AVAILABILITY AND UTILIZATION OF ROBOTICS KITS FOR TEACHING COMPUTER STUDIES IN SECONDARY SCHOOLS IN ENUGU STATE

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Abstract

This study investigated the availability and utilization of robotics kits in teaching computer studies in secondary schools in Enugu state using a descriptive survey design. Four research questions guided the study. The sample for the study is made up of 30 teachers selected from ten schools. A structured questionnaire was used for the data collection. The instrument was face validated by three experts and yielded a reliability of 0.89. The data collected for the study were analysed using percentage, mean and standard deviation to answer the research questions. The results of this study show that the only available robotics technology for teaching computer studies in secondary schools in Enugu state are Python tutorial packages and temperature sensors. While Lego Mindstorm Education EV3, Lego Mindstorms robotics tool Kits, Arduino Kits, Raspberry Pi, Scratch (Block programming) package, PIR motion sensor and Ultrasonic sensor were not available, their extent of utilization in teaching computer studies in secondary schools was low. Also, the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State were found to include: the high cost of robotics kits, inadequate physical infrastructure, and insufficient budget allocation for purchasing robotics technology tools, among others. The study also recommended some measures for addressing these challenges, namely provision of grants to schools and departments to minimise the high cost of robotics equipment, adequate provision of physical infrastructure for teaching robotics by schools and the provision of periodic retraining of teachers on how to use robotics tool kits in teaching.

Keywords: Availability; utilization; Robotics Kits; Teaching; Secondary Schools

Introduction

Advancement in technological innovations has affected all fields of human endeavours from manufacturing industries, to agriculture, scientific exploration and education. The education sector has been revolutionized by the advent of pervasive technologies such as the Internet of Things (IoT), Big Data and Robotics. Now, teaching and learning difficult and abstract concepts is made easy, attractive and fun-filled with the help of Robots.

A robot is defined as a programmable multi-function manipulator designed to move material parts, tools or specialized devices, through variable programmed motions for the performance of a variety of tasks (Robotics Institute of America, 2010). Robotics is the engineering science and technology of robots, and their design, manufacture, application, and structural disposition. It requires a working knowledge of electronics, mechanics, and software (British Robots Association, 2020). Robotics is a well-recognized motivational tool for engineering as well as computer science education (Singh & Mansotra, 2019). In the last few years, the advent of smaller, less expensive robots has made it possible for the lower tier of education such as secondary, primary and pre-primary school levels to afford these robotics kits for teaching and learning worldwide. Nigerian education institutions were not left out as many of them are now integrating robotics into their secondary school and undergraduate computer science curricula (Armstrong, 2020).

Although, there is no specific curriculum for robotics in Nigerian senior secondary schools, a number of both public and private educational institutions and schools in Nigeria have implemented robotics. Also, the extent and specific inclusion of robotics education in Senior Secondary Schools vary (Benyeogor et al, 2021). Some schools, particularly those focusing on technology and innovation, offer robotics courses or extracurricular activities as part of their curriculum. Nonetheless, robotics education is becoming more and more well-known throughout Nigeria as a crucial component of STEM (Science, Technology, Engineering, and Mathematics) education (Nnadi,

2019). Yet, not much is known of the level of availability and utilization of these robotic kits in Enugu state, Nigeria.

Rising education demands are forcing technology users to think about new ways to support academic institutions' priorities. Within the present economic context, robotic technology is one of the most important solutions on the education scene (Ajith & Hemalatha, 2020). Corroborating, Fagbola (2019) asserted that the adoption of robotic technology into the education system in secondary schools will improve teaching and learning efficiency and will also arouse the interest of the learners to learn computer studies. Mehmet and Serhat (2015) identified some of the benefits offered by robotics technology in education to include teaching topics such as computer programming, electricity and other engineering courses. Robotics also found application in medical education, such as robot-assisted learning that teaches the medical student how to carry out medical operations with high precision and accuracy, digital archive, marketing and other educational resources in Nigeria University. Educational robotics plays the role of fostering essential life skills (cognitive and personal development, teamwork) through which people can develop their potential to use their imagination, express themselves and make original and valued choices in their lives (Riedo et al., 2012).

