



RE-ENGINEERING BUSINESS EDUCATION CURRICULUM FOR PROACTIVE RESPONSE TO INDUSTRY 4.0 IN NIGERIA

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Abstract

The advent of Industry 4.0, marked by advancements in digital technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data, and automation, is fundamentally transforming global business landscapes. In Nigeria, the current Business Education curriculum requires significant re-engineering to align with these technological shifts and equip graduates with the skills needed to thrive in a rapidly evolving economy. This paper explores strategies for updating the Business Education curriculum to proactively respond to Industry 4.0 in Nigeria. Key recommendations include the integration of digital literacy and emerging technologies, the emphasis on data analytics and decision-making skills, and the fostering of interdisciplinary collaboration. Additionally, the paper advocates for promoting an entrepreneurial mindset, updating pedagogical approaches to include project-based learning, and enhancing industry-academia collaboration. Continuous curriculum review processes, the development of soft skills, and an emphasis on sustainability and ethical practices are also highlighted as essential components of a re-engineered curriculum. The proposed curriculum changes aim to produce graduates who are not only technically proficient but also adaptable, innovative, and capable of leading in a dynamic business environment. By aligning Business Education with the demands of Industry 4.0, Nigeria can better prepare its workforce to contribute to national development and compete in the global economy. This paper provides a framework for educators, policymakers, and industry stakeholders to collaboratively develop a curriculum that meets the challenges of the 21st century.

Keywords: Re-Engineering, Business Education, Curriculum, Industry 4.0, Nigeria

Introduction

The world is in the midst of a transformational change. The changes are rapid- economic, social and technological transformations. These transformations and in particular, the impact of the fourth industrial revolution driven by digital technologies, have increased demand for higher-order skills, competencies and knowledge. According to Ndung'u and Landry (2020), the Fourth Industrial Revolution (4IR) characterized by the fusion of the digital, biological, and physical worlds, as well as the growing utilization of new technologies such as artificial intelligence (AI), cloud computing, robotics, 3D printing, the Internet of Things, and advanced wireless technologies, among others has ushered in a new era of economic disruption with uncertain socio-economic consequences for Africa.

As Spöttl and Windelband (2021) stated, the 4th Industrial Revolution is one of the most widely discussed technological and socioeconomic developments of the modern world with a deep impact on the agenda of education policies and strategies. While there is rather widespread agreement that the 4th Industrial Revolution will have a substantial impact on education and training, still comparatively little attention is being paid to the exploration of the current and potential implications of the 4th industrial Revolution for the key processes of education and training, and, in particular, for their curricular development.

The implications of the AI revolution for business, industry and daily life remain to some extent in the realm of speculation, but have nevertheless been discussed widely. The most obvious matters are those that relate to the ways in which the nature of work and the job market are changing – and will continue to change at an increasing pace. Apart from the nature of work, there is considerable disagreement as to



whether or not the Fourth Industrial Revolution will create more employment or result in the loss of work opportunities.

Just what it might mean for education has had less attention, although the implications are extensive – both in terms of what universities can (or should) contribute to the advancement of AI and its applications and how curricula and learning will need to change. The challenge of responding to the myriad of changes occasioned by the drivers of industry 4.0 is not the same for all countries. For least developed countries, like Nigeria, where training institutions and skills policies are not fully developed, this represents a particularly difficult process. In these countries, high levels of informality, or a lack of legal framework to enforce certain training standards usually characterizes training systems. For them, a revision of the curriculum of training systems and the skills delivered through these establishments is essential for adaptation.

Concept of Business Education

Business Education has been defined by various authorities from different points stand. However, Udu, Oguegbulu and Ogbuagu (2015). defined business education as a formidable force in equipping youths with the appropriate skills, knowledge, abilities and competencies to enable the individual to be: Self-employed and self-reliant leading to sustainable economic growth and poverty eradication in the society. Udu, Oguegbulu and Ogbuagu (2015) see business education as a type of education which deals with the acquisition of practical skills, knowledge, and values to enable an individual to function effectively in society.

