

Introducing Robotics into the Nigerian Secondary Schools Curriculum: Likely Impacts, Challenges and Possible Solutions

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Abstract— One of the ways by which the youths of nowadays can be galvanized and empowered to go on and proffer solutions to the existing, emerging and future technology problems is by introducing them to robotics at their early age. The trend in most developed countries is that priority is usually placed on robotics at all levels of education i.e. primary, secondary and tertiary. This is expected considering the numerous areas of application of robots and its effects on economic growth and technological development of such countries. Reverse is the case in Nigeria. One would then wonder why robotics has not been fully and officially incorporated into the Nigeria secondary schools' curriculum. Probably, some of the top officials in government are not really convinced that introducing such would make any meaningful impact as far as the economy and technological advancement are concern. While relying on data obtained from various secondary sources, this study focuses on presenting the likely impacts and challenges of introducing robotics in to the Nigerian secondary schools curriculum and to put possible solutions forward. The results showed that creation of job opportunity, increased interest in engineering and computer science among prospective university candidates, enhanced academic performance, and solution to the problem of "digital divide" are some of the likely impacts while Inadequate budgetary allocation, Inadequate physical infrastructure, and dwindling electrical power supply have been identified as the major challenges which are likely to be encountered if robotics is finally introduced into the Nigerian secondary schools curriculum.

Keywords— robotics, curriculum, secondary, education, Nigeria, impact, challenge, solution.

INTRODUCTION

Motivating the current crop of secondary students to go on and become the problem-solving leaders of tomorrow without given them the right background is tantamount to sending farmers to the farm without given them the required implements. One of the ways by which the youths of nowadays can be galvanized and empowered in other to be able to proffer solutions to the existing, emerging and future technology problems is by introducing them to robotics at their early age.

The trend in most developed countries is that priority is usually placed on robotics at all levels of education i.e. primary, secondary and tertiary. This is expected considering the numerous areas of application of robots and its effects on economic growth and technological development of such countries. Increased labour productivity, total factory productivity; raised annual growth of gross domestic product (GDP); increased operational safety, enhanced surgery performance, reduction in need for care and care home, more help for the elderly and the chronically ill, possibility of long distance monitoring of isolated patients, are some of the effects of robots cum the variety of applications in the military and nuclear power plants. Against the notion that robots contributes to the unemployment rate, they have been proven to create jobs. Robots cannot design, develop and maintain themselves. Humans have to be employed to carry out those tasks [1, 2, 4, 5, 6].

In Nigeria, it so unfortunate and disheartening that robotics has not been given the right attention and the failure of government to have it included in the secondary schools curriculum has undoubtedly limited our technological capacity. Several attempts have been made in the past by individuals, private, and co-operate bodies to render assistance in this regard. However, these have not been enough.

One would then wonder why robotics has not been fully and officially incorporated into the Nigerian secondary schools curriculum. Probably, some of the top officials in government are not really convinced that introducing such would make any meaningful impact as far as the economy and technological advancement are concern. The major objectives of this work, therefore, are to present the likely impacts of introducing robotics into the Nigerian secondary schools curriculum and to consider the challenges that may be encountered if such policy is to be implemented and finally, to present possible solutions to the identified challenges.

Relevant literature have been reviewed and included in this paper in other to further broaden knowledge and provide an in-depth understanding of the study especially for anyone, a novice, who might be interested in taking up the report of this work

LITERATURE REVIEW

Czech playwright, Karl Capek (1921), in his play R.U.R (Rossum's Universal Robots), brought the word robot forward for the first time [16]. George Devol and Joe Engelberger, in the late 50's and early 60's, developed the first industrial modern robots which were then known as the Unimates [15].

While there is no standard definition for robots, several attempts have been made in the past in this regard. According to the Robot Institute of America (1979), robots are reprogrammable, multifunctional manipulators designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of task [15]. Robots have also been referred to as machines-which can be angular, flat, tubby, spindly, bulbous, may or may not have faces, bodies- designed to execute one or more tasks repeatedly, with speed and precision. [12, 13, 14]. Robots which are capable of doing too dangerous, boring, onerous, or just plain nasty work are the most frequently encountered types especially in the auto, medical, manufacturing, and space industries [12]. Robots, unlike humans, don't get sick; don't violate company rules; don't demand raises; are quicker and easier to refuel and repair; are less prone to be bored by repetitive task; need no rest; are able to work on 7 * 24; can withstand extremely high and low temperature [4, 5, 6].

