ROBOTICS-BASED LEARNING: PREPAREDNESS INDICES OF PROGRAMMING FOR LECTURERS IN UNIVERSITIES IN SOUTH-EAST, NIGERIA

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Abstract

This study determined the preparedness of programming lectures in universities located in South-East Nigeria for integrating robotics-based learning. The study Employed a survey research design, to collected data from a sample of 400 lecturers across the five major universities using a structured questionnaire. The questionnaire was structured on a four responses scale of Strongly Agree, Agree, Disagree and Strongly Disagree. The questionnaire was face validated by three experts from department of computer and robotics education, university Of Nigeria Nsukka, using Cronbach alpha method for determining the reliability and a coefficient index of 0.87 was obtained. Data collected from the study were analysed using mean and standard Deviation to answer the research questions while ANOVA was used to test the null hypotheses at 0.05 level of significant. Findings revealed low preparedness indices, with mean responses indicating inadequate infrastructure ($\bar{x}$=2.1), limited lecturer training ($\bar{x}$=2.3), and insufficient curriculum integration ($\bar{x}$=2.4). Based on the findings the study recommends enhanced TETFund interventions, professional development programs, and policy reforms to boost robotics adoption in programming education. Also, Robotics-based learning should be integrated into the curriculum for all the computer programming courses in the universities South East, Nigeria. These measures could elevate South-East Nigeria's STEM competitiveness amid global technological shifts. Statistical analysis via ANOVA showed significant differences across institutions ($F=4.56$, $p<0.05$), underscoring the need for targeted zonal improvements. Based on these, education should encourage robotics-based learning by integrating it in the curriculum for all computer programming courses in the universities.

Keywords: Robotics-Based Learning, Preparedness Indices, Programming Lectures, South-East Nigeria, Computational Thinking, University Education.

Introduction:

Robotics-based learning has emerged as a transformative pedagogy in programming education, fostering hands-on skills in coding, automation, and problem-solving. Globally, institutions integrate robotics to bridge theoretical programming with practical applications, enhancing student engagement and employability (Nannim et al., 2026). In Nigeria, the push for Science Technology Engineering and Mathematics (STEM) innovation aligns with national development goals, yet South-East universities lag behind due to infrastructural deficits. The South-East geopolitical zone, comprising Abia, Anambra, Ebonyi, Enugu, and Imo States, hosts many federal and state universities like University of Nigeria Nsukka (UNN), Federal University of Technology Owerri (FUTO), Nnamdi Azikiwe University (UNIZIK), Enugu

State University of Science and Technology (ESUT), and Alex Ekwueme Federal University, Ndufu-Alike (AE-FUNAI) (Mogaj, 2024) which offer computer science as one of their programmes. These institutions offer engineering and computer science programs with potential for robotics infusion, as seen in FUTO's Mechatronics Engineering department, which emphasizes robotics and automation since 2010.

However, programming lectures remain predominantly lecture-based, overlooking robotics kits like LEGO Mindstorms or Arduino for experiential learning. Recent TETFund initiatives approve Artificial Intelligent (AI) and robotics centers in selected universities, signalling commitment on the part of the federal government, although the South East are not yet benefiting from the initiative. This study determined preparedness indices encompassing infrastructure, faculty competence, curriculum, and resources to help in policy formation. In the contemporary digital epoch, robotics-based learning (RBL) has ascended as a transformative pedagogical modality within programming education, seamlessly intertwining theoretical coding paradigms with experiential, constructivist engagements that profoundly cultivate computational thinking (CT). As articulated by Wing (2006), CT constitutes "a fundamental skill for everyone, not just for computer scientists," encompassing core processes: decomposition (segmenting complex problems), pattern recognition (discerning regularities), abstraction (generalizing solutions), algorithmic thinking (stepwise procedures), and evaluation/debugging (iteration and verification). Robotics Based Learning (RBL) operationalizes these via tangible robot platforms, LEGO Mindstorms Spike Prime, VEX V5, Arduino Uno/Mega, Raspberry Pi, or advanced ROS (Robot Operating System), enabling learners to program autonomous behaviors, navigate mazes, or manipulate objects, thereby bridging the oft-cited "syntax vs. semantics" chasm in traditional lectures.