Udu, Oguegbulu and Ogbuagu (2015) sees business education as an education process or context whose primary aim is the preparation of people for roles in business enterprises such as employers, entrepreneurs or as self-employed. Business education from whatever perspective, is an education which provides with the knowledge, and skills capable of improving the lives of its beneficiaries to positively touch on the lives of others.

From a wider and more encompassing perspective, business education is seen as an aspect of the total educational programme that provides knowledge, skills, understanding, and attitudes needed to transfer business knowledge as well as perform in the business world as producer or consumer of goods and services that business offers (David and Egbeyemi, 2023).

Industrial Revolution during the Ages

Stearns (2018) argues that “the industrial revolution was the most important single development in human history over the past three centuries.” Industrial revolution could be argued to be a major development, change, or transformation that has taken place in the history of human society; from the use of machines, telecommunications, electricity, to new developments in the form of technology. Any industrial revolution changes government policies and the way the government provides services to various communities, and influences both the social and economic aspects of society. Vries (2008) explains that “industrial revolution” refers to the occurrence, during the transition from a pre-industrial to an industrial society, of modern economic growth; in other words, a sustained and substantial increase of gross domestic product per capita in real terms.

The world has seen three different industrial revolutions that have taken place in the course of history. Ionescu (2018) states that the First Industrial Revolution (1IR) had its roots in the Middle Ages and lasted to the year 1780. The 1IR saw the invention and expansion of the canal and later railway networks, which increased communication ability, and the invention of the stock exchange, which led to the rise of banks, financiers, and private investment (Roberts 2015). The 1IR was mainly based in Britain. After the transformation of the British Empire, many European countries soon followed in the revolution. The 1IR changed many societies dramatically from lower-income households to rich countries. The 1IR was so successful that it brought European countries out of the Dark Ages. The success of this revolution gave European countries supremacy over other parts of the world. The 1IR was a step in the right direction for human civilization.

The 1IR covered the period between the 18th and 19th centuries. During this period, human communities developed from agricultural activities to the use of mechanisation. The steam engine was invented in the 1IR, which changed the means available for production. Communities around the world, mainly in Europe and North America, developed new ways of doing business and dealing with social issues. These changes brought new possibilities, responsibilities, and abilities. Through the 1IR, many countries were able to develop, expand, increase, and diversify their economies. The 1IR was essentially the



improvement of infrastructure. The 1IR across the world is credited with the improvement of living standards, new skills, increased urbanisation, and many more.

The Second Industrial Revolution (2IR) was the continuation of the previous era and began in the early 19th century. The 2IR saw major technological developments in steel, chemicals, electricity, and in various other fields (Agarwal and Agarwal 2017). The invention of electricity was a crucial development as it made it possible for many industries to operate and expand their businesses. This technological advancement also made mineral exploration possible. The 2IR was characterised by the use of machines, which were mostly powered by electricity.

The Third Industrial Revolution (3IR) began in the mid-1900s. Roberts (2015) notes that the 3IR was pushed by the development of technological advancements in manufacturing, distribution, and energy factors. One of the biggest advancements in the 3IR era was the development of nuclear power, as well as the wide use of electronics. During the 3IR, many parts of the world began to catch up with Europe. The first three industrial revolutions were characterised by technological advancements but not at the rate of current times. Recent times have seen rapid development, implementation, and use of technology for various reasons. Technology has become a huge part of human beings' life. Technology is giving societies new abilities and capacities and is changing lives.

David and Kim (2018) explains that the 4IR entails a society whereby individuals are able to move and interact with one another between digital domains with the use of technology to assist and manage life. Furthermore, the 4IR is about the digital revolution happening at the current moment.

The 4IR has ushered in new possibilities and opportunities for society. It is built up from the continuation of many successes of the previous revolutions. The 21st century has different challenges that will need new ideas to solve them. The 4IR encompasses different emerging technologies. The new revolution encompasses new ideas, new possibilities, new creations, and new inventions. This new revolution is about breaking frontiers. Schwab (2016) points out that the new revolution is "characterized by a much more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence [AI] and machine learning." During the turn of the century, the use of mobile devices increased dramatically.

