, individually or in teams, to apply their knowledge and skills in solving complex engineering problems. This approach fosters critical thinking, teamwork, and problem-solving abilities (Ramirez et al. 2024).

Industry Collaboration: Foreign engineering programs often have strong ties with industries. They offer opportunities for internships, industry visits, and guest lectures by professionals. These collaborations ensure that students gain exposure to real engineering practices, industry standards, and emerging technologies. (Shah & Gillen, 2024; Sheppard et al. 2009)

2.3.2. Local Practices

Theoretical Emphasis: In some local engineering education systems, there is a relatively higher emphasis on theoretical knowledge rather than practical skills. The curriculum may focus more on academic coursework, lectures, and examinations, with limited practical exposure (Abubakar, 2023).

Limited Resources: Many local engineering institutions in certain regions may face challenges in terms of limited resources, outdated equipment, and inadequate infrastructure. This can restrict the availability of hands-on practical training opportunities for students (Onyia, 2024).

Vocational Training: Some local engineering education systems may incorporate vocational training programs, such as apprenticeships and technical skills development, alongside academic coursework. These programs aim to provide practical skills and bridge the gap between theoretical knowledge and industry requirements (Sofulowe, 2013).

Local Industry Relevance: Local engineering education systems often emphasize the local industry's needs and requirements. This may involve tailoring the curriculum to address specific challenges and priorities of the local engineering sector, ensuring graduates are better prepared for the local job market. (Okebukola, 2014)

3. Research Methodology

In the context of investigating the practical content of engineering education for entrepreneurship, innovation, safety, and sustainability in Nigeria, it is important to select appropriate research methods to gather relevant and reliable data. Interviews, observations and surveys are some commonly used research methods for research projects. Survey which involves collecting data from a large number of participants using questionnaires was most suitable and adopted for this study. Surveys can be administered online or in-person and can include closed-ended questions (e.g., Likert scale, multiple-choice) or open-ended questions. Surveys are useful for gathering quantitative data on participants' perceptions, experiences, and attitudes towards practical content in engineering education. They allow for statistical analysis to identify trends, patterns, and relationships between variables.

There are several software options available to analyze survey data in research methodology like R, SPSS, Microsoft Excel among others. Microsoft Excel, a common spreadsheet software, was used for basic survey data analysis. It offers functions for data cleaning, data manipulation, basic statistical calculations, and charting. However, it may not have as advanced statistical capabilities as dedicated statistical software, but was primarily used for this survey data analysis. The study focuses on investigating the practical content of engineering education for entrepreneurship, innovation, safety, and sustainability in Nigeria with more emphasis on University of Nigeria Nsukka (UNN) as the case study, hence survey participants are the employed professionals in UNN like Lecturers, Lab Technicians and Students who are invested participants in the programmes of UNN.

The questionnaires were designed based on the research question for academic staff and students of the Faculty of Engineering, UNN. The questionnaire was streamlined to the topic of the research work. The Likert five-point scale was employed to explore the respondent's opinions in relation to the questions posed in the study, where "1" represents

strongly disagree, "2" represents disagree, "3" represents neutral, "4" represents agree and "5" is strongly agree. The main reason behind the adoption of the Likert five-point scale was to give some degree of flexibility of choice to reflect the intensity of respondent views. This will be done through use of Google Form for quicker and larger outreach.

4. Results and Discussions

This study firstly presents the results of the survey in the form of descriptive and inferential statistics using tables, figures, and charts as well as other non-parametric statistical tools to describe its findings in the first instance. Secondly, the findings from the objectives of this case study were presented using tables, charts etc. The study population consists of 300 respondents involving students from eight (8) different departments in the Faculty of Engineering of the University of Nigeria, Nsukka (UNN). Questionnaires were administered to the respondents through Google form where they signed into using their verified UNN official email and submitted a response after exhausting the questions.

Before delving into the specific findings, this section provides background of survey respondents. Demographic details, such as academic levels, engineering disciplines are presented. This contextual information helped to establish the diversity and representation of viewpoints within the research study.

