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Exploring Fourth Industrial Revolution Skills Required for Employability of Mechatronic Graduates in Lagos State, Nigeria

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Abstract: The study investigated fourth industrial revolution skills required for employability of graduates in mechatronic workshops in Lagos State, Nigeria. Two (2) objectives and research questions were posed to guide the study. The population of the study comprised of one hundred and fifty-two (152) respondents. No sample was taken for lecturers in the both institutions since the population was manageable. A researcher developed questionnaire structured on five (5) point Likert scale was used to elicit the responses of respondents. The instrument was subjected to face and content validity by three (3) experts. The instrument was administered on the respondents with the help of three (3) assistants and retrieved within an interval of fourteen (14) working days. In determining the internal consistency of the instrument, ten (10) copies of the instrument was pilot-tested on lecturers of University of Ibadan and industry-based supervisors in Oyo State, which yielded a coefficient of .81. The researcher analyzed the responses of respondent using mean and bar chart to represent the degree of respondents' opinion. The yardstick for decision making was chosen at 3.50. The study found that automation and artificial intelligence skills are required of graduates for employment in mechatronic workshop in Lagos State, Nigeria. Recommendation reached amongst others is that tertiary institutions offering engineering technology-related courses should update her curriculum, pedagogical models and methodologies, to integrate Industry 4.0 skills identified in this study.

Keywords: Fourth Industrial Revolution, Employability and Mechatronic

Introduction

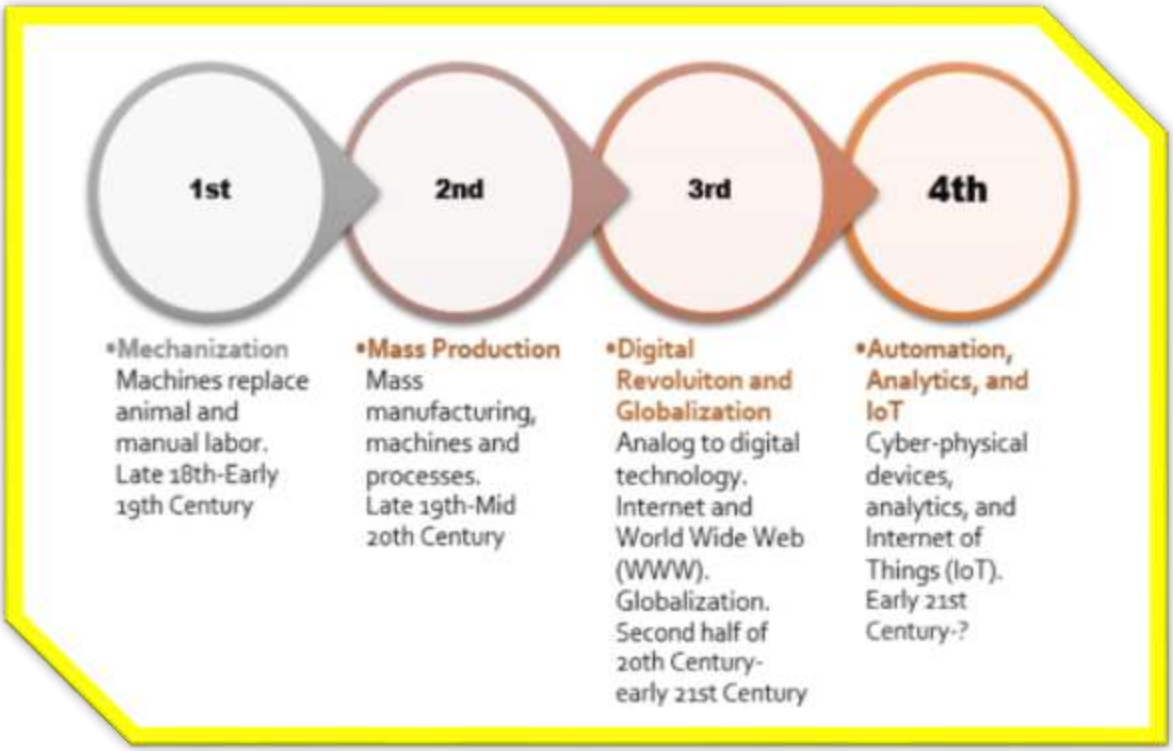
Engineering education is undergoing a profound transformation, marked by the convergence of disruptive technologies, digital interconnectivity, advanced automation, and artificial intelligence, all of which are reshaping industrial processes and business models (Lu et al., 2019). The education of engineering professionals demands competencies for increasingly changing work and social environments. This is compounded by scientific evidence revealing that knowledge is not static but a dynamic process characterized by high levels of competencies, short product life cycles, and constant testing of new processes, products, and services (Mendes et al., 2020). Addressing these challenges necessitates a significant transformation in engineering education to produce highly skilled professionals. In this regard, accreditation emerges as a paramount concern, adopting evaluation frameworks to gain international recognition for engineering programs (Narong & Hallinger, 2024). Meanwhile, the European Network for Accreditation of Engineering Education (ENAEE) stressed it focus on harmonizing and ensuring the quality of engineering programs in Europe, promoting student and professional mobility within the region. These systems, along with others like Japan Accreditation Board for Engineering Education (JABEE), Institute of Engineering Education Taiwan (IEET), and the National Board for Technical Education (NBTE) in Nigeria are fundamental in maintaining the excellence and relevance of engineering education on a global scale (Saue, 2024; Haro, et al., 2023; Jalali, et al., 2022; Olvera, et al., 2021). In exploring the present day industry 4.0 skills, mechatronic engineering is fundamental.