During the last decade robotics has attracted the high interest of teachers and researchers as a valuable tool to develop cognitive and social skills for students from pre-school to high school and to support learning in science, mathematics, technology, informatics and other school subjects or interdisciplinary learning activities (Ayuba & Timayi, 2018). Most robots today are used to do repetitive (boring and dull) actions or jobs considered too dangerous and difficult for humans Ayuba and Timayi (2018). They are also used in factories to build things like cars and electronics. Some robots are even designed to explore underwater and on other planets. Another reason we use robots is that it is cheaper, easier and sometimes the only way we can get things done Robots can explore inside gas tanks, volcanoes, Mars and other places too dangerous for humans to go. Robots also can do one thing over and over again without getting bored. Another reason to use robots is that they never get sick; don't need to take a day off, and best of all they don't ever complain. It is clear that while robots have positive educational potential, there appeared a scarcity of studies that try to investigate if these robotics kits are available in Nigerian schools for teaching and learning purposes. Benitti (2011) highlights that most of the literature on the use of robotics in education is descriptive and is based on reports of teachers achieving positive outcomes with individual initiatives.

There have been arguments in recent times over the lack of quantitative research on how robotics can increase learning achievements in students (Bredenfeld et al., 2010). In other cases, the expected benefits have not been clearly measured and defined because there is no system of indicators and a standardized evaluation methodology for them (Ortiz et al., 2011). Despite the usually positive educational and motivational benefits, studies suggest that rigorous quantitative research is missing from the literature.

The new paradigm of robotic technology explores benefits and challenges as compared to the previous education system. In the last few years, robotic technology has expanded from being a promising logic; education with its virtualization concept to one of the fastest growing segments of education such as the use of LEGO mind storms, Arduino and Raspberry Kits. A major reason for the use of these robots is that it is cheaper and easier to use (Armstrong, 2020).

In any case, the impact of robotics in promoting student learning and developing skills needs to be validated through research evidence. However, there appeared a scarcity of studies that try to investigate if these robotics kits are available in Nigerian schools for teaching and learning purposes. With robotics technology, children with autism are learning communication and social skills and students with developmental issues and attention disorders are learning focus (Raptopoulou et al., 2021; Arshad et al., 2020). Individuals with severe physical disabilities are also offered constant companion and health monitoring systems (Audu & Agbo, 2010). According to Yusuf (2012), it is expected that the educational system in Nigeria should be standardized to a global level through the use of robotics technologies to equip students with the needed technological skills to face the present and future world of information technology.

Despite all these benefits derived from the use of robots in teaching and learning in our secondary schools, the use of robotics in schools still remains problematic. It is in view of the above deficiencies in existing studies that this study sought to investigate the level of availability and utilization of robotics technologies in Nigerian schools for teaching and learning.

Purpose of the study

The broad purpose of this study is to ascertain the availability and utilization of robotics technology for teaching computer studies in secondary schools in Enugu state. The specific objectives of this study are to determine the:

1. availability of robotics technology used for teaching computer studies in secondary schools in Enugu State.
2. extent of the utilization of the available robotics technology in teaching computer studies in secondary schools in Enugu State.
3. challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State.
4. measures for controlling the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State.

Research Questions

The following research questions were raised to guide the study:

1. What are the available robotics technology kits for teaching computer studies in secondary schools in Enugu State?
2. To what extent is robotics technology kits utilized in teaching computer studies in secondary schools in Enugu State?
3. What are the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State?
4. What are the measures for controlling the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State?

Methodology

This study adopted a descriptive survey research design. Agada (2020) states that a descriptive survey research design is one in which a group of people or items are studied by collecting and analysing data from only a few people or items considered to be representative of the entire group. Hence the study will elicit the opinion of the respondents on the level of availability and utilization of robotics technology in teaching and learning in secondary schools in Enugu State. The population of the study is 1871 teachers from public secondary schools in Enugu educational zone. The study adopted the cluster sampling technique where the Purposive sampling technique was used to select ten (10) secondary schools in Enugu state for the study. The ten schools were selected because of the availability of ICT infrastructures and other utilities within the secondary school. This was then followed by a total sampling technique which gave 30 teachers in the ten schools as the sample for the study.

The instrument for data collection was a structured questionnaire constructed by the researcher based on the literature reviewed. The questionnaire consists of two section-section A and B. Section A is concerned with background information of the respondents, while section B comprises of the research questions, clustered as cluster 1, cluster 2, cluster 3 and cluster 4 respectively. Cluster 1 comprises 9 items on a 3-point rating scale while cluster 2 comprises 8 items, cluster 3 comprises 7 items and cluster 4 comprises 6 items which were designed on a 4-point rating scale making a total of 30 items.

The instrument was face validated by three experts in the Department of Computer and Robotics Education, University of Nigeria Nsukka. The validated questionnaire was trial-tested on 15 students in secondary schools in Anambra States which is outside the area of study. Their responses were used in the computation of the reliability coefficient of the instrument using Cronbach Alpha. A reliability coefficient of 0.62, 0.67, 0.88 and 0.86 was obtained for clusters 1, 2, 3, 4 respectively. An overall reliability index of 0.89 was obtained.