4.1. Gender of Respondents

From the gender of the respondents, the findings indicate that 206 (68.04%) of the respondents are male. While 30% of the respondents were female and this demonstrates a significant increase in female participation in engineering when compared to our previous studies (Onyia, 2019; Onyia, 2024; Onyia and Madueme, 2025). However, two respondents declined to reveal their gender.

Table 1 clearly shows the survey results of the age of the respondents of students and lecturers of UNN

Table 1 Respondents Gender

Gender	Frequency	Percentage
Male	206	68.04%
Female	92	30.25%
Prefer not to say	2	0.71%
TOTAL	300	100.00%

4.2. Age of Respondents

On the age of the respondents, the findings indicates that 175 (58.33%) of the respondents are 21 years – 26 years which is the most occurred, age group of 16 years – 20 years representing 20.67% of the respondents are the second most occurred while age groups of 41 years – 45 years, 51 years – 55+years, had no entry.

Table 2 clearly show the survey results of the age of the respondents of students of UNN.

Table 2 Age of Respondents

Age group	Frequency	Percentage
16 years – 20 years	62	20.67%
21 years – 25 years	175	58.33%
26 years – 30 years	52	17.33%
31 years – 35 years	9	3.00%
36 years – 40 years	1	0.33%
41 years – 45 years	0	0.00%
46 years – 50 years	1	0.33%

51 years – 55 years	0	0.00%
56 years and above	0	0.00%
TOTAL	300	100.00%

4.3. Academic Level

A total of 300 respondents were recorded. Findings indicate that 239 (79.67%) of the respondents are undergraduates which is the most occurring. 38 (12.67%) of the respondents are postgraduates while 1 respondent with Doctorate (Ph.D) featured. This finding demonstrates that the respondents are within the study area needed to contribute to the research thus providing the needed insights into the research.

Table 3 clearly shows the survey results of the academic levels of respondents in UNN.

Table 3 Respondents' Academic Levels

Academic level	Frequency	Percentage
Undergraduate	239	79.67%
Postgraduate	38	12.67%
Masters	7	2.33%
Doctorate (Ph.D)	1	0.33%
Others	15	5.00%
TOTAL	300	100.00%

4.4. Year of Study

A total of 251 respondents were recorded. Findings indicate that 89 (35.46%) of the respondents are in their final year of undergraduate studies which is the most occurring. 64 (25.50%) of the respondents are in 400L while the least occurring of the respondents are 300L with 11.55%. This finding demonstrates that the responses cut across the entire years of undergraduate studies within the study area needed to contribute to the research thus providing the needed insights into the research.

Table 4 clearly shows the survey results of the year of study of students who responded.

Table 4 Year of Study

Academic level	Frequency	Percentage
100L	29	11.55%
200L	40	15.94%
300L	29	11.55%
400L	64	25.50%
500L	89	35.46%
TOTAL	251	100.0%

4.5. Engineering Field

A total of 300 respondents were recorded. Findings indicate that 121 (40.33%) of the respondents are in the civil engineering department which is the most occurring. 65 (21.67%) of the respondents are in the electrical engineering department while the least occurring of the respondents are from metallurgical/materials engineering department

with 3.00%. This finding demonstrates that the responses cut across the entire faculty within the study area needed to contribute to the research thus providing the needed balance and rationale into the research.

Table 5 Respondents Engineering Field

Engineering field	Frequency	Percentage
Agric. And Bio-resources Engineering	26	8.67%
Civil Engineering	121	40.33%
Electrical Engineering	65	21.67%
Electronics Engineering	17	5.67%
Mechanical Engineering	20	6.67%
Metallurgical/Materials Engineering	9	3.00%
Mechatronics Engineering	14	4.67%
BioMedical Engineering	28	9.33%
TOTAL	300	100.0%

The relative importance index (RII) approach was used to rank the various responses to the research questions.