Mechatronics is a multidisciplinary field of engineering and technology that integrates mechanical engineering, electrical and electronic engineering, computer science, and control engineering to design and create intelligent systems and products. It involves the synergistic combination of mechanical components, electronic control systems, and software to develop advanced and automated devices. Mechatronics engineering as stated by Afolalu, et al., (2021) is a basic concept in the design of manufacturing systems and plays a vital role in the manufacturing industry by bridging the gap between the physical and digital worlds. Furthermore, the use of advanced mechatronic systems, including cutting-edge technologies in sensors, actuators, information communication technology (ICT), intelligent control, etc., is essential in implementing the principles of Industry 4.0, as they offer the hardware and software infrastructure required for an intelligent manufacturing environment (Stankovski, et al., 2019). Mechatronics encompasses the necessary hardware and software components to facilitate the automation and control of manufacturing processes. However, this flourishes more in industry 4.0 which offers the medium to connect and analyze data, allowing real-time monitoring and control of these processes.

Therefore, Fourth industrial revolution and industry 4.0 are used interchangeably and many academicians use industry 4.0 as the synonym of 4IR (Demir, 2021). The first industrial revolution began in England around 1750 to 1760 associated with invention of steam power and mechanical manufacturing triggering urbanization and entrepreneurship (Mohajan, 2019). The second industrial revolution began in America around 1860 until 1914. This stage was characterized by chemical industry, oil and gas, tap water with domestic pipes, electrical communication technologies, telephones, artificial fertilizers and mass production (Demir, 2021). The third industrial revolution began in early 1945 following the World War II and it mostly emphasized the power of data. This stage was more characterized by the development of computer inventions, renewable energy technology and smart grid technology, and hybrid and fuel cell-based transportation (Philbeck & Davis, 2019). Hence, the fourth industrial revolution and industry 4.0 are used interchangeably and many academicians use industry 4.0 as the synonym of 4IR (Marzano & Martinovs, 2020; Kitole, 2023; Nasution, 2021). The 4IR is characterized by the fifth generation mobile network (5G), Cloud Computing, Artificial Intelligence (AI), three-dimensional (3D) printing, robotics, drones, biometrics, genomics, virtual reality (VR) and augmented reality (AR), internet of things (IoT), industrial internet of things (IIoT) and block chain (Mhlanga, 2022).

Fourth Industrial Revolution represents a profound digital transformation that is impacting industrial operations and the global economy, enhancing business capabilities through the integration of emerging technologies (Grabowska & Saniuk, 2022). Industry 4.0 is fundamentally revolutionary within organizations, as it has the potential to catalyze fundamental changes in business processes and organizational adaptation. This technological integration enables faster decision-making based on precise, real-time data, promoting the transformation towards intelligent and highly efficient manufacturing environments (D'Orazio et al., 2020). Key technological pillars such as the Internet of Things (IoT), cyber-physical networks, automation, among others, have triggered a true revolution not only in the way production processes are carried out but also in business models, allowing holistic connectivity across different stages of the value chain (Nitlarp & Kiattisin, 2022).

