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ROBOT-ASSISTED AIDE (RAA): AN INSTRUCTIONAL DELIVERING APPROACH TO COMPUTER PROGRAMMING IN UNIVERSITIES IN ENUGU STATE, NIGERIA

BY

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ABSTRACT

Robots are becoming an integral component of our society and have great potential in being utilized as an educational technology. Over the years, research has shown that programming has proved to be a challenging task to many students. Due to this, several instructional delivery tools have been developed to aide in teaching and learning computer programming. This study aimed at determining ways to improve instructional delivery approaches in computer programming using Robot-Assisted Aide(RAA) in universities in Enugu State, Nigeria.A structured questionnaireon robot-assisted aide:an instructional delivering approach tocomputer programming was administered to 22 lecturers and 13 instructors. A descriptive analysis was performed, where weighted mean was used to answer the research questions and t-test was used to test the formulated hypothesis at 0.05 level of significance. Results revealed that instructional resources, platforms and frameworks if adequately provided will help lecturers and instructors in constructing Robot-assisted aide which in-turn improve the academic achievements of studentsand their interest in computer programming language.

Key Words– *Robot, Robot-Assisted Aide, educational robotics, educational robots, computer programming.*

INTRODUCTION

Background of the Study

Teaching and learning is the core business of every school and other centers of learning. Schools always ensure that children and young people have the highest quality learning experiences and to help learners achieve their fullest degree. These teaching and learning aims lie at the very heart of curriculum for excellence. According to Boyd (2008), curriculum for excellence is intended to help children and young people gain the knowledge, skills and attributes needed for life in the 21st century, including skills for learning, life and work. Curriculum for excellence is designed to achieve a transformation in education by providing a coherent, more flexible and enriched curriculum. The term curriculum is understood to mean everything that is planned for children and young people throughout their education, not just what happens in the classroom (James, 2007). According to Ehren and Visscher (2008), curriculum has two stages: the broad general education and the senior phase. The broad general education has five levels (early, first, second, third and fourth). The senior phase is designed to build on the experiences and outcomes of the broad general education using instructional delivery tools like computer aided instruction, robot, among others.

A robot is a machine designed to execute one or more tasks automatically with speed and precision (Rouse, 2016). Using robots to support teaching and learning in the universities have become a popular research topic in recent years (Klassner, 2002; Klassner & Anderson, 2003; Ryu,Kwak, & Kim, 2008). One approach to learning known as constructionism, as opposed to the traditional style of instructionism allows students to learnhow to construct their own knowledge from experience. One of the constructionism approaches is the use of robot in teaching and learning.There are as many different types of robots as there are tasks for them to perform. Robots that resemble humans are known as androids (Johnson, 2003); however, many robots aren't built on the human model. Industrial robots, for example, are often designed to perform repetitive tasks that are not facilitated by a human-like construction. A robot can be remotely controlled by a human operator, sometimes from a great distance. A telechir (remotely-controlled robot) is a complex robot that is remotely controlled by a human operator for a telepresence system, which gives that individual the sense of being on location in a remote, dangerous or alien environment and the ability to interact with it. Telepresence robots, which simulate the experience and some of the capabilities of being physically present, can enable remote business consultations, healthcare, home monitoring and childcare, among many other possibilities (Chang, Lee, Chao, Wang, and Chen, 2010). An autonomous robot acts as a stand-alone system, complete with its own computer (called the controller). The most advanced example is the smart robot, which has a built-in artificial intelligence (AI) system that can learn from its environment and its experience and build on its capabilities based on that knowledge. According to Rouse (2016), robots are sometimes grouped according to the time frame in which they were first widely used. First-generation robots date from the 1970s and consist of stationary, nonprogrammable, electromechanical devices without sensors. Second-generation robots were developed in the 1980s and can contain sensors and programmable controllers. Third-generation robots were developed between approximately 1990 and the present. These machines can be stationary or mobile, autonomous or insect type, with sophisticated programming, speech recognition and/or synthesis, and other advanced features. Fourth-generation robots are in the research-and-development phase, and include features such as artificial intelligence, self-replication, self-assembly and nanoscale size (physical dimensions on the order of nanometers, or units of 10^{-9} meter) (Mubin, Stevens, Shahid, Al Mahmud, and Dong, 2013). Some advanced robots are called androids because of their superficial resemblance to human beings. Androids are mobile, usually moving around on wheels or a track drive (robots legs are unstable and difficult to engineer). The android is not necessarily the end point of robot evolution. Some of the most esoteric and powerful robots do not look or behave anything like humans. Furthermore, the use of robots is not limited to traditional uses but isdistributed across a variety of arts and science courses. The use of robotics by non-engineering, non-technicalinstructors has been termed a robotic revolution (Hendler, 2000).