Schwab (2016) states that the 4IR includes gene sequencing, nanotechnology, renewables, and quantum computing. The new revolution therefore goes beyond the use of smart technology, computers, and much more. It is the fusion of these technologies and their interaction across the physical, digital, and biological domains that make the 4IR fundamentally different from the previous revolutions (Schwab 2016). These new developments have been taking place at the same time to move the world into a new phase of growth, development, and discovery. The current revolution is taking place in all fields, sectors, and spheres of life.

The four industrial revolutions seen in the world were technology driven, and the use of various technologies assists the government and the private sector to experience growth at a quick pace. In current times, various new concepts and ideas are brought to life due to the use of technology. Ideas such as virtual worlds, smart cities, big data, Internet of Things (IoT), and AI have taken centre stage in driving development in the new era. Another similarity in these revolutions is the improvement of lives and the ease of doing business and providing services.

The 4IR is also known as Industry 4.0; however, the term "Industry 4.0" is mostly used in the business world. Erboz (2017) define Industry 4.0 as a collective term for technologies of value chain organisations. Industry 4.0 deals with creating more digitised systems and network integration via smart systems (Erboz 2017).

In Industry 4.0, new systems will replace existing ways of performing tasks with human labour by using machines.

Characteristics of the Fourth Industrial Revolution (4IR)

Erboz (2017) argues that the components of Industry 4.0 are categorised as the IoT, Cyber Physical Systems, Internet of Services, and Smart Factory. There are, however, many other characteristics and features of the 4IR, such as AI, three-dimensional (3D) printing, robotics, blockchain technology, cryptocurrency, quantum computing, nanotechnology, and bioengineering. According to Skilton and Hovsepian (2018), these technologies are changing how materials, products, and services are produced and consumed.

The 4IR is also characterised by the use of information and communications technology (ICT). ICT is widely used in business, government, and civil society organisations. The use of ICT involves computer software and hardware to perform tasks. The 4IR is viewed as the revolutionary change that takes place when ICT



thrives in all industries, namely the primary, secondary, and tertiary industries (Lee et al. 2018:3). This is the case that the world has seen since the beginning of the 21st century.

Big Data

Big data refers to large sets of complex data, both structured and unstructured, which traditional processing techniques and/or algorithms are unable to operate on (Taylor-Sakyi 2016). Big data is seen as high-volume, high-velocity, and/or high-variety information assets that demand cost-effective and innovative forms of information processing that enable enhanced insight, decision making, and process automation. Big data platforms could assist organisations to analyse and make meaningful decisions based on the data available to them. As the world becomes more connected each day, large amounts of data are collected from different devices. A need to analyse these data for future use arises in order to reveal hidden information. De Mauro, Greco and Grimaldi (2015) state that one of the important reasons for the big data phenomenon is the current extent to which information can be generated and made available. Governments and businesses depend on the amount of information generated through different technological modes for their decisions. For a government, this could be the number of people visiting a local police station or provincial hospital, or categorising a crime hotspot. In addition, the large amounts of data collected will need sufficient space for storage, hence the use of new technological inventions.

Artificial Intelligence (AI)

The concept of AI has existed for over 60 years. It is the ability of computers to perform complex functions associated with human intelligence; however, AI has superior intelligence and capacity. Alsedrah (2017) states that AI is the field of study that describes the capability of machines to learn like humans and the ability to respond to certain behaviours. Through new computer algorithms and commands, machines are instructed to perform tasks in the same way as human beings. AI is referred to as the field of science aimed at providing machines with the capacity to perform functions such as logic, reasoning, planning, learning, and perception (Perez, Deligianni, Ravi and Yang 2018). In other words, AI is computer software with human-like characteristics. The world has seen increased use of AI in self-driving cars, Apple's Siri, and Google. With the use of new technologies, computers are programmed to complete certain tasks by processing large amounts of data and recognising patterns in the data.

Robotics

Robotics is built on the developments made in mechatronics, electrical engineering, and computing (Perez et al. 2018:24). As the environment changes, so too the use of robotics. Robotics is deeply rooted in industries such as car manufacturing plants that rely heavily on the use of machines for production. As pointed out by Karabegovi and Husak (2018), it is impossible today to imagine the production process in any industrial sector without industrial robots. The use of robots in different industries contributes to a faster production rate. Different companies resort to the use of robots to perform tasks that are seen as too complex for human beings to perform. Karabegovi and Husak (2018) further argue that the 4IR has contributed to the development of robotic technology because the strategies of the leading countries are to fully automate the production process, or to enable "intelligent automation." Companies seek increased productivity, hence the need for robots with superior abilities and intelligence. This leads to new developments and technologies to create robots in order to surpass the previous generation.