The researcher administered (30) copies of the instrument and retrieved them by hand on the spot with the help of three research assistants. The data collected for this study was analyzed using percentages, bar chat, mean and standard deviation to answer the research questions. To answer research question 1, items with scores of 50% and above were considered “Available” while items with ratings below 50% were considered “Not Available”. For items in cluster 2, real limits were used for decision-making thus: $\frac{4-1}{3} = \frac{3}{3} = 1.00$. Therefore, the real limits are 0.99-1.99 (Low Extent), 2.00-3.00 (Moderate Extent), 3.01-4.00 (High Extent) (see Mohammed, 2016). For clusters 3 and 4, a criterion mean of 2.5 was used in taking decision. Any item with a mean rating of 2.5 and above was accepted, while items with mean rating less than 2.5 were rejected.

Results

The result of this study was presented based on the research questions guiding the study.

Research Question 1: What is the level of availability of robotics technology used for teaching computer studies in secondary schools in Enugu State?

To answer this question, the data collected from respondents on level of availability of robotics technology used for teaching computer studies in secondary schools in Enugu State was analyzed. The result is presented in

Figure 1.

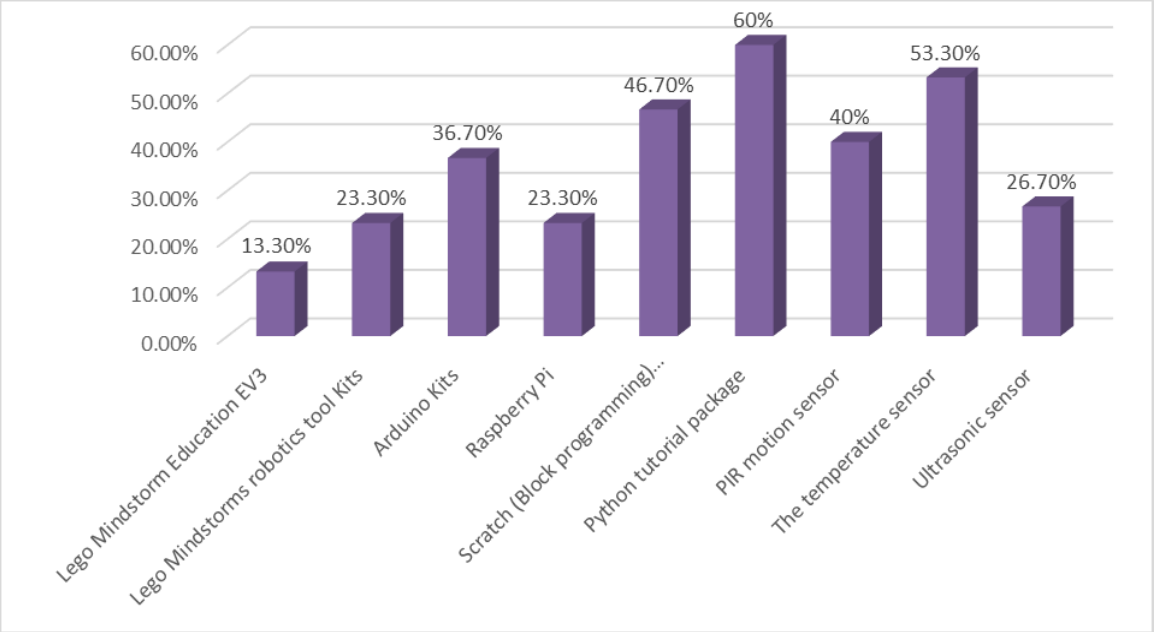

Figure 1. Percentage of Availability of Robotics Technology in Secondary Schools in Enugu state

Only two items were considered available. These available items were Python tutorial package (60%), and the temperature sensor (53.30%). The remaining items were considered not available since they have a percentage rating of less than 50%.

Results in Figure 1 show that there is no availability of relevant robotics technologies for teaching purposes in Secondary Schools in Enugu state.

Research Question 2: To what extent is robotics technology utilized in teaching computer studies in secondary schools in Enugu State?