Typical representation of the characteristics of each industrial revolution as adapted below:



Source: https://www.td.org/insights/2025

Fourth industrial revolution technology enables the transformation of the entire manufacturing structure of companies in terms of productivity at a faster rate while maintaining high quality at lower costs (Kitole and Sesabo, 2022). Through such automation, the economic conditions have replacing human labor with automated and intelligent machines which are more accuracy enough to minimize transaction costs attributable to human errors and thus, it has replaced labor intensive capital investment to father reducing employment while graduates are flocking in the labor market every year seeking jobs. Furthermore, the 4th industrial revolution

aims at transforming and improving production methods in industries (Marzano & Martinovs, 2020). The fourth industrial revolution has forced organizations, institutions, and MSMEs to navigate in searching for new way of employing more technical skills relevant the 4IR characteristics fueling graduate unemployment in case they are not prepared by the university curricula and policies to be acquainted with the skills that are required for self-employment (Madjid & Bahiroh, 2020). The present industrial revolution as the previous, has its skills that distinguished it from the former. These skills are peculiar and vital in the industries.

Consequently, skills is the ability of carrying out a task with an expectation of a certain outcomes or results, usually within a given period of time and/or with an individual efforts. In other words, skills in the ability of an individual to put into action the knowledge he/she has, in order to achieve the intended goal (Kassema, 2016). However, competence is the fusion of capabilities and skills essential for an individual to effectively meet job demands and excel in their professional environment (Salman, et al., 2020). In another words, Kinkel et al. (2017) described competence as the individual dispositional ability and readiness to act successfully and in a self-organized manner when facing novel, unstructured or complex situations or tasks and the ability to develop solutions for future situations. Corroborating with the above, The European Commission (2019) posited that competencies is a combination of essential skills, knowledge, and attitudes necessary for the full development of citizens in today's society including such skills as automation and Artificial intelligence (AI).

Automation has become a great tool almost in all industries due to the various advantages it offers. Automation, characterized by the use of technology to perform tasks with little to no human involvement, has significantly reshaped the labor and industrial sectors. Automation according to Sostero (2020) are technologies designed to replace human labour input by machine input for some types of tasks within economic processes. Automation can been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination.

Artificial intelligence (AI) systems use various techniques, including machine learning, deep learning, natural language processing, and computer vision, to analyze large amounts of data and make pre dictions or decisions based on that analysis (Munim, et al., 2020). Artificial intelligence (AI) refers to the development of computer systems that can perform tasks that typically require human intelligence, such as learning, problem solving, perception, decision-making, and language understanding (Franken & Wattenberg, 2019). Acquisition of such skills as described afore showcases high chances of graduate employment in the society.

Hence, employability focuses on the ability to get initial employment to focus on the skills and capabilities that enable employees to manage their careers throughout their careers. However, majority of the definitions highlighted the importance of acquiring the job market skills and acknowledge to be competitive in the job market. Tymon, (2013) maintained that personal attributes are also important, which are aligned to personality theory or in other words, the personality traits of employees. Lowden et al. (2011) termed employability generally as the group of skills, qualities, and characteristics that employers anticipate from employees.

Several economic reports, noted that advanced digitization and automation of work known as the "fourth industrial revolution", are expected to have a massive impact on individual future career experiences by changing the very basis of work, employment, and doing business in the upcoming future. It is also predicted that these changes will eliminate thousands of jobs (Hirschi, 2018; World Economic Forum, 2023). At the same time, the Cognizant Centre for the Future of Work has predicted that around 21 Min new jobs would be generated in the coming years, thus increasing the demand for new future skills in order to fulfil the future job requirements. Both the World Economic Forum and the British Council in the UAE specified in their reports a set of job-related skills known as employability skills that university graduates need to possess by the year 2030. Basing on such reports, student's employability skills are often seen as effective tools to sustain employment at the future labor markets.