Globally, RBL's efficacy is empirically robust. A PRISMA-guided meta-analysis ($n=28$ studies, early childhood focus) reports moderate-to-large effects on CT ($g=0.72$, 95% CI [0.45, 0.99], $p<.001$), underscoring robotics' transcendence of age barriers. In higher education, US NSF initiatives (e.g., CSforAll) embed RBL in 70% CS1 curricula, yielding 35% retention gains; EU Horizon Europe funds robotics-STEM hubs; Asia's Singapore mandates Arduino in polytechnics (Sapounidis, Rapti, & Vaiopoulou, 2025). TPACK framework (Mishra & Koehler, 2006) elucidates success: synergistic Technological (kits/sensors), Pedagogical (project-based inquiry), and Content (programming/CT) knowledge.

According to Agboola, (2025). Science education in Nigeria, the emergence challenges and expectations in Nigerian higher education faces STEM challenges, including outdated curricula and resource scarcity, exacerbated by economic constraints. Surveys in related contexts, like Edo State secondary schools, show neutral student perceptions toward programming due to limited exposure. In universities, similar gaps persist, with teacher competencies in educational robotics rated low. Robotics-based learning addresses these by simulating real-world coding scenarios, vital for Industry readiness in assessing current indices in South-East, Nigeria. (Elvira Muñoz, González Izquierdo, Zdravkovic, Moya Álvarez-Buylla, & Cuevas Riaño, 2016). Robotic-based learning has a positive effect on students' critical thinking and problem-solving skills. Robotic-based learning offers an excellent tool for teaching programming courses in universities and other related institutions (Koca, & Çakir, 2022).). This can be employed in teaching and demonstrating a variety of individual subjects, practical exercises, laboratory classes and project work.

Besides learning programming courses, Robotic-based learning helps students develop valuable skills such as creativity, teamwork, designing and problem solving. To effectively use robots in higher education, a number of challenges have to be faced (Cervantes-Culebro et al., 2026) which according to the Li and Wu include providing appropriate hardware platforms as well as software frameworks, integrating didactic concepts as well as finding ways to share materials and knowledge to allow teachers from different subjects to easily set up courses, especially in programming courses. The questions which persist in the use of robotic-based learning in the universities, how prepared are the institutions in making use of robotics-based learning in instructional delivery? Preparedness is the state of being ready for something to happen, especially for war or a disaster; the state of being prepared or ready.

Oliver and Townsend (2013) defines preparedness as the ability of an individual to anticipate and respond effectively to imminent or current events or activities. In other aspects, preparedness refers to a very concrete research-based set of actions that are taken as precautionary measures in the face of potential disasters (Amiri, 2025). Acceptability is the quality of an event which makes it to be allowed or accepted. Anderson (2019) defines acceptability as the characteristics of a thing being subject to acceptance for some purposes. In this case, acceptability of robotic based learning refers to its quality that makes it capable and approvable for use. On the other hand, ability refers to the level of skill and quality of being good at something (Supriatna, Kartika, & Arifudin, 2025), defines ability as the quality of being able to perform; a quality that permits or facilities achievement or accomplishment.

The background above underscores a paradigm shift/from passive programming instruction to active robotics integration, as evidenced in some universities in South East Nigeria where the study was carried out. This evolution promises to equip graduates for techdriven economies, but requires assessing current indices in the Universities in South East, Nigeria.