Table 1. Mean and Standard Deviation of Extent of Robotics Technology Utilization in Teaching Computer Studies in Secondary Schools in Enugu State

S/N	Item statement	N	$\bar{x}$	SD	Remark
10	I use Lego Mindstorm Education EV3 in my school	30	1.27	0.69	Low Extent
11	I use Arduino Kits in my school for robotics projects	30	1.83	1.09	Low Extent
12	I use Raspberry Pi in my school for Robotics projects	30	1.43	0.94	Low Extent
13	I use scratch (Block programming) package/Tutorials in my school	30	1.63	1.00	Low Extent
14	I use Python tutorial package in my school	30	2.27	1.11	Moderate Extent
15	I use PIR motion sensor in my school for Robotics projects	30	1.97	1.22	Low Extent
16	I use temperature sensor in my school for robotics projects	30	2.20	1.19	Moderate Extent
17	Ultrasonic sensor is used in my school for robotics projects.	30	1.87	1.25	Low Extent
Cluster Average		**30**	**1.81**	**0.59**	**Low Extent**

Key: $\bar{x}$ =Mean; $\bar{x}$ between 0.99-1.99 (Low Extent), 2.00-3.00 (Moderate Extent), 3.01-4.00 (High Extent); **N**=Number of Respondents; **SD**=Standard Deviation

Table 1 shows that six (Items 10, 11, 12, 13, 15, and 17) out of the eight items were being utilized to a low extent. Two items (14 and 16) were utilised to a moderate extent. The cluster mean of (1.81±0.59) implies that the extent of utilization of robotics technology in teaching computer studies in secondary schools in Enugu State is low.

Research Question 3: Challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State?

To answer the research question on challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State, the mean and standard deviation of teachers' responses were computed and results are presented in Table 2.

Table 2. Mean and Standard Deviation of Challenges Militating Against the Utilization of Robotics Technology for Teaching Computer Studies in Secondary Schools in Enugu State

S/N	Item statement	N	$\bar{x}$	SD	Remark
18	High cost of robotics kits	30	2.83	1.18	Agreed
19	Inadequate physical infrastructure	30	2.97	1.00	Agreed
20	Insufficient budget allocation for purchasing robotics technology tools	30	3.17	0.83	Agreed
21	Insufficient competent and qualify teachers to teach Robotics in school	30	3.27	0.78	Agreed
22	Little interest by the students in learning robotics in school	30	2.93	1.05	Agreed
23	Inadequate robotics kits (components) for use in school	30	3.10	1.06	Agreed
24	Lack of reward system for teachers who are using robotics kits in their teaching	30	2.83	0.99	Agreed
Cluster Average		**30**	**3.01**	**0.76**	**Agreed**

Key: $\bar{x}$ =Mean, $\bar{x}$ >=2.5 = Agreed; $\bar{x}$ <=2.5 = Disagreed; **N**=Number of Respondents; **SD**=Standard Deviation

Table 2 shows that all the items in this cluster (Items 18, 19, …, 24) had mean ratings greater than the benchmark of 2.5. These items had a cluster average of (3.01±0.76). This means that the teachers agreed to all the items as challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State. An average SD of 0.76 shows that the respondents' responses were not far from each other.

Research Question 4: What are the measures for controlling the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State?

To answer this research question, the mean and standard deviation of teachers' responses on measures for controlling the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State were computed. The result is presented in Table 3.

Table 3. Mean and Standard Deviation of Measures for Controlling the Challenges Militating Against the Utilization of Robotics Technology for Teaching Computer Studies in Secondary Schools in Enugu State

S/N	Item statement	N	$\bar{x}$	SD	Remark
25	The high cost of robotics equipment should be minimized through provision of grants to schools and departments.	30	2.97	1.19	Agreed
26	Schools/ Governments should provide adequate physical infrastructure for teaching robotics.	30	2.97	1.00	Agreed
27	Provision of quarterly training to teachers on the use of robotics in teaching.	30	2.83	1.02	Agreed
28	Government/Schools should allocate sufficient budget for purchasing robotics kits.	30	2.87	1.07	Agreed
29	Schools should promote the use of robotics kits such as Arduino kits, Lego Mindstorm, PIR motion sensor and other kits for teaching purposes through donation of kits to the departments.	30	2.83	0.87	Agreed
30	Government/schools should encourage the use of robotics kits in teaching of computer related topics and concepts by rewarding teachers who are using them in teaching.	30	2.93	0.91	Agreed
Cluster Average		**30**	**2.90**	**0.78**	**Agreed**

Key: $\bar{x}$ =Mean, $\bar{x}$ >=2.5 = Agreed; $\bar{x}$ <=2.5 = Disagreed; **N**=Number of Respondents; **SD**=Standard Deviation

Results in Table 3 show that the teachers agreed to all the items as the required measures for controlling the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools. These items had mean scores above the benchmark of 2.5. The cluster mean of (2.90±0.78) implies that on average, all the items are measures for controlling the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools in Enugu State.

