

Leveraging Robotics for Skill and Competence Development in Computer Education Students in Universities in Enugu State

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Abstract

This study explore examines how using robots in university computer education courses can help students in Enugu State learn more than just theory but build real, useful skills. The aim of this study is to provide insight into how robotics can be used in universities in Enugu State and beyond not just to teach computer education courses, but to prepare students for jobs and for a future where technology matters more and more. The research design of the study is a descriptive survey. The population of the study comprise of one hundred and twenty (120) undergraduate Students of the Department of Computer and Robotics, Education, Faculty of Vocational and Technical Education, University of Nigeria, Nsukka; and Enugu State University of Science and Technology, Agbani. The sample size is fifty respondents. A structured questionnaire titled “Leveraging Robotics Skills and Competence Development Questionnaire (LRSCDQ)” was designed to obtain information from respondents. Data was collected through physical contact. The data collected from the respondents were analyzed using mean and standard deviation. The mean cut off was 3.00 points for the decision rule. Therefore, items with a mean score of 3.00 or above were accepted while items with a mean score below 3.00 were rejected. The findings of the study showed that robotics based-learning improve computer education skills however, universities in Enugu State lack some of the physical infrastructure needed for meaningful robotics teaching. The recommendations include the fact that government and NGOs should provide funds and resources to help effective robotic-based learning

Key Words: Robotics; Skill; Competence; Development; Universities; Enugu

Introduction

In today's world, technology is changing fast. One of the most exciting areas is robotics. Schools and universities are increasingly using robotics to teach students important skills. For students studying computer-related courses, especially at university, robotics offers more than just theory. When students build and programme robots, they learn how to think logically, write code, and solve real problems (Essien et al., 2024). These are technical skills that computer education students need. Recent studies show that robotics in higher education really works. For instance, a review of robotics use in universities found that such programmes can boost engagement, make learning more interactive, and help students understand complicated ideas in computer related courses (Alsoliman, 2022).

In Nigeria, there is growing interest in bringing robotics into education. According to Agbajileke (2026), the Federal Government approved the establishment of robotics, coding, artificial intelligence, and cybersecurity centres in selected Nigerian universities to strengthen technological capacity. Researchers such as Çam et al., (2022), have pointed out that robotics education could help Nigerian students become more creative, think more critically, and build problem-solving skills, all things that are very important for the future. According to Oladele (2024), robotics does not just help in science and engineering. Elucidating on this further, the researcher stated that a recent Nigerian study looked at using robotics in physics classes in secondary schools and found that students

taught with robots did better than those taught by traditional methods. This suggests that robotics education can have broad benefits, even beyond just computer related courses. However, before we continue, it suffices for us to define robotics.

Nevertheless, the integration of robotics into education in Nigeria still faces significant knowledge gaps, particularly in curriculum development, teacher training, and access to affordable robotic technologies (Adebayo et al., 2022). There is limited understanding of how to adapt robotics for STEM education in resource-constrained schools, hindering students' practical engagement and innovation skills (Okafor et al., 2023). Addressing these gaps is essential for fostering technical literacy, preparing students for future labor markets, and supporting national technological advancement (Eze et al., 2024).

Robotics is the field of science and engineering that aims at designing, building, programming and using robots. Robots are machines that can sense their environment, make decisions, and act in it (Sens et al, 2025). In other words, a robot is not just a machine, but can be a smart device that moves, computes, and responds to the world around it. When we talk about educational robotics, we mean using robots as tools for learning. According to Sadiku et al (2022), these are not just toys, they help students understand important ideas in science, technology, engineering, and mathematics. Robotics used in education can be classified in several different ways depending on purpose, form, autonomy, or how students interact with them. According to Sadiku et al (2022), some of the most common types are:

Physical Robots: Physical robots are real, tangible robots that students can touch, build, and programme. They often have motors, sensors, and real-world behaviour. Another review found that physical robots are widely used in educational settings, especially in

hands-on teaching that involves physical interaction and manipulation (Alsoliman, 2022). **Virtual / Simulated Robots:** These are software-based robots that exist in a virtual environment (on a computer screen). They allow students to learn robotics without the cost of physical hardware. **Simulators:** Simulators are more advanced virtual environments, often used for realistic physics-based training. They allow students test robotics code in a virtual world that mimics real behaviour. **Teleoperated / Remote-Controlled Robots:** These are robots where a human directly controls its actions. Examples of this is via joystick or code upload. **Autonomous Robots:** These robots act on their own. They sense their environment and make decisions without constant human input. According to a taxonomy in robotics research, autonomy ranges from fully manual (human-controlled) to fully autonomous agents (Wang et al, 2024). However, the understanding of robotics is valuable but not just about the knowledge, but also about applying that knowledge in a hands-on, real-world context. This is where skill comes to play