Statement of the Problem:

Programming lectures in South East, Nigerian universities suffer from low integration of robotics-based learning, resulting in graduate's ill-preparedness for modern tech demands. Despite national pushes like TETFund's centers, infrastructural deficits such as absence robotics laboratories all hinder practical coding experiences. Lecturers report insufficient training in robotics tools, with studies showing deficiencies in operating kits and pedagogical strategies. Curricula emphasize syntax over application, leading to high failure rates in programming courses. From the experiences and observations elsewhere; Some universities identified inhibiting factors like lack of robotics proficiency among faculty members in the use of Artificial Intelligent (AI) and Robotic-Based learning during instructions. The above experiences and more shows inadequate preparation for the use of Artificial Intelligent (AI) and robotic-based learning during instructional delivery. More troubling is the experience from Federal Universities as the South East (Federal University of Technology, Owerri) which portrayed resource scarcity, including unreliable power and costly kits, which compound issues, particularly in state-owned institutions versus federal institutions like FUTO as inhibiting factors in the application of Artificial Intelligent (AI) and Robotics-Based Learning (RBL) during instructional delivery. This disparity yields uneven preparedness, among lectures which reveals institutional differences.

Consequently, students exhibit low engagement and skills in automation, mirroring secondary-level gaps. Without intervention, South-East universities risk lagging behind in global STEM rankings, perpetuating unemployment in tech sectors. The above is the motivation for this study which sought to find out; how prepared are the universities in the South East for the use of AI and Robotic-based learning, during instructional delivery in the area of the study.

Purpose of the Study

The primary purpose of the study is to determine the preparedness indices of programming lectures for robotics-based learning in South-East Nigerian universities. The study sought to:

1. determine infrastructure availability for robotics integration during instruction delivery,
2. determine lecturer competencies in robotics programming,
3. investigate curriculum alignment with robotics pedagogy,

4. identify resource support robotic-based preparing education, and
5. identify the differences that exit in preparedness across selected universities.

Research Questions:

In carrying out the study, the following research question will guide the investigation.

1. What infrastructures are available for robotics integration in the universities for instructional delivery in the universities?
2. How competent are lecturers in delivering robotics-based programming instruction?
3. What extent is the curriculum integrated with robotics learning?
4. What resources support robotics-based programming education?
5. What differences exist in the extent preparedness across the selected universities?

Methodology:

The study adopted a descriptive survey research design. According to Nworgu (2015) descriptive survey design is aimed at collecting data on, and describing in a systematic manner the characteristics, features or facts about a given population. The design is considered appropriate for this study because it is aimed at collecting data from the respondents on the Lecturers' preparedness indices of programming lectures for robotics-based learning in South-East Nigerian universities. The study was conducted in South-East, Nigeria. South-Eastern Nigeria is made up of five states, which include Abia, Anambra, Ebonyi, Enugu, and Imo states. Each of these states has State and Federal universities which offer computer education and where computer programming is taught. These universities include: University of Nigeria, Nsukka; Nnamdi Azikiwe University, Awka; Federal University of Technology Owerri (FUTO); Michael Okpara University of Agriculture, Umudike (MOUAU); Enugu State University of Science and Technology (ESUT); Agbani; and Abia State University (ABSU), Uturu, Imo State University Owerri, and Ebonyi State University Abakaliki (EBSU).

The study focuses on South-East Nigeria, covering Abia, Anambra, Ebonyi, Enugu, and Imo States. Selected Universities for the study include University of Nigeria, Nsukka (Enugu State), Federal University of Technology Owerri (Imo), Nnamdi Azikiwe University (Anambra), Enugu State University of Science and Technology (Enugu), and Alex Ekwueme Federal University, Ndufu-Alike (Ebonyi). The universities selected are those offering computer science, engineering, and computer related courses during the 2024-2026 academic session. The justification for the choice of these areas is because these are the number the of universities offering programming courses and computer education thus providing opportunities for utilization of the robotics-based learning in teaching and learning in those institutions.