Statement to the Problem

The world is undergoing a rapid transformation driven by the new Industrial Revolution (4IR), where emerging technologies, including digitalization, have significantly altered our lifestyles, consumption patterns, and production processes (World Economic Furum, 2023; Kohlbeck, 2021; Campos, et al., 2023). This shift necessitates adaptation to new challenges, particularly, manufacturing companies are compelled to embrace new processes and strategies to remain competitive in this dynamic industrial environment (Sannö, 2019). Consequently, the fourth industrial revolution technology enables the transformation of the entire manufacturing structure of companies in terms of productivity at a faster rate while maintaining high quality and efficiency (Kitole & Sesabo, 2022). Undoubtedly, most of tertiary institutions nationwide are yet to respond to these emerging trends by equipping the new generation of engineers with the necessary skills and competencies to compete in the present fourth industrial revolution (Winberg, et al., 2020). In corroboration with the above, Fuertes et al., (2021) noted that there is a growing concern among universities to provide education that responds to the needs of Industry 4.0 or 4IR, where human talent and technology converge to create new opportunities, seeking solutions, solving various problems, and exploring different possibilities for innovation. Hence, the need for combining engineering education with emerging technologies into courses and training in order to continuously integrate

the young graduates into the world of industries cannot be overstretched. Based on the above, the study titled "exploring fourth industrial revolution skills required for employability of mechatronic graduates in Lagos State, Nigeria' was carried out. The researcher proposed two (2) objectives to guide the study.

1. To investigate the automation skills required for employability of graduates in mechatronic workshops in Lagos State
2. To determine the artificial intelligence skills required for employability of graduates in mechatronic workshops in Lagos State

Research Questions

Two research questions were formulated to guides the study.

1. What automation skill is required for employability of graduates in mechatronic workshops in Lagos State?
2. What artificial intelligence skill is required for employability of graduates in mechatronic workshops in Lagos State?

Methodology

- **Design:** Descriptive research design was adopted for the study.
- **Population**: The population of the study consisted of one hundred and fifty-two (152) respondents. The population of the study consisted of mechatronic engineering lecturers of Universities and Polytechnics as well as industry-based supervisors drawn from selected firms in Lagos States Nigeria. The population comprised of fourteen (14) lecturers from Yaba College of Technology, Yaba, seventeen (17) lecturers from Lagos State University of Science and Technology Ikorodu and one hundred and twenty-one (121) supervisors from selected firms in Lagos State, Nigeria.
- **Sample and Sampling Technique:** No sample was taken for lecturers in the both institutions since the population was manageable. However, a total of one hundred and twenty-one (121) supervisors was drawn from selected firms using a purposive sampling technique.
- **Instrument for Data Collection:** A researcher developed questionnaire was used to elicit the responses of respondents. The instrument was structured on five (5) point Likert scale ranging from Highly Required (HR) = 5, Required (R) = 4, Moderately Required (MR) = 3, Not Required (NR) = 2 and Highly Not Required (HNR) = 1 respectively.
- **Validity:** The instrument was subjected to face and content validity by three (3) experts. Their critiques, correction and recommendations was used to draft the final copy of the instrument.
- **Reliability of Instrument:** In determining the internal consistency of the instrument, ten (10) copies of the instrument was pilot-tested on lecturers of University of Ibadan and industry-based supervisors in Oyo State, which yielded a coefficient of .81.
- **Administration of Instrument:** The instrument was administered on the respondents with the help of three (3) assistants and retrieved within an interval of fourteen (14) working days.
- **Method of Data Analysis:** Upon retrieval of instrument, the researchers analyzed the responses of respondents using mean and bar chart to represent the degree of respondents' opinion. The yardstick for decision making was taken at 3.50.