4.6. Perceptions of the Practical Content of Engineering Education for Entrepreneurship, Innovation, Safety and Sustainability in Nigeria

The Likert five-point scale was employed to explore the respondent's opinions in relation to the questions posed in the study, where "1" represents strongly disagree, "2" represents disagree, "3" represents neutral, "4" represents agree and "5" is strongly agree.

The results presented in Table 6 shows that the most important variable contributing to perception of the practical content of engineering education for entrepreneurship, innovation, safety and sustainability in Nigeria is "safety education is important for engineering students" with a RII of 0.9040 and ranked first. While the results indicate that "practical training opportunities for engineering students are easily available" has the least relative importance index RII of 0.6667 and ranked fifteenth. "Practical training provides enormous skills for engineering students" and the huge "importance of introducing entrepreneurship education for engineering students" are next in the list of the highest ranked factors with RII of 0.8680 and RII of 0.8653 respectively.

This result suggests that while there is a generally positive perception of the inclusion of entrepreneurship, innovation, safety, and sustainability in engineering education as recommended by Onyia & Madueme (2025) and Akeel et al. (2017), there is room for improvement in some areas, such as more comprehensive integration of entrepreneurship and sustainability education, and increasing the availability of practical training opportunities. The importance of safety education and the impact of practical training on skill development and career preparation are particularly noteworthy. It emphasized that practical training provides enormous skills for engineering students and there is a huge importance of introducing entrepreneurship education for engineering students.

Table 6 Perceptions of the Practical Content of Engineering Education for Entrepreneurship, Innovation, Safety and Sustainability in Nigeria

S/N		SD	D	N	A	SA	RII	RANK
		1	2	3	4	5		
PE-1	You are aware of inclusion of entrepreneurship, innovation, safety, and sustainability in engineering education	1	10	30	139	120	0.8447	4
PE-2	Have received any education or training related to entrepreneurship during your engineering studies at school	4	38	53	130	75	0.7560	12

PE-3	Engineering education led to exposure to innovation-related courses or projects	1	10	41	158	90	0.8173	8
PE-4	Innovation education contributes to the overall development of engineering students	2	6	31	146	115	0.8440	5
PE-5	Huge importance of introducing entrepreneurship education for engineering students	0	5	29	129	137	0.8653	3
PE-6	There are adequate safety education courses during your engineering studies	5	39	63	123	70	0.7427	13
PE-7	Have been exposed to sustainability concepts or courses in your engineering education	5	24	77	143	51	0.7407	14
PE-8	Safety education is important for engineering students	1	2	17	100	180	0.9040	1
PE-9	Safety education should be integrated into specific engineering course	4	21	34	106	135	0.8313	6
PE-10	Safety education should be offered as a stand-alone course	5	25	66	108	96	0.7767	11
PE-11	There is encouragement of sustainability education in engineering programs	1	17	56	150	76	0.7887	10
PE-12	Have participated in any practical training activities (e.g., internships, industrial projects) during your engineering studies	1	24	36	133	106	0.8127	9
PE-13	Practical training opportunities for engineering students are easily available	14	60	79	106	41	0.6667	15
PE-14	Practical training provides enormous skills for engineering students	0	4	32	122	142	0.8680	2
PE-15	A way to prepare adequately for the challenges and demands of the engineering profession	4	6	42	145	103	0.8247	7

4.7. Identifying and Exploring New Teaching Methods and Approaches That will Enhance The Practical Content of Engineering Education

The Likert five-point scale was employed to explore the respondent's opinions in relation to the questions posed in the study, where "1" represents strongly disagree, "2" represents disagree, "3" represents neutral, "4" represents agree and "5" is strongly agree.

The results presented in Table 7 shows that the most important new approaches and methods towards enhancing the practical content of engineering education in Nigeria is "collaboration with industry professionals or companies" with a RII of 0.8960 and ranked first. While the results indicate that "SIWES: (Students Work Experience Scheme) should start from 200L" has the least relative importance index RII of 0.7780 and ranked twelfth. "Provision and use of CAD Software laboratories" and "Project-Based Learning (PBL which involves assigning students real-world engineering projects that require them to apply their theoretical knowledge to solve practical problems" are the next in the list of the highest ranked factors with RII of 0.8813 and RII of 0.8800 respectively.