Robotics is the branch of mechanical engineering, electrical engineering and computer science that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing.These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behaviour, and or cognition. Many of today's robots are inspired by nature, contributing to the field of bio-inpired robotics (Han, 2012).The concept of creating machines that can operate autonomously dates back to classical times, but research into the functionality and potential uses of robots did not grow substantially until the 20th century (Nocks, 2007).Throughout history, it has been frequently assumed that robots will one day be able to mimic human behavior and manage tasks in a human-like fashion. Today, robotics is a rapidly growing field, as technological advances continue; researching, designing, and building new robots serve various practical purposes, whether domestically, commercially or militarily (Ruzzenente, Koo, Nielsen, Grespan, and Fiorini, 2012). Many robots are built to do jobs that are hazardous to people such as defusing bombs, finding survivors in unstable ruins, and exploring mines and shipwrecks. Further, robots are also extensively used in teaching and learning STEM (Science, Technology, Engineering, and Mathematics) particularly as an instructional delivery aide.

Instructional delivery can be defined as a process in which teachers apply a repertoire of instructional strategies to communicate and interact with students around the academic content and to support students' engagement in order to achieve the desired goal (Akudolu, 2000).Instructional delivery is an instructor's personal approach to teaching based on his or her own professional identity helping to create a unique classroom culture (NAIT, 2016). Instructional delivery combines the complexities of teaching with institutional expectations and student demand for quality instruction. Instructors should take into account best practices and their own style when making delivery choices. The instructor not only models the behaviors that will be expected of them in classroom but also cultivates a positive, safe, learning rich environment where students are engaged with the content. The use of any instructional aide must be planned, based on its ability to support a specific point in a lesson. A simple process can be used to determine if and where instructional aides are necessary. Instructional aides should be simple and compatible with the learning outcomes to be achieved. Since aides are normally used in conjunction with a verbal presentation, words on the aide should be kept to a minimum. In many cases, visual symbols and slogans can replace extended use of verbiage. Instructional aides should appeal to the student and be based on sound principles of instructional design. When practical, they should encourage student participation. They also should be meaningful to the student, lead to the desired behavioral or learning objectives, and provide appropriate reinforcement. Instructional aides that involve learning a physical skill should guide students toward mastery of the skill or task specified in the lesson objectives. Instructional aides have no value in the learning process if they cannot be heard or seen (Huang, Huang, and Tschopp, 2010). Recordings of sounds and speeches should be tested for correct volume and quality in the actual environment in which they will be used. The effectiveness of aids and the ease of their preparation can be increased by initially planning them in rough draft form. Revisions and alterations are easier to make at that time than after their completion. The rough draft should be carefully checked for technical accuracy, proper terminology, grammar, spelling, basic balance, clarity, and simplicity. Instructional aides should also be reviewed to determine whether their use is feasible in the training environment and whether they are appropriate for the students. Some of the most common and economical aids are chalk or marker boards, and supplemental print materials, including charts, diagrams, and graphs. Other aids, which are usually not common are projected materials, video, computer-based programs, models, robot-assisted aids, among others.