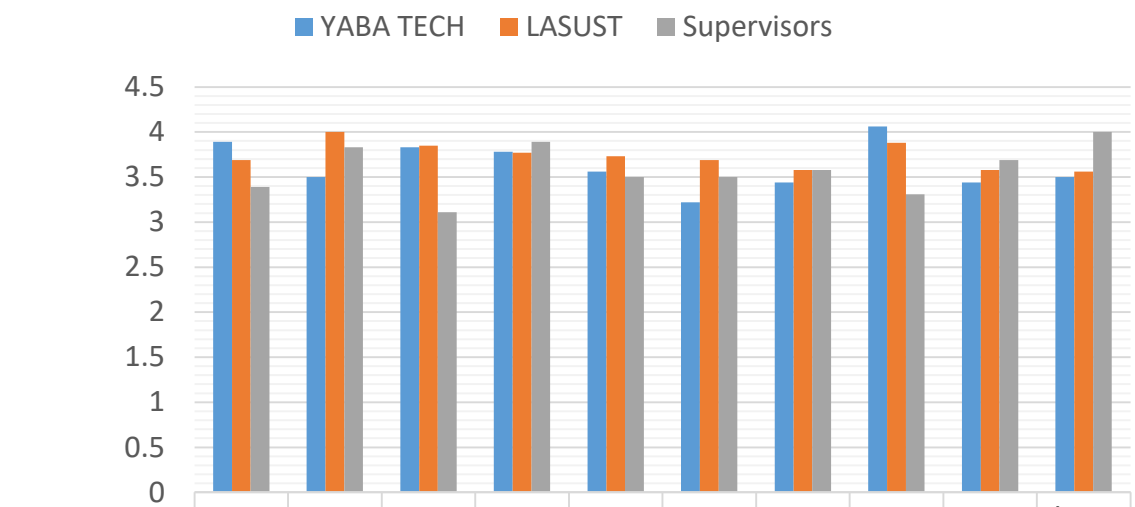
Results

Research Question 1: What automation skill is required for employability of graduates in mechatronic workshops in Lagos State?

Table 1: Automation skills required for employability of graduates in mechatronic workshops in Lagos State

S/N	Observable Skills
1.	Programming logic controller (PLC) skill
2.	Troubleshooting skill
3.	Calibration and adjustment of machine part
4.	Advanced robotics skill
5.	Circuit design skill
6.	Networking skill
7.	Cybersecurity skill
8.	Human-Machine Interface skill
9.	Programmable Logic Controllers (PLCs) skill
10.	Data Analysis skill

*Significant at 5% level of Significance



	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
YABA TECH	3.89	3.5	3.83	3.78	3.56	3.22	3.44	4.06	3.44	3.5
LASUST	3.69	4	3.85	3.77	3.73	3.69	3.58	3.88	3.58	3.56
Supervisors	3.39	3.83	3.11	3.89	3.5	3.5	3.58	3.31	3.69	4

Figure 1: Presentation of responses on automation skills

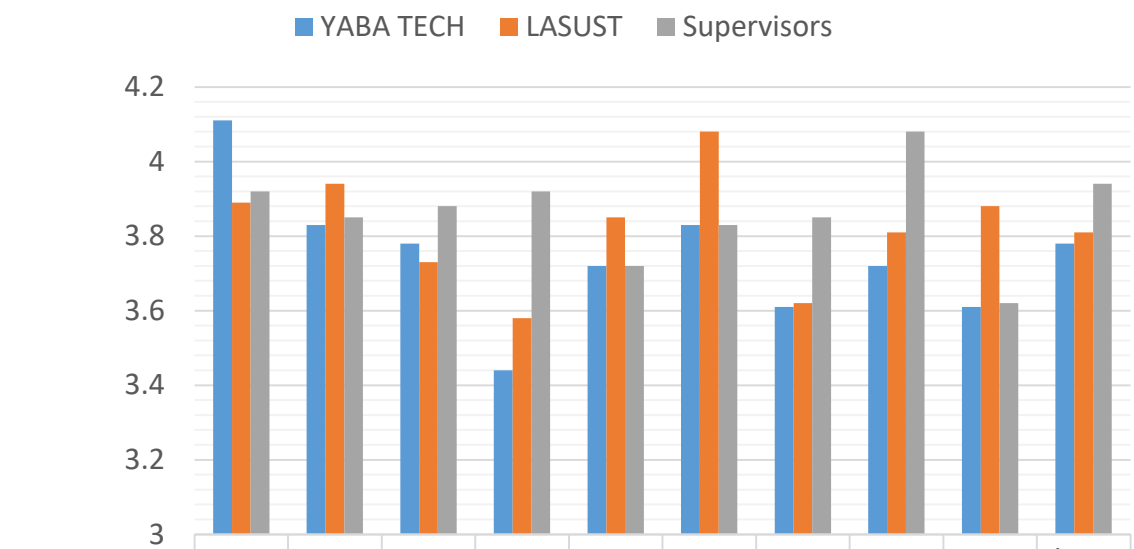
Figure 1 above shows the mean response of respondents on automation skills required for employability of graduates in mechatronic workshops in Lagos State. Based on the decision level of 3.5, the responses of respondents indicated "required' on all the items presented except for item 6(3.22), 7(3.44) and 9(3.44) for lecturers of Yaba Tech and item 1(3.39), 3(3.11) and 8(3.31) respectively. Hence, the result revealed that automation skills are required of graduates for employment in mechatronic workshop in Lagos State, Nigeria.