The Internet of Things (IoT)

In recent times, there have been developments in technology with the new concept known as IoT. Imagine a world where different electronic devices such as fridges, computers, television sets, mobile devices, and many more are connected to one another and to the Internet. This is possible through the concept of IoT. This connection via the Internet enables various devices to send and receive information from one another (i.e. to share data). Gartner.com (2016) defines IoT as the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. This digital interaction between and within machines and systems forms the heart of the 4IR (Karabegovi and Husak 2018). In simple terms, as argued by De Saulles (2017), IoT has the potential to change the way humans work and live to a great extent.

Three-Dimensional (3D) Printing

According to Eisenberg (2013), the era of 3D printing is here. The historical patterns of growth in 3D printing are similar to those associated with the growth of home computing in the late 1970s. 3D printing is a process of making solid 3D objects from a digital file, or, as Chow-Miller (2018) refers to it, the process of making items using what is called additive manufacturing. This new technology has seen widespread use in various fields such as medicine, car manufacturing, and many others, for different purposes. Some of the uses of 3D printing include making aeroplane parts, and artificial organs using human cells. This



technology has been in use since the 1980s; however, it has passed through different developments. Nevertheless, it is only in recent times that the technology has gained momentum. 3D printing presents a much faster and cheaper way to create objects.

Quantum Computing

According to Microsoft (2019), quantum computing takes days or hours to solve problems that would take billions of years using today's computers. It also enables new discoveries in the areas of healthcare, energy, environmental systems, smart materials, and beyond. Similarly, IBM (2019) explains that quantum computers could promote the development of new breakthroughs in science, life-saving medicine, machine learning methods to diagnose illnesses sooner, materials to make more efficient devices and structures, financial strategies to live well in retirement, and algorithms to quickly direct resources such as ambulances. According to Marshall (2016), "modern societies are characterised in part by the value given to education." In order for countries to benefit from the 4IR, a significant shift in the education sector is required to ensure participation in the digital society.

However, education is susceptible to "wicked problems." Wicked problems entail that there are multiple explanations of key elements and commonly contain mutually dependent problems that are interconnected (Marshall 2016). This article will discuss a number of key elements for consideration in education. In essence, a new strategy for the consideration of ICT in education is pivotal to overcoming some of the wicked problems presented by the 4IR.

Conceptualization of the Curriculum

Conceptualizations of curriculum have evolved over time, driven mainly by contextual factors and by intellectual perspectives. The new concept of curriculum is broad based, consisting of the totality of experience that students receive through the manifold activities that goes on in the school, in classroom, library, laboratory, workshop, social settings and in the numerous contacts between the teachers and students. Marope (2017) classifies the curriculum concept into two understandings. First, curriculum is a document, a codified form of educational intentions. Second, curriculum is the totality of (planned) activities influencing the teaching and training process. Curriculum in education and training is viewed as the structural basis for the organization and implementation of education and training as well as for achieving the intended learning outcomes. The curriculum defines:

1. Objectives, outcomes and contents of education and training,
2. Processes and activities necessary for their achievement and implementation (organizational forms, strategies, models and methods of teaching and learning),
3. Ways of assessment and criteria for the assessment of achievement.

A sound curriculum is the basis for remodelling education in Nigeria in the light of sweeping fourth industrial technological changes. The nature and practice of education needs to change in accordance with global/industry demands. The demands today are for smart and articulate workers who possess higher-order skills, are creative and can solve problems (Caleb, 2019). The curriculum is a microcosm of the wider society outside school. It constitutes what a society elects to remember about its past, what it believes about its present, and what it hopes and desires for the future. It is both retrospective and prospective, and it encourages learners to look back at the past and look forward to the future in particular ways. The design of a curriculum shapes the minds and mentalities of young people and encourages them to understand and act in society in particular approved ways. As a result, the local detail of all curriculum reform needs to be understood and grounded in long waves of societal change that are pursued from the past into the present and from there projected into the future (Ryan, 2010).