Robot-Assisted Aide (RAA) here is the act of using robots to teachcomputer programming language.Weinberg and Yu (2003) described three factors (unique learning experience, cost, and plug-and-play feel) todemonstrate that robots will successfully support education. Robots are the mechanical devicesembodied of computations and provide unique experiences for the learner. They provide a wide design space for students toexplore, to make guess about how things work, and to conduct experiments to validate their beliefs andassumptions. Students can receive strong, instinctive feedback from physically experiencing their work. An importantexample is the work by Turkle and Papert (1992) where a small mobile robot called Logo Turtle was developed, and children were shown how to use it to solve simple problems in an environment of play and the main aim is to improve the way children think and solve problems. This project led to the development of several platforms for educational robots. Thesecond factor described by Weinberg and Yu is cost. Over the last decade, the cost of computation has droppedexponentially. As a result, robot controllers have been designed and marketed at prices that are accessible to schoolswith even modest budgets (Marin, Mikhak, Resnick, Silverman, & Berg, 2000). The third important factor is theplug-and-play feel of the new robot platforms. The multidisciplinary nature of robots has previously relegated theirstudy to larger research institutions that have the range of prerequisite knowledge for engineering complex systems.Robot controllers, such as the Handy Board and the Mindstorm RCX, have mitigated this need by making itrelatively simple to plug in motors and sensors and use well-known or simple programming environments.The development of educational robots is still in the initial stages. Robot technologies bring new developments toeducation. The literature includes many studies that have tried to use robots to support teaching and learning, especially inmathematics and science. However, there are still few papers that discuss the use of robots to improve computer programming instructional delivery in the universities (Gyebi,Marc, and Grzegorz, 2016).

Computer programming (otherwise called programming) is a process that leads from an original formulation of a computing problem to executable computer program. Programming involves activities such as analysis, developing understanding, generating algorithms, verification of requirements of algorithms including their correctness and resources consumption, and implementation (commonly referred to as coding) of algorithms in a target programming language (Shaun, 2014). Source Code is written in one or more programming languages. A programming language is a formal computer or constructed language designed to communicate instructions to a machine, particularly a computer. Programming languages can be used to create programs to control the behavior of a machine or to express algorithms. The purpose of programming is to find a sequence of instructions that will automate performing a specific task or solving a given problem (Chun-Jen, 2012). The process of programming thus often requires expertise and facilities.The potential benefits of using robotsfor teaching and learning of computer programming, optimal design of computer programming robots, and any limits and challenges in using robots needs tobe addressed. Therefore, this study aimed at exploringways of using robots to improve instructional delivery approaches in teaching and learning of computer programmingin universities in Enugu State.

Statement of the Problem

Computer programming is a very useful skill and it is fundamental in computer education. However, students consider computer programming courses to be very difficult, especially for the beginners. It is experienced thatcollege of education students shy away from learning QBASIC programming language due to the abstract nature of the course. On the other hand, lecturers also find it difficult to teach QBASIC programming language due to the technicalities involved. Furthermore, there are inadequate facilities to practice QBASIC programming language. This results in students' inability to write/develop simple QBASIC programs and this has become a situation of concern which needs to be tackled.

It is therefore pertinentto introduce a new approach that would increase students' interest in computer programming and also permit more practice. Hence, this study tends to determine the ways of improving instructional delivery approach in teaching and learning Computer Programming using Robot-Assisted Aide (RAA) in universities in Enugu State.

Purpose of the Study

The major purpose of this study is to determine ways ofimproving instructional delivery approach in computer programming using Robot-Assisted Aide (RAA) in universities in Enugu State. Specifically, the study sought to determine:

1. availability of instructional resources for enhancing computer programming instructional delivery using robot-assisted aide.
2. appropriate hardware frameworks required to set up robot-assisted aide.
3. appropriate software platforms required to set up robot-assisted aide.

Research Question

The following research questions were formulated to guide the study;

1. What are the availableinstructional resources for enhancing computer programming instructional delivery using robot-assisted aide?
2. What is the appropriate hardware frameworks required to set up robot-assisted aide?

3. What is the appropriate software platforms required to set up robot-assisted aide?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

H_{01}: There is no significant difference in the mean ratings of lecturers and instructors on the appropriate hardware frameworks required to set up robot-assisted aide.

H_{02}: There is no significant difference in the mean ratings of lecturers and instructors on the appropriate software platforms required to set up robot-assisted aide.