Research Question 2: What artificial intelligence skill is required for employability of graduates in mechatronic workshops in Lagos State?

Table 2: Artificial intelligence skills required for employability of graduates in mechatronic workshops in Lagos State

S/N	Observable Skills
1.	Intelligent User Interfaces (IUI) skills
2.	Machine learning skill
3.	Deep learning skill
4.	Programming language skill
5.	Data analysis skill
6.	Data visualization skill
7.	Analytical and Mathematical skills
8.	Natural Language Processing (NLP) skill
9.	Data Warehousing and Processing skill
10.	Diagnosing skill

*Significant at 5% level of Significance



	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
YABA TECH	4.11	3.83	3.78	3.44	3.72	3.83	3.61	3.72	3.61	3.78
LASUST	3.89	3.94	3.73	3.58	3.85	4.08	3.62	3.81	3.88	3.81
Supervisors	3.92	3.85	3.88	3.92	3.72	3.83	3.85	4.08	3.62	3.94

Figure 2: Presentation of responses on artificial intelligence skills

Figure 2 above shows the mean response of respondents on artificial intelligence skills required for employability of graduates in mechatronic workshops in Lagos State. Based on the decision level of 3.5, the responses of respondents indicated "required' on all the items presented except for item 4(3.44) for lecturers of Yaba Tech. Hence, the result revealed that artificial intelligence skills are required of graduates for employment in mechatronic workshop in Lagos State, Nigeria.

Discussion of Findings

Figure 1 above shows the mean response of respondents on automation skills required for employability of graduates in mechatronic workshops in Lagos State. Based on the decision level of 3.5, the responses of respondents indicated "required' on all the items presented except for item 6(3.22), 7(3.44) and 9(3.44) for lecturers of Yaba Tech and item 1(3.39), 3(3.11) and 8(3.31) respectively. Hence, the result revealed that automation skills are required of graduates for employment in mechatronic workshop in Lagos State, Nigeria. Also, Figure 2 above shows the mean response of respondents on artificial intelligence skills required for employability of graduates in mechatronic workshops in Lagos State. Based on the decision level of 3.5, the responses of respondents indicated "required' on all the items presented except for item 4(3.44) for lecturers of Yaba Tech. Hence, the result revealed that artificial intelligence skills are required of graduates for employment in mechatronic workshop in Lagos State, Nigeria. This finding is in congruence with Agolla (2018), who noted that the progressive rise in the use of intelligent machines in industries underscore the growing significance of Industry 4.0 skills for employment. Kovacs, (2018) argued that employability in the time of industry 4.0 has been a challenge because few employment opportunities do not require human interaction because most of works are automatically performed by robots and others supported by artificial intelligence.

Conclusion

Todays' industries are complex and more of computing than the previous manually-operated system. The fourth industrial revolution generation requires that students are equipped with future requirements of industries to address the present realities. Figure 1 & 2 above presented the responses of respondents which indicated "required' on 13-items and "not required" on 7-items respectively. This deduced that respondents that automation and artificial intelligence skills are required of mechatronic engineering graduates for employment in Lagos State, Nigeria.

Recommendations

Following the results of the study, the researchers recommended as follows:

1. Engineering education is pivotal in training future professionals with the required skills to thrive in the digital era. Hence, tertiary institutions offering engineering technology-related courses should update her curriculum and pedagogical models and methodologies, to integrate Industry 4.0 skills identified in this study.
2. The industry-school collaboration should be enforced and maintained across all Nigerian tertiary institutions to bridge the industry-school divides in skill training.
3. Regular workshop and training of lecturers and technologists is paramount towards providing effective training for graduates' employment upon graduation.

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