Current conceptualizations of the curriculum have been on how the curriculum might be redesigned and reformed in the perceived context of the digital age. This is hinged on the premise of constantly changing technologies, accompanied by complex, long waves of social and technological change in the economic, political, and cultural dimensions of existence (Caleb & Israel, 2021).

Business Education and Industry 4.0: Adapting for the 21st Century

Industry 4.0, often referred to as the Fourth Industrial Revolution, is characterized by the fusion of physical and digital technologies, transforming industries and reshaping business operations globally. This revolution is driven by advancements in artificial intelligence (AI), the Internet of Things (IoT), robotics, big data, blockchain, and cloud computing (Schwab, 2016). For Business Education to remain relevant in the 21st century, it must evolve to incorporate these technologies and prepare students for the demands of Industry 4.0.

Curriculum Modernization

The integration of Industry 4.0 into Business Education begins with curriculum modernization. Traditional business courses must be supplemented with content that addresses the digital skills required in the



modern workforce. This includes teaching students how to utilize AI in decision-making processes, employ big data analytics for strategic planning, and understand the implications of IoT in supply chain management (Bals, Kirchoff, & Foerstl, 2019). Furthermore, cybersecurity has become a critical area of focus, given the increased risks associated with digital transformation. Educating students on cybersecurity practices is essential for protecting business operations in an interconnected world (Weber, 2010).

Skill Development

Industry 4.0 demands a workforce equipped with not only technical skills but also strong problem-solving and critical thinking abilities. Business Education programs must emphasize the development of these skills by incorporating project-based learning and real-world problem-solving exercises into the curriculum (Fisk, 2017). Collaborative skills are also paramount, as Industry 4.0 often requires cross-disciplinary teamwork. Programs should foster collaboration between business students and their counterparts in engineering, computer science, and other fields to encourage interdisciplinary learning (Valdez-DeLeon, 2019).

Entrepreneurial Mindset

The rapid technological advancements of Industry 4.0 offer fertile ground for innovation and entrepreneurship. Business Education should cultivate an entrepreneurial mindset by encouraging students to identify opportunities in emerging markets and to innovate within existing business structures (Hisrich, Peters, & Shepherd, 2013). This includes training students in the use of digital platforms to launch and scale businesses, as well as promoting sustainable business practices that align with the United Nations' Sustainable Development Goals (SDGs) (Elkington, 1998). By doing so, students are not only prepared to succeed in the current market but also to contribute positively to global challenges.

Practical Experience and Industry Collaboration

To ensure that students are well-prepared for Industry 4.0, Business Education programs should emphasize the importance of practical experience. Internships, co-op programs, and partnerships with businesses that are leaders in digital innovation are essential for providing students with hands-on experience (Kolb, 1984). These opportunities allow students to apply theoretical knowledge to real-world situations, bridging the gap between academia and industry. Additionally, collaboration with industry leaders in developing the curriculum ensures that the skills taught are aligned with current industry needs (Stuart, 2004).

Lifelong Learning and Continuous Improvement

In the rapidly evolving landscape of Industry 4.0, the concept of lifelong learning is more critical than ever. Business Education programs must instill in students the importance of continuous learning and professional development (Senge, 2006). Institutions should provide alumni with access to ongoing education and training programs that help them stay abreast of technological advancements and industry trends (Marr, 2019). This commitment to lifelong learning will enable professionals to adapt to the continuous changes that characterize Industry 4.0.

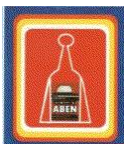
Conclusion

Business Education must undergo significant transformation to remain relevant in the era of Industry 4.0. By modernizing curricula, focusing on skill development, fostering an entrepreneurial mindset, and enhancing practical experience and industry collaboration, Business Education programs can equip students with the tools necessary to thrive in the 21st century. Moreover, by promoting lifelong learning, these programs ensure that graduates are not only prepared for the present but are also adaptable to future changes in the business landscape. As Industry 4.0 continues to evolve, Business Education must stay dynamic, ensuring that its graduates are capable of leading and innovating in a digital, interconnected world.