Robotics- a term coined by Isaac Asimov, a Russian-born American scientist and writer – can be defined as the study and use of robots [15]. Robotics, according to webopedia and wikipedia, is the field of computer science and engineering concerned with design, construction, operation, and application of robots. [16, 17].

Studying robotics, therefore, implies that students must be actively involved in physics, mechanical engineering, electrical engineering, structural engineering, mathematics, computing, and in exceptional cases, biology, medicine, and chemistry in a deeply problem-posing problem-solving environment [12]. Taking Carnegie Mellon Robotics Academy as a case study. Some of the robotics curriculum dedicated to students in middle schools include: Introduction to Programming VEX IQ, VEX Cortex Video Trainer using ROBOTC (Legacy), Introduction to Programming LEGO MINDSTORMS EV3, ROBOTC Graphical Introduction to Programming LEGO MINDSTORMS EV3, Robot Engineering Vol. 1 – Introduction to Mobile Robotics, Robot Engineering Vol. 2 – Guided Research, Robot Science, NXT Video Trainer 2.0, ROBOTC Curriculum of TETRIX and LEGO MINDSTORMS, and Robot Virtual Worlds. These, according to the academy, were created to, “allow students, in junior high schools to go from having no robotics experience, to programming advanced behaviors.” [18]

METHODOLOGY

Data used for the purpose of this study are those obtained from various secondary data sources namely: web information, historical data and information, mass media products, textbooks, journals, magazine articles, news reports, encyclopedia, and progress reports. In other to achieve the objectives of this work, facts and figures obtained from the data sources were used in carrying out extensive analysis with the sole aim of presenting the likely impacts, and challenges of introducing robotics in to the Nigerian secondary schools curriculum and also, to put possible solutions forward. The information so obtained from the afore-mentioned sources has also been useful in compiling, interpreting and structuring of the entire study.

RESULT AND DISCUSSION

IMPACT

The likely impacts, both positive and negative, of introducing robotics into the Nigerian secondary schools curriculum are discussed below:

• CREATION OF JOB OPPORTUNITY

According to a survey conducted by Jobberman, out of the 500 000 graduates being turned out by Nigerian Universities annually, only 57 percent get employed [25]. With the rate of unemployment on the rise, teaching robotics in secondary schools, both junior and senior, is a potential career opportunity to be explored by graduates of Mechatronics Engineering, and in exceptional cases, those of Electrical and Electronics Engineering, Computer Engineering, Mechanical Engineering, and Computer Science. While some of these graduates with high grades have a better chance of either being retained by their various universities or getting employed by the so-called, “big companies”, others could find a safe abode in teaching robotics at secondary schools. Similarly, Introducing robotics into the Nigerian secondary schools' curriculum will definitely results in having more robots around. Since robots cannot design, develop and maintain themselves, humans have to be employed to get those tasks done. Having more robots around, therefore, will in no doubt results in more jobs for experts in robotics.

• INCREASED INTEREST IN ENGINEERING AND COMPUTER SCIENCE AMONG PROSPECTIVE UNIVERSITY CANDIDATES

Global reform movements, according to Mehmet Ayar, Tubitak, Bugrahan Yalvac and Fatih Ugurdag (2013), are aimed at cultivating STEM (Science, Technology, Engineering and Mathematics) education at K-16 levels because of the decreasing numbers

of youth entering the STEM fields and medicine and the lack of student Interest in these fields [19]. Cher C. Hendricks, Meltem Alemdar, Tamra Williams Ogletree (2012), In their study, reported that 87% of students interviewed, after their participation in a robotics competition, said they were more interested in having a job in a STEM or computer field [20]. It has been shown that only 16 percent of students graduating secondary schools are interested in pursuing a career in STEM (Science, Technology, Engineering, and Mathematics). There is a prospect of increasing this number if robotics is introduced into the Nigerian secondary schools curriculum. Engaging secondary school students, both junior and senior, in robotics activities such as recognition and use of various mechanical, electronic and electrical materials is capable of sparking their interest in the field of engineering [19].