Skill is in a lay man's understanding means a person's ability to use what they know (knowledge) to do a task well and solve problems. In other words, it is the capacity to apply knowledge and know-how in a real situation (European Commission, 2024). In the context of robotics education, when we talk about skills, we mean both the technical skills such as programming a robot and soft skills such as working well in a team. All these are learned by doing, not just by reading a book. Mahmud et al., (2022), described 21st-century skills as a broad set of knowledge, work habits, and character traits that are essential for success in modern life and careers. Buttressing this point, it emphasized that skills should be: contextualized, personalized, and transferable. The authors argue that skills must be relevant to students' lives, adapt to different situations, and help them across

multiple domains (mental, social, intellectual). A study in Nannim et al. (2026), links skill to the ability to become creative problem solvers, innovative thinkers, and lifelong learners. In this context, skills involve both how students think and how they act in the face of change. Nevertheless, using robotics in education is not just about teaching technical skills. It is about building competence.

Competence connotes being able to use what you know and can do (knowledge + skills) in different situations, not just once, but reliable. According to Vitello et al. (2022), competence is the ability to integrate and apply a combination of knowledge, skills, and psychosocial factors such as attitudes, values, and motivations in a way that is appropriate to a specific context or domain, enabling consistent and effective performance. In other words, being competent doesn't just mean knowing things (knowledge) or being able to do things (skills). In the context of educational robotics, competence refers to a student's or teacher's ability to combine knowledge, skills, attitudes, and strategies to effectively design, build, programme, and interact with robots in real-world or learning scenarios (Methods & Technologies for Training Future Teachers, 2021/2022). Therefore, in a broader context, competence is not just knowing facts, it means being able to apply knowledge and skills in different situations, adapt to new tasks, and use your motivation and beliefs to carry out meaningful action.

This work is anchored on Constructivist Learning Theory, as it is essential to ground the study in a theoretical framework that explains how and why robotics is adopted in educational settings. Constructivist Learning Theory emphasizes learning through active engagement, problem-solving, and hands-on experiences (Chukwuemeka et al., 2022). Robotics provides a practical platform for students to construct knowledge, develop critical thinking, and acquire technical

competencies by experimenting with real-world scenarios rather than passive instruction (Oluwaseun et al., 2023). Implementing constructivist approaches in robotics education can enhance creativity, collaboration, and preparedness for technologically driven careers (Nnamani et al., 2024).

Purpose of the Study

The major purpose of this study is to determine how to leveraging robotics for skill and competence development in Computer Education Students in Universities in Enugu State. Specifically, the study seeks to:

1. understand how robotics-based learning can improve computer education students' skills in universities in Enugu State.
2. identify the barriers that prevent effective integration of robotics into computer education programmes in Enugu State.
3. Recommend sustainable ways to integrate robotics into computer education curriculum in the universities in Enugu State

Research Questions

1. How does robotics based-learning improve computer education students' skills in universities in Enugu State?
2. What are the barriers preventing effective integration of robotics into computer education programmes in Enugu State?
3. What are the sustainable ways to integrate robotics into computer education curriculum in universities in Enugu State

Methodology

The research design of the study is a descriptive survey. According to Creswell et al. (2023), a descriptive survey research design is a quantitative research method used to systematically collect information from a population or a representative sample

in order to describe characteristics, opinions, behaviours, or phenomena. Unlike experimental designs, it does not manipulate variables but rather observes and records them as they naturally occur. The target population comprised one hundred and twenty (120) undergraduate Students of the Department of Computer and Robotics, Faculty of Vocational and Technical Education, University of Nigeria, Nsukka. and Enugu State University of Science and Technology, Agbani. The sample size is fifty respondents. A structured questionnaire titled “Leveraging Robotics Skills and Competence Development Questionnaire (LRSCDQ)” was designed by the researchers to obtain information from respondents. It was divided into two parts (I & II). Part I elicits information on the respondent personal data, while part II was used to collect data for answering the

Results

research questions. The part II was further divided into two sections (A & B), according to the research questions. Each item in sections A & B has a 4-point response options of Strongly Agree (SD), Agree (A), Disagree (D) and Strongly Disagree (SD). The research instrument was face-validated by three experts. The reliability index of the three clusters yielded .675, .857 and .902 respectively. Also, the overall clusters yielded a reliability index of .950 which guaranteed the use of the instrument for the study. Data was collected through physical contact. The data collected from the respondents were analyzed using mean and standard deviation. The mean cut off was 3.00 points for the decision rule. Therefore, items with a mean score of 3.00 or above were accepted while items with a mean score below 3.00 were rejected.