This result shows that through collaboration with industry professionals or companies and provision and use of CAD software laboratories will go a long way in facilitating a more robust and effective approach to teaching curriculum that emphasizes practice over theory. Online collaborative platforms as recommended by Onyia (2024) should be encouraged to facilitate teamwork and knowledge sharing among engineering students. Here, it is important to note that students learn quickly and easily from each other and so, group projects, seminars, presentations and research should be adopted as early as possible. The results highlight the respondents' viewpoints on various methods and approaches to enhance the practical content of engineering education. Collaboration with industry professionals, gamification, practical projects, and leveraging technology all seem to be highly valued. The rankings and RII scores provide insights into the perceived importance and potential impact of these approaches on improving the practical aspects of engineering education.

Table 7 Identifying and Exploring New Teaching Methods and Approaches That will Enhance The Practical Content of Engineering Education

S/N		SD	D	N	A	SA	RII	RANK
		1	2	3	4	5		
TM-1	SIWES: (Students Work Experience Scheme) should start from 200L	5	46	42	91	116	0.7780	12
TM-2	Deploying Artificial Intelligence, Machine Learning and Convergent Technologies	2	13	45	120	120	0.8287	11
TM-3	Gamification: Integrate game elements, such as quizzes, challenges, and competitions, into engineering courses to make learning more engaging and enjoyable	1	5	37	124	133	0.8553	10
TM-4	Collaboration with industry professionals or companies	0	6	17	104	173	0.8960	1
TM-5	Students' union can host training or support that would benefit faculty members.	1	5	24	118	152	0.8767	5
TM-6	Online collaborative platforms to facilitate teamwork and knowledge sharing among engineering students.	1	2	22	129	146	0.8780	4
TM-7	Digitalization of Engineering drawing courses	3	4	36	108	149	0.8640	8
TM-8	Provision and use of CAD Software laboratories	1	4	29	104	162	0.8813	2
TM-9	Simulation and Virtual Laboratories	1	7	28	125	139	0.8627	9
TM-10	Flipped Classroom: In a flipped classroom, students access lecture materials online before class	2	4	25	126	143	0.8693	6
TM-11	Provision and use of a central faculty of engineering electronic library	2	7	23	124	144	0.8673	7
TM-12	Project-Based Learning (PBL which involves assigning students real-world engineering projects that require them to apply their theoretical knowledge to solve practical problems.	0	3	22	127	148	0.8800	3

4.8. Benefits of Promoting Practical Content of Engineering Education

The Likert five-point scale was employed to explore the respondent's opinions in relation to the questions posed in the study, where "1" represents strongly disagree, "2" represents disagree, "3" represents neutral, "4" represents agree and "5" is strongly agree.

The results presented in Table 8 shows that the most important benefit associated with promoting practical contents of engineering education is "strengthening collaboration between engineering education institutions and industries in Nigeria" with a RII of 0.8953 and ranked first. While "Contributes to the overall development of engineering students" and "Prepare students adequately for the challenges and demands of the engineering profession" are next on the list with RII of 0.8940 and RII of 0.8900 respectively. The result indicates that "Compliance to international standards" has the least relative importance index RII of 0.8647 and ranked fourteenth.

The highest-ranked benefit of "strengthening of collaboration between engineering education institutions and industries" provides students with real-world exposure and experiences, aligning education with industry needs. Other benefits include improved student preparation for the profession, enhanced skills, innovation, and alignment with global standards. Practical education is perceived to foster a holistic development of students while bridging theory and practice, all of which contribute to producing competent and capable engineering professionals.