Having a close look at the robotics curriculum for high schools discussed under literature review, one would also conclude that students, upon completion of the secondary schools education, must have been acquainted with the rudiments of programming including its basic elements such as functions, file O/I, classes, abstraction, inheritance, etc. graduating secondary schools students - based on the computational, mathematical, and modeling skills they obtained - must have enriched their knowledge and broadened their problem-solving capability, thus making them more creative and innovative. In a nut shell, the number of prospective University candidates, who are capable and willing to pursue their bachelor's degree program in Mechatronics Engineering, Electrical and Electronics Engineering, Computer Engineering, Mechanical Engineering and Computer Science will have been increased significantly.

- **ENHANCED ACADEMIC PERFORMANCE**

Pat Ko of the University of Texas once submitted a proposal to study and analyze the differences in performances of robotics and non-robotics students in various examinations such as SAT. He stated, in his submission, that there is a theoretical connection between CT skills and students performance (one of the identified long term benefits of CT). In other words, there is a likelihood that robotics students will perform better than students who do not have CT experience [21]. Studying robotics, according Mehmet Ayar, Tubitak, Bugrahan Yalvac and Fatih Ugurdag (2013), provides the motivation for students to learn science, mathematics and other subjects to succeed in the nation-wide university entrance exam [19].

In Nigerian Universities and Polytechnics, one of the major challenges being faced by academic staff/lecturers in the Faculty of Engineering is the increasing failure rates of students. Most times, lecturers, in the name of face-saving, often resort to upgrading of results/addition of marks just to push them to or above the pass mark. The poor academic performance of engineering students is indeed not due to a lack of capacity for new students on the part of tertiary institutions but a lack of interested and qualified students. Studying robotics is not only capable of sparking interest of graduating secondary students in Engineering and related fields but also capable of enhancing their academic performances in tertiary institutions as well as in external/ national examinations [20].

- **SOLUTION TO THE PROBLEM OF “DIGITAL DIVIDE”**

Records have shown that students from educationally-less developed states and minority groups are really lagging behind in terms of participation in Engineering, Computer Science and related fields. This problem of ‘digital divide’ has been attributed, by many, to intentional marginalization of these parts of the country by successive governments. This is not true. It has been proven that most students, while in junior secondary schools, tend to develop interest in particular fields. This has a major influence on them when choosing their career paths. Several students with the potential of becoming future technology problem-solvers opted for other fields like business, law, medicine, etc. This is due to lack of exposure to a curriculum that integrates math, science, and technology content and skills. Technology, they say, ‘is no longer the private domain of a self-selected group of nerds.’ Incorporating robotics into the Nigerian secondary schools curriculum will get the students engage in a ‘complex, strategic problem-solving and higher-order thinking’. This will in turn spark a high level of interest in Engineering, Computer Science and related fields among the students, thereby putting an end to the problem of ‘digital divide.’ [22]

- **NEGATIVE IMPACTS**

Introducing robotics into the Nigerian secondary schools’ curriculum will definitely results in having more robots around. One of the fears of having more robots around is the prospect of robots displacing or replacing workers, mostly low-skilled.

- **OTHERS**

Introducing students to robotics at the secondary school level is capable of making them: designers and developers of future intelligent information technology systems (not just users and consumers), productive in employment and higher institutions, etc. [22]. Evidence has shown that introducing secondary schools students to robotics early is capable of increasing their understanding of physics content [23]. All in all, robotics has been identified as a valuable tool for students to develop cognitive, meta-cognitive and social skills necessary in the workplace of the 21st century [24].

CHALLENGE

Having presented the likely impacts, and seeing that the positives outnumbered the negatives, we cannot but discuss the challenges

which are likely to be encountered if robotics is finally introduced into the Nigerian secondary schools curriculum.

Dimitris Alimisis (2013), identified time consuming nature of robotic activities, high cost of equipment needed for such activities, lack of technologies that support the 21st-century learning skills in schools, and the perceptions that robotics is hard, highly gender-biased (only for boys!) as some of the challenges facing robotics education [24].