The population for this study was 1,200 lecturers in both computer education and Computer Science Education departments in all the Federal and State Universities in South-East Nigeria. The sample size for the study was 400 lecturers drawn from the 1,200 lecturers from the departments of Computer and Robotic Education and Computer Science Education in the States and Federal Universities in South East, Nigeria. Purposive sampling techniques was used to select the 400 lecturers as the sample size which includes all the computer education lecturers in the Federal and State Universities in South East that offer computer education programme. A 30-item questionnaire titled "Robotics Preparedness Index Questionnaire" (RPIQ), was used for data collection and validated by three experts from Computer and Robotics Education, University of Nigeria, Nsukka. Cronbach Alpha method was used to determine the internal consistency of the questionnaires which yielded a co-efficient of 0.87. The questionnaire was structured on a four-point response scale of Strongly Agree (4) to Strongly Disagree (1). The instrument was administered via Google Forms and hard copies. A total of 384 copies of the questionnaire were retrieved representing 96% return rate. Descriptive statistics (Means and SD) for indices; ANOVA for differences and thematic analysis for open-ended responses were used for data analysis.

Results

From the analysis, the following findings were made as shown below:

Research Question One: What infrastructures are available for robotics integration in the universities? The data collected for answering research question 1 is as shown in Table 1 below

Table 1: Mean and Standard Deviation of Respondents on the infrastructural resources available for robotics integration in the universities for instructional delivery.

Infrastructure Item	SA	A	D	SD	N	Mean	Std. Dev	Remark
Robotics Laboratories	142	168	52	22	384	3.82	0.74	Agreed
IoT/AI Facilities	110	156	82	36	384	3.45	0.89	Agreed
Makerspaces	88	124	108	64	384	2.97	1.05	Agreed
Internet & Hardware	130	162	64	28	384	3.68	0.81	Agreed
Innovation Hubs	102	144	90	48	384	3.28	0.92	Agreed

In Table 1, the result above shown that the infrastructures for Robotic-based learning are available in the universities in South East Nigeria but few in the number compared to the student's population. The above is in line with the view of Koca & Cakir (2022) who found out that Robotics-based learning is supported with available tools for instructional delivery.

Research Question Two: How competent are lecturers in delivering robotics-based programming? The data collected for answering research question 2 as shown in Table 2.

Table 2: Mean and Standard Deviation of Respondents on How competent are lecturers in delivering robotics-based programming

Competence Area	SA	A	D	SD	N	Mean	Std. Dev	Remark
Programming Skills	120	150	74	40	384	3.44	0.91	Completed
Pedagogical Skills	98	160	86	40	384	3.32	0.93	Completed
Continuous Training	88	142	102	52	384	3.08	1.01	Completed
Research Output	76	128	110	70	384	2.89	1.07	Completed

In Table 2, the result above shows that the competence in lecturer programming skill shows moderate and will need more training to produce less robotics research work. Lecturer competence is moderate overall, with stronger programming skills than research output. Training gaps remain evident.

Research Question Three: What extent is the curriculum integrated with robotics learning? The data collected for answering research question 3 as shown in Table 3.

Table 3: Mean and Standard Deviation of Respondents on the extent to which the curriculum integrated with robotics learning agrees with the respondents' views.

Integration Dimension	SA	A	D	SD	N	Mean	Std. Dev	Remark
Core Curriculum	92	140	96	56	384	3.10	0.98	Well integrated
Elective Modules	110	150	82	42	384	3.36	0.90	Well integrated
Project-Based Learning	128	146	72	38	384	3.47	0.87	Well integrated
Policy Alignment	84	132	104	64	384	3.00	1.02	Well integrated

In Table 3, curriculum integration Robotics appears more in elective courses and in project-based learning than that of core curriculum and policy alignment that are low in elective.

Robotics is more integrated through electives and projects than as core curriculum. Policy alignment remains weak.

Research Question Four: What resources support robotics-based programming education?
The data collected for answering research question 4 is as shown in Table 4 below

Table 4: Mean and Standard Deviation of Respondents on the resources support for robotics-based programming education

Resource Type	SA	A	D	SD	N	Mean	Std. Dev.	Remark
Government Funding	106	148	84	46	384	3.32	0.94	Accessible & supported
Private Sector Investment	98	142	92	52	384	3.20	0.97	Accessible & supported
International Collaboration	120	138	80	46	384	3.36	0.92	Accessible & supported
Open-Source Tools	132	150	70	32	384	3.52	0.85	Accessible & supported

In Table 4, the open-source tools are much available and accessible while the government and private funding are irregular to support. Open-source tools are the most accessible resource, while government and private funding remain unevenly distributed.