Table 8 Benefits of Promoting Practical Content of Engineering Education

S/N		SD	D	N	A	SA	RII	RANK
		1	2	3	4	5		
BE-1	Strengthening collaboration between engineering education institutions and industries in Nigeria	1	3	16	112	168	0.8953	1
BE-2	Prepare students adequately for the challenges and demands of the engineering profession	1	2	21	113	163	0.8900	3
BE-3	Digital and technological literacy	1	5	19	110	165	0.8887	4
BE-4	Compliance to international standards	0	5	36	116	143	0.8647	14
BE-5	Intelligent and effective approaches	1	0	20	128	151	0.8853	6
BE-6	Contributes to the overall development of engineering students	0	2	25	103	170	0.8940	2
BE-7	Stimulates student's innovative tendencies	0	7	26	119	148	0.8720	11
BE-8	Enhancement of Entrepreneurship skills among students	1	4	26	117	152	0.8767	10
BE-9	Bridges the gap between theory and practice	0	7	26	101	166	0.8840	7
BE-10	Improved critical thinking	1	5	20	118	156	0.8820	8
BE-11	Enhances public perception of engineers	2	3	28	130	137	0.8647	13
BE-12	Encourages teamwork and collaboration among students	0	4	20	116	160	0.8880	5
BE-13	Design and implementation of safer engineering solutions	3	4	18	124	151	0.8773	9
BE-14	Sustainability and environmental conservation	1	6	25	126	142	0.8680	12

5. Conclusion

This paper, conducted at the University of Nigeria, Nsukka (UNN), closely scrutinized the practical content of its engineering education, focusing on the critical dimensions of entrepreneurship, innovation, safety, and sustainability. The findings explicitly underscore a significant gap between the current curriculum and the evolving demands of the global and local job market. While engineering education is an essential component for national development, the analysis reveals that existing programs at UNN, despite their foundational strengths, do not sufficiently equip graduates to navigate the complexities of modern industry, nor do they fully prepare them with the innovative capabilities, entrepreneurial mindset, safety consciousness, and sustainable practices essential for 21st-century engineering challenges.

Our study highlights the paramount importance of embedding innovation and entrepreneurship within engineering curricula. These skills are no longer complementary; they are central to fostering economic growth and technological advancement. Likewise, the study emphasizes the unconditional necessity of integrating robust safety and sustainability principles into every dimension of engineering education. Graduates must be competent in prioritizing safety protocols and equipped with the knowledge and skills to confront pressing environmental and societal challenges. Besides, the findings emphasize the critical need for contextual adaptation within Nigerian engineering education. Curricula ought to be tailored to Nigeria's unique infrastructure requirements, entrepreneurial ecosystem and sustainable development goals, addressing local needs while ensuring global relevance.

In view of these conclusions, this research strongly recommends a comprehensive curriculum enhancement process at UNN. This involves not just revising course content to integrate practical elements of entrepreneurship, innovation, safety, and sustainability but also providing faculty with the necessary training to effectively deliver the revised curriculum. Interdisciplinary collaboration between engineering departments and other faculties, like business, law and environmental sciences, is vital to facilitating a more holistic educational approach. Moreover, establishing robust industry-academia collaboration will provide students with essential real-world exposure, internships, and mentorship opportunities, guaranteeing curriculum relevance and facilitating practical skill development. Implementing a sturdy safety culture through strict adherence to protocols, regular training, alongside a deep integration of sustainability principles, will guarantee that graduates are well-versed in responsible engineering practices. Ultimately, a system for

continuous improvement and assessment of the practical content, embedding feedback mechanisms and alumni engagement, is crucial for ongoing enhancement engineering education.

By adopting these suggestions, Nigeria stands to significantly elevate the quality of its engineering education. This will not only empower UNN graduates with the practical skills needed to thrive in the modern workforce but also position the university as a frontrunner in nurturing engineers who are ready to drive entrepreneurship, innovation, safety, and sustainability, thereby making a substantial contribution to national development in particular and international at large. This study in all serves not as a critique of existing practical engineering education but as a sense of urgency, highlighting the profound benefits of adopting new teaching methods and approaches that will enhance the practical content of engineering education for a more enduring prosperity.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

All participants provided written informed consent prior to their participation in the study.

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