METHODOLOGY

The design for the study was descriptive survey. The study was carried out among universities in Enugu state, Nigeria. The population for the study consists of lecturers and instructors of department of Computer Education of University of Nigeria Nsukka (UNN) and department of Computer Education of Enugu State University of Science and Technology (ESUT). The two universities were chosen because they are the only public universities in Enugu State. A total of 35 respondents were used in this study. The respondents were made up of 22 computer education lecturers from the aforementioned universities and 13 computer education instructors from the same universities. The entire population was studied because of its small size and was considered adequate for the study. A structured questionnaire containing 27 items in two clusters was used to collect data for the study. The instrument was faced validated by three experts in the field. The data collected were analyzed using weighted mean for the research questionsand t-test statistics to test the hypotheses of no significant difference at 0.05 level of significance and relevant degree of freedom.

Research questionone was answered using percentage (%) to determine the availability of instructional resources for enhancing computer programming instructional delivery using robot-assisted aide.Research questions twoand three were answered using mean scores. Mean score that was within the real limit of 4.00 - 3.50 was adjudged highly required (HR) and 3.49 – 2.50 was adjudged required (R) while 2.49 – 1.50 was considered averagely required (AR) and 1.49 – 1.00 was considered not required (NR) for appropriate hardware frameworks as well as software platforms to set up robot-assisted aide respectively.

Results

The result of the study was obtained from the analysis of the data collected and null hypotheses formulated to guide the study.

Research Question One: What are the available instructional resources for enhancing computer programming instructional delivery using robot-assisted aide?

The data for answering research question one was presented in Table1.

Table 1: Percentage of the available instructional resources for enhancing computer programming instructional delivery using robot-assisted aide.

S/NO	ITEM STATEMENTS	Available (%)	Not Available (%)
1	Software libraries	0.0	100
2	Digital cameras and Video recorder	8.0	92
3	Hardware descriptions	0.0	100
4	Technical documentation	0.0	100
5	Integrated development environment (dedicated software environment, high-level language support and simulators)	0.0	100
6	Quality and variety of tutorials and lesson plans	0.0	100
7	Robotic kits(Lego Mind Storms)	0.0	100
8	Free wireless/internet connections	0.0	100
9	Computer accessories (Scanners, Projectors, Interactive whiteboard, etc)	28.6	71.4
10	Multimedia computer systems	22.9	77.1

The data presented in Table 1 revealed that,almost all the instructional resources for enhancing computer programming instructional delivery using robot-assisted aide arenot available. However,items statement number2, 9 and 10 revealed 92%, 71.4% and 77.1% not available respectively, which shows inadequate availability of those instructional resources in the universities in Enugu State.

Research Question Two: What is the appropriate hardware frameworks required to set up robot-assisted aide?

Hypothesis One: There is no significant difference in the mean ratings of lecturers and instructors on the appropriate hardware frameworks required to set up robot-assisted aide.

The data for answering research question two and testing hypothesis were presented in Table 2.

Table 2: Mean ratings and t-test analysis of the responses of lecturers and instructors on the appropriate hardware frameworks required to set up rebot assisted aide.