Discussion

The findings of this study were discussed based on the research questions guiding the study. Results from research question one show that seven out of the nine items on the availability of robotics technology were not available for teaching computer studies in secondary schools in Enugu State. Only two items were considered available. These available items were the Python tutorial package (60%), and the temperature sensor (53.30%). Lego Mindstorm Education EV3, Lego Mindstorms robotics tool Kits, Arduino Kits, Raspberry Pi, Scratch (Block programming) package, PIR motion sensor, and ultrasonic sensor were not available. This result could mean that the Government are not doing enough to equip secondary schools in the state with the required robotics kits or that the high cost of these robotics equipment is responsible for the insufficiency of these tools for teaching computer studies in secondary schools in Enugu State. Also, the schools, non-governmental organisations and private individuals may not be doing enough to equip schools with basic robotics kits for teaching and learning. This result is in agreement with the findings of Hassan and Aliyu (2020); Mehmet and Serhat (2015); Eguchi (2010) who found low availability of robotics kits or technology for teaching purposes in schools. However, it disagreed with Armstrong (2020) who found that robotics technology or kits are available for teaching purposes in schools.

Results from research question two show that the extent of utilization of robotics technology in teaching computer studies in secondary schools in Enugu State is low. Six out of the eight items had their mean ratings below the 2.50 criterion mean, which implied that they were being utilised to a low extent. The low extent of utilization of robotics technology in teaching is plausibly due to non-availability of robotics technology for teaching purposes in secondary schools. This result agrees with Mehmet and Serhat (2015) which show that there is low extent of utilization of robotics technology for teaching purposes in schools.

Results from Research question three presented the challenges militating against the utilization of robotics technology for teaching computer

studies in secondary schools in Enugu State. Findings from this research question show that there is a high cost of robotics kits, inadequate physical infrastructure, insufficient budget allocation for purchasing robotics technology tools, insufficient competent and qualified teachers to teach robotics in school, little interest by the students in learning robotics in school, inadequate robotics kits (components) for use in school, lack of reward system for teachers who are using robotics kits in their teaching. All these items had mean ratings above the mean benchmark of 2.5, hence, were considered the challenges militating against the utilization of robotics technology for teaching computer studies in secondary schools. This result agrees with Zakaria (2011) who identified insufficient competent and qualified teachers to teach robotics in school, little interest by the students in learning robotics in school, and inadequate robotics kits (components) for use in schools as challenges to the utilization of robotics technology in schools. It also agrees with the findings of Carter (2009) who found lack of a reward system for teachers who are using robotics kits in their teaching as a major challenge.

Research question four investigated measures for controlling the challenges militating against the utilization of robotics technology for teaching computer studies in schools. The study identified these measures to include: provision of grants to schools and departments to minimise the high cost of robotics equipment, adequate provision of physical infrastructure for teaching robotics by schools and Governments, provision of quarterly training to teachers on the use of robotics in teaching, sufficient allocation of budget for purchasing robotics kits by the governments and schools, promoting the use of robotics kits such as Arduino kits, Lego Mindstorm, PIR motion sensor and other kits for teaching purposes through donation of kits to the departments. Also, Government/schools should encourage the use of robotics kits in teaching of computer-related topics and concepts by rewarding teachers who are using them in teaching. This result agrees with Baker (2020) who identified the provision of grants to schools and departments to minimize the high cost of robotics equipment, and adequate provision of physical infrastructure for teaching robotics by schools and Governments as ways of improving the utilization of robotics technology in teaching. Also, Adem and Uzun (2020) found donation of robotics kits to schools by Government and philanthropic organizations as an effective way of overcoming the challenges militating against the utilization of robotics technology in teaching.

Conclusion

The use of robotics kits has the potential to increase student's level of academic productivity in computer studies. However, the high cost of robotics kits, inadequate physical infrastructure, insufficient budget allocation for purchasing robotics technology tools, insufficient competent and qualify teachers to teach robotics in school, little interest by the students in learning robotics in school are major challenges. Also, the inadequate robotics kits (components) for use in school, and lack of a reward system for teachers who are using robotics kits in their teaching, are some major challenges hindering the effective utilization of educational robotics for teaching and learning in Enugu state secondary schools. Taking into account the challenges confronting the utilization of robotics technology are already mentioned, it is pertinent that appropriate measures should be taken by the government and concerned school authorities in Enugu state to ensure complete availability of these kits as well as the appropriate utilization of each of them.

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