Marion Usselman, Mike Ryan, Jeffrey .H. rosen, Jayma Koval, Sabrinna Grossman, Nancy Anna Newsome, and Marcela Nicole Moren (2015), in their submission, concluded that time allocated to basic science subjects, in conformity with the physical science standards, is limited, and so robotics couldn't be accommodated within the allotted class time without jeopardizing student learning of required science standards. In other to further buttress this point, they argued that ,”the middle school physical science curriculum is generally tightly packed with required science content, leaving little time for students to really engage in important science practices, let alone learn valuable but tangential content like computer programming or the basics of mechanical engineering construction” [23].

Robotics, having been considered as a branch of educational technology, will not be exempted from the same old problems well known to be facing the latter, some of which are:

1. Inadequate budgetary allocation: Failure of successive governments to make enough funds available for the education sector has resulted into poor quality of service delivery. It is a well-known fact that old facilities in public secondary schools will not be sufficient if robotics is to be fully incorporated into the Nigerian secondary schools.

2. Inadequate physical infrastructure: most public secondary schools in Nigeria lack libraries equipped with scholastic materials and well equipped science laboratories. These are required, according to Dimitris Alimisis (2013), in other to, “foster critical thinking, problem solving, creativity, and teamwork and communication skills since they are architected for rigorous, disciplined, and scripted experiences” [119].

3. Dwindling electrical power supply: In a country where power generation reportedly dropped from 5000 megawatts to below 1600 megawatts early this year [26], without a stand-by alternative power supply, the problem of disruption and interruption during robotic sessions may be inevitable.

POSSIBLE SOLUTION

The measures listed below will go a long way in overcoming the challenges which are likely to be encountered if the government finally decides on incorporating robotics into the Nigerian secondary schools curriculum:

- The ministry of education, in collaboration with relevant agencies, should come up with a robust time-table which will accommodate robotics in secondary schools without jeopardizing students learning of required science standards.
- Government should make enough funds available for public schools. This will be useful in procuring standard robot kits and other logistics which are indispensable for a thorough, mind-blowing robotics activities.
- The problem of epileptic power supply should be tackled head-on. While concrete steps are being taken towards that, the government should make at least a generator/inverter available in all public secondary schools to avoid unnecessary interruption during robotics sessions.
- Well-equipped science laboratories and libraries equipped with scholastic materials should be put in place in all public secondary schools.
- Finally, the government should set-up control mechanisms and do follow-up on every policy effected to ensure effective monitoring and implementation.

FUTURE

Over the next decades, five key aspects of robotics are expected to make major economic impacts and transform societies. They are: drones; artificial assistants; driverless cars; medical procedures, operations; prosthetics and exoskeleton [10]. According to the saying of William Gibson, “the future is already here- It's just not evenly distributed.” Nigeria cannot afford to lag behind in this regard. With this at the back of our mind and considering the prospect of robots displacing or replacing workers (mostly low-skilled), the onus lies on the government to take the big steps now in anticipation of the glorious and exciting new future.

Finally, the data sources used for the purpose of this study are secondary. This paper, therefore, provides the platform for future researchers who may be willing to carry out further studies on similar issues based on data obtained from primary sources.

CONCLUSION

The results showed that creation of job opportunity, increased interest in engineering and computer science among prospective university candidates, enhanced academic performance, and solution to the problem of “digital divide” are some of the likely impacts while Inadequate budgetary allocation, Inadequate physical infrastructure, and dwindling electrical power supply have been identified as the major challenges which are likely to be encountered if robotics is finally introduced into the Nigerian secondary schools curriculum. Hence, possible solutions were put forward. While it is true that robotics has enormous potential to offer in education, perhaps it must be stated that the benefits thereof can only be guaranteed and fully harnessed when the curriculum is combined with an enabling, conducive learning environment and a holistic educational philosophy. The only thing that remains constant in life is change. As the world keep changing in this direction, the government of the day must rise to the occasion in other to actualize the vision 20-2020 i.e. to be among the top twenty industrialized country by the year 2020. Taking such steps will definitely provide us with the platform to taking a rightful place in the committee of developed nations.

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