Recommendations

By following these recommendations, Nigeria's Business Education programs can be re-engineered to produce graduates who are not only equipped with the skills and knowledge necessary for Industry 4.0 but also capable of driving innovation and sustainable development in the Nigerian economy.

1. Integrate Digital Literacy and Emerging Technologies: To align with the demands of Industry 4.0, the Business Education curriculum in Nigeria should incorporate comprehensive digital literacy training. This includes understanding and applying emerging technologies such as artificial intelligence (AI), the Internet of Things (IoT), blockchain, big data analytics, and cloud computing. Courses should provide hands-on experience with these technologies to ensure that students are not only familiar with them but can also leverage them effectively in business settings.



2. Emphasize Data Analytics and Decision-Making Skills: Given the central role of big data in Industry 4.0, it is crucial that Business Education curricula place a strong emphasis on data analytics. Students should be trained in data collection, analysis, and interpretation techniques, enabling them to make informed, data-driven decisions. Incorporating case studies and projects that require the application of analytics tools will help students develop practical skills that are highly valued in the modern business environment.

3. Foster Interdisciplinary Collaboration: Industry 4.0 requires professionals who can work across disciplines to solve complex problems. The Business Education curriculum should encourage interdisciplinary collaboration by integrating courses or projects that involve students from other fields such as engineering, computer science, and information technology. This approach will prepare students to work in diverse teams and understand how different areas of expertise contribute to business innovation.

4. Promote an Entrepreneurial Mindset: The curriculum should nurture an entrepreneurial mindset, encouraging students to identify opportunities in emerging markets and innovate within existing business frameworks. Courses should cover entrepreneurship, innovation management, and start-up incubation, with a focus on how Industry 4.0 technologies can drive new business models and solutions. Supporting this with mentorship programs, business incubators, and opportunities for real-world venture creation can further enhance students' entrepreneurial skills.

5. Update Pedagogical Approaches: To keep pace with Industry 4.0, Business Education programs in Nigeria should adopt modern pedagogical approaches such as project-based learning, experiential learning, and flipped classrooms. These methods engage students actively and provide practical experience that mirrors the complexities of the business world. Utilizing simulation tools and virtual environments can also give students a taste of real-world business scenarios enhanced by Industry 4.0 technologies.

6. Enhance Industry-Academia Collaboration: Strengthening partnerships between educational institutions and industry is critical for curriculum relevance and effectiveness. Regular consultations with industry leaders can help ensure that the curriculum reflects the latest industry trends and needs. Internships, co-op programs, and collaborative projects should be integrated into the curriculum, allowing students to gain practical experience and apply their learning in real-world contexts.

7. Continuous Curriculum Review and Flexibility: The rapid evolution of Industry 4.0 technologies necessitates a curriculum that is both current and adaptable. Business Education programs should establish a continuous review process that incorporates feedback from students, alumni, and industry partners. This process should allow for the timely introduction of new courses, modules, or technologies, ensuring that the curriculum remains relevant and responsive to industry changes.

8. Develop Soft Skills and Lifelong Learning: Beyond technical skills, Industry 4.0 demands strong soft skills such as critical thinking, problem-solving, communication, and adaptability. The curriculum should integrate these skills into all aspects of learning, ensuring that students are well-rounded professionals. Moreover, fostering a culture of lifelong learning is essential, encouraging graduates to continuously update their skills in response to technological advancements and industry shifts.

9. Encourage Sustainability and Ethical Business Practices:

As Industry 4.0 technologies can have significant environmental and societal impacts, the curriculum should incorporate modules on sustainability, corporate social responsibility (CSR), and ethical business practices. This will prepare students to lead in ways that are not only profitable but also socially and environmentally responsible, aligning business objectives with the broader goals of sustainable development.

10. Invest in Faculty Development and Infrastructure: Finally, to successfully implement these recommendations, there must be substantial investment in faculty development and educational infrastructure. Educators need continuous professional development to stay current with Industry 4.0 technologies and pedagogical innovations. Additionally, institutions must invest in the necessary technological infrastructure, including labs, software, and online learning platforms, to support the delivery of a modern, Industry 4.0-aligned curriculum.

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