S/NO	ITEM STATEMENTS	$\bar{X}_I$	$\bar{X}_L$	$\bar{X}_G$	S_I	S_L	P-Value	RQ	DEC
1	A flexible architecture: mechanical, electrical and software interfaces must allow instructors to assemble systems into a variety of operational units	3.00	3.33	3.20	1.04	0.66	0.25	R	NS
2	There is a need for a layered architecture that allows interfacing to the system at all levels from motors to advanced behaviors	3.36	3.24	3.29	0.63	0.54	0.56	R	NS
3	The system must have a variety of basic components to allow for construction of basic mobility systems, sensory modules such as odometers, ranging (sonar or laser), processing power and control computer system	3.21	3.38	3.31	0.80	0.59	0.48	R	NS
4	Easy configuration: a standard set of components should allow for simple modular setup to facilitate tailoring to courses in the different disciplines	3.64	2.52	2.97	0.63	0.51	0.00	AR	S
5	There is need for LEGO like, but more flexible and powerful modules to be used for the construction of systems	3.71	3.29	3.46	0.47	0.56	0.02	R	S
6	Scalable performance that allows the system to be used from simple setups to sophisticated platforms with complex behaviours	3.71	3.71	3.71	0.47	0.46	1.00	HR	NS
7	Flexible and diverse interfaces to accommodate different disciplines and allow a minimal learning curve	3.79	3.57	3.66	0.43	0.51	0.20	HR	NS
8	Interfaces to be used with standard educational tools such as MATLAB, Virtual.Lab and Java are particularly desirable	2.07	3.10	2.69	1.00	1.00	0.01	R	NS
9	A complementary software library of standard modules for navigation, detection of obstacles, basic trajectory so as to allow different instructors to focus on different parts of the system	2.71	3.76	3.34	1.12	0.44	0.00	R	S
10	A comprehensive suite of documentation to allow simple use of the system and also a quick start to get it going	3.64	3.52	3.57	0.50	0.51	0.50	HR	NS
	CLUSTER MEAN	**3.27**	**3.34**	**3.32**	**0.26**	**0.14**	**0.41**	**R**	**NS**

Keys: $\bar{X}_G$ Grand Mean, $\bar{X}_I$ Mean of Instructors, $\bar{X}_L$ Mean of Lecturers, S_I Standard deviation of Instructors, S_L Standard deviation of Lecturers, NS Not Significant, HR Highly Required, R Required, S Significant, AR Averagely Required, RQ Research Question.

The result in Table 2 revealed a mean cluster (X = 3.27) which was within the limit of 3.49 – 2.50 indicating that the appropriate hardware frameworks required to set up robot-assisted aide is required. The Table 2 specifically revealed that out of ten (10) appropriate hardware frameworks required to set up robot-assisted aide that were suggested in the instrument, items statement number 6, 7 and 10 were within the real limit of 4.00 – 3.50, while items statement number 1, 2, 3, 4, 5, 8, 9 were within the limit of3.49 – 2.50.This indicated that the appropriate hardware frameworks required to set up robot-assisted aide is requiredfrom the responses of the respondents.

The result in Table 2 also show that the cluster mean on the appropriate hardware frameworks required to set-up robot-assisted aide had its p-value as 0.41 which is greater than 0.05 indicating that there was no significant difference in the mean ratings of the responses of lecturers and instructors on the appropriate hardware frameworks required to set-up robot-assisted aide

Research Question Three: What is the appropriate software platforms required to set up robot-assisted aide?

Hypothesis Two: There is no significant difference in the mean ratings of lecturers and instructors on the appropriate software platforms required to set up robot-assisted aide. The data for answering research question three and testing hypothesis were presented in Table 3.

Table 3: Mean ratings and t-test analysis of the responses of lecturers and instructors on the appropriate software platforms required to set up robot-assisted aide.

S/NO	ITEM STATEMENTS	$\bar{X}_I$	$\bar{X}_L$	$\bar{X}_G$	S_I	S_L	P-Value	RQ	DEC
1	Thymio II	3.23	3.27	3.26	0.73	0.70	0.87	R	NS
2	Scribbler 2	3.38	3.27	3.31	0.65	0.55	0.59	R	NS
3	Jasmine	3.15	3.45	3.34	0.80	0.60	0.21	R	NS
4	AERobot	3.77	3.18	3.40	0.44	0.50	0.31	R	NS
5	Lollybot	3.69	3.41	3.51	0.48	0.50	0.11	HR	NS
6	Microbot	3.77	3.68	3.71	0.44	0.48	0.59	HR	NS
7	Kilobot	3.77	3.59	3.66	0.44	0.50	0.30	HR	NS
	CLUSTER MEAN	**3.54**	**3.41**	**3.46**	**0.23**	**0.12**	**0.08**	**R**	**NS**

Keys: $\bar{X}_G$ Grand Mean, $\bar{X}_I$ Mean of Instructors, $\bar{X}_L$ Mean of Lecturers, S_I Standard deviation of Instructors, S_L Standard deviation of Lecturers, NS Not Significant, HR Highly Required, R Required, AR Averagely Required, RQ Research Question.