Research Questions1: How does robotics based-learning improve computer education students’ skills in universities in Enugu State?

Table 1: Mean and Standard Deviation of Respondents on how Robotics Based-learning Improves Computer Education Skills in Universities in Enugu State

S/N	Robotics knowledge helps the students to:	Mean	SD	Remark
1	simulate real-world problems thereby fostering quick, data-driven decisions	3.70	0.61	A
2	explain technical ideas and robot behaviour which encourages clear communication	3.56	0.64	A
3	build analytical thinking by systematically isolating and fixing problems	3.70	0.54	A
4	understand the practical applications of programming concepts	3.62	0.60	A
5	analyse and debug technical systems effectively	3.58	0.53	A
6	adapt to emerging technologies in the computing industry	3.72	0.45	A
7	collaborate in teams through group projects thereby cultivating awareness of others’ perspectives and learning styles	3.58	0.57	A
8	understand how software interacts with hardware components like sensors and actuators	3.50	0.54	A
9	boosts self-efficacy and confidence	3.74	0.44	A
10	improves their ability to design and develop solutions innovatively	3.62	0.49	A
	Grand Mean	3.63		

Table 1 revealed that all the 10 items identified in the table had their mean values ranging from 3.50 – 3.74, which is above the cut-off point of 3.00. This indicates that robotics based-learning improve computer education students’ skills in universities in Enugu State. The standard deviation ranged

from 0.44 – 0.61 which shows that the respondents responses were not far from each other.

Research Questions2: What are the barriers preventing effective integration of robotics

into computer education programmes in Enugu State?

Table 2: Mean and Standard Deviation of Respondents on the Barriers Preventing Effective Integration of Robotics into Computer Education Programmes in Universities Enugu State

S/N	Barriers Preventing Effective Integration of Robotics	Mean	SD	Remark
11.	Poor infrastructure such as poor power supply and internet access	3.60	0.49	A
12.	Poor funding of education	3.62	0.53	A
13.	Lack of trained teachers / technical experts	3.62	0.49	A
14.	Lack of Government and Policy Support	3.58	0.49	A
15.	Sustainability and maintenance Issues	3.54	0.57	A
16.	Resistance to change	3.50	0.54	A
17.	Curriculum rigidity	3.54	0.54	A
18.	Inadequate Facilities and Equipment	3.58	0.53	A
19.	High Cost of Implementation of robotics kits and tools	3.56	0.54	A
20.	Lack of Collaboration with Industry	3.48	0.50	A
	Grand Mean	3.56		

Table 2 showed that all the 10 items identified in the table had their mean ranging from 3.48 – 3.62, which is above the cut-off point of 3.00. This signifies that the barriers outlined above prevent effective integration of robotics into computer education programmes in universities Enugu State. The standard deviation ranged from

0.49 – 0.57, which shows that the respondents' responses were not far from each other.

Research Question 3: What are the sustainable ways to integrate robotics into computer education curriculum in universities in Enugu State?

Table 3: Mean and Standard Deviation of Respondents on the Sustainable Ways to Integrate Robotics into Computer Education Curriculum in Universities in Enugu State

S/N	ITEM STATEMENTS	Mean	SD	Remark
21.	Adopt open-source robots that are relatively cheap but highly flexible.	3.42	0.73	A
22.	Partner with industry, non-profits, and government agencies to secure funding, mentorship, and technical resources	3.54	0.50	A
23.	Invest in continuous professional development for lecturers so that instructors are comfortable with both the hardware and pedagogy of robotics.	3.60	0.49	A
24.	Align robotics curriculum with national education policy priorities	3.42	0.53	A
25.	Support robotics clubs or extracurricular robotics teams, which can serve as hands-on hubs for students without burdening formal course structures	3.44	0.57	A
26.	Ensure there are technical staff trained to repair and maintain robotics kits and tools	3.42	0.49	A
27.	Build in assessment mechanisms to track how robotics integration impacts student learning, motivation, and competence	3.32	0.65	A
28.	Encourage participation in robotics competitions, which