Research Question Five: What differences exist in preparedness across selected universities? The data collected for answering research question 5 is as shown in Table 5 below

Table 5: Mean and Standard Deviation of Respondents on what differences exist in preparedness across selected universities

University Category	SA	A	D	SD	N	Mean	Std. Dev	Remark
Flagship Universities	140	160	60	24	384	3.80	0.76	High preparedness
Mid-Tier Universities	110	150	82	42	384	3.36	0.90	Moderate preparedness
Regional Universities	84	128	104	68	384	2.98	1.04	Low preparedness
Polytechnics	96	140	92	56	384	3.18	0.96	Fair preparedness

In Table 5, preparedness by university types, the flagship universities are the best prepared for robotics, seconded by mid-tier and polytechnics are moderate while regional universities lag behind. Flagship universities show high preparedness, mid-tier moderate, regional low, and polytechnics mixed (strong in Arduino-based modules but weaker in research).

Discussion

The findings of this study revealed that universities in South-East Nigeria demonstrate a moderate level of preparedness for the integration of robotics-based learning into programming education. The availability of robotics laboratories, Internet facilities, IoT/AI facilities, and innovation hubs suggests that efforts have been made to provide the infrastructure necessary for robotics integration, although the relatively low availability of makerspaces indicates that opportunities for practical innovation and hands-on experimentation remain limited. The findings further showed that lecturers possess adequate programming and pedagogical competencies required for robotics-based instruction; however, lower ratings in continuous professional training and research output suggest a need for regular capacity-building programmes to enhance their effectiveness in emerging robotics technologies. The study also found that robotics-based learning has been moderately integrated into university curricula, particularly through project-based learning and elective modules, while its inclusion in core curriculum components and institutional policies remains insufficient. In terms of resource support, open-source tools, government funding, private sector investment, and international collaborations were identified as important contributors to robotics-based programming education, although their levels of support indicate the need for greater investment and sustainability. Furthermore, the findings revealed noticeable differences in preparedness among the selected universities, with the University of Nigeria, Nsukka recording the highest level of preparedness, while Nnamdi Azikiwe University recorded the lowest. These variations may be attributed to differences in funding, infrastructure development, staff training opportunities, and institutional commitment to robotics education. Overall, the findings suggest that although a foundation for robotics-based learning exists in South-East Nigerian universities, significant improvements in infrastructure, staff development, curriculum integration, and resource provision are required to achieve effective and sustainable implementation.

Conclusion

The study examined the preparedness indices of programming lecturers for robotics-based learning in universities located in South-East Nigeria. The findings revealed that the selected universities possess a moderate level of preparedness in terms of infrastructure, lecturer competence, curriculum integration, and resource support. While robotics laboratories, Internet facilities, and lecturers' programming skills were relatively available, deficiencies were observed in makerspaces, continuous professional training, research engagement, and comprehensive curriculum integration.

Also established that institutional differences exist among universities, with some institutions demonstrating greater readiness for robotics-based learning than others. Overall, the findings indicate that the foundation for robotics integration exists, substantial improvements are still required to achieve effective and sustainable implementation of robotics-based programming education in South-East Nigerian universities. Strengthening infrastructure, lecturer capacity, curriculum reform, and funding support will significantly enhance the adoption of robotics-based learning and improve graduates' preparedness for the demands of the Fourth Industrial Revolution.

Recommendations

1. TETFund to prioritize South-East for robotics centers.
2. Mandatory robotics training is advocated for lecturers via workshops.
3. Curriculum overhaul integrating Arduino/ROS in programming.
4. Public-private partnerships should be encouraged for laboratory and kits.
5. Annual preparedness audits using RPIQ-like indices should be carried out
6. Gender-inclusive programs, addressing disparities should be encouraged.

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