The result in Table 3 revealed a mean cluster (X = 3.46) which was within the real limit of 3.49 – 2.50 indicating that the appropriate software platforms required to set up robot-assisted aide is required. The Table 3 specifically revealed that out of seven (7) appropriate software platforms required to set up robot-assisted aide that were stated in the instrument, items statement number 5, 6, 7 were within the real limit of 4.00 – 3.50, while items statement number 1, 2, 3, 4 were within the real limit of 3.49 – 2.50.This indicated that the appropriate software platforms to set up robot-assisted aide are requiredfrom the responses of the respondents.

The result in Table 3 also show that the cluster mean on the appropriate software platforms required to set-up robot-assisted aide had its p-value as 0.08 which is greater than 0.05 indicating that there was no significant difference in the mean ratings of the responses of lecturers and instructors on the appropriate software platforms required to set-up robot-assisted aide

Discussion

The findings of this study were organized according to the research questions and the hypothesis tested.

Table 1 addresses the available instructional resources for enhancing computer programming instructional delivery using robot-assisted aide. It is clear from theresult inTable 1 that most of the instructional resources to enhance computer programming instructional delivery using robot are not available.This agreed with Mason and Cooper

(2013) who stated that there is need to ensure that the instructional materials and activities to facilitate learning of fundamental programming concepts by novices should be in place.Since there is need for instructional materials, facilities like electricity, hardware, among others are paramount.

Table 2 addresses the appropriate hardware frameworks required to set-up robot-assisted aide. The findings have shown that appropriate hardware frameworks to set-up robot-assisted aide are necessary and required. This agreed with Wagner, Hohmann, and Gerecke (2004)who affirmed that to use robots efficiently in education, a number of requirements have to be met to satisfy both teachers'and students' needs. These findings also agreed with Alimisis (2012) who stated that platforms which come equipped with detailed tutorials can support teachers with little or no previous experience in educational robotics which may encourage others to participate in such initiatives to make them sustainable. Moreover, hardware cannot work without software.

Table 3 addresses the appropriate software platforms required to set-up robot-assisted aide. The findings have shown that appropriate software platforms to set-up robot-assisted aide are very important and required for a robot-assisted aide to function properly. This study supportsGyebi, Hanheide, and Cielniak (2015)who affirmed that to use robots efficiently in education, a number of software platforms needs to be provided to satisfy both teachers'and students' desire in teaching and learning of computer programming.

The way Forward

The issue of improving instructional delivery in computer programming using an autonomous robot also engages the issues of real-world problem solving, multidisciplinary teamwork, and creative and critical thinking. Building an actual robot, rather than programming a simulation, requires lecturers and instructors to immediately confront the non ideality of real-world devices, and provides immediate feedback about the success or failure of their ideas. By having computer educationlecturers and instructors work in teams, the course will encourage them to pool their individual expertise, allows them to specialize on specific subtasks, and gives them experience in developing the interpersonal skills to articulate and defend their views, but ultimately reach a consensus that is best for the group as a whole.

In summary, robotics would be an excellent tool for teaching computer programming language and would be a welcome idea if it is been tried out in this part of south-East geopolitical zone in Nigeria. However, the art, science, and pedagogy of teaching practical robotics is still in its infancy, and we are all pioneers in this field.

Recommendation

1. The findings of this study should be used by the university administrators as guide to provide all the instructional resources, software platforms and hardware frameworks to enhance computer programming delivery. This is to enablelecturers and instructors in constructing robot for effective delivery.
2. School administrators should ensure that adequate instructional facilities are provided to every computer laboratory to enable students learn and master sound programming skills.
3. Parents, host communities and other major stake holders of our education should assists our universities by donating some of the instructional facilities required for constructing robot-assisted aide.
4. Robotics education needs to be integrated into computer education undergraduate curriculum to set the stage and establish a pipeline for a truly technology-savvy future for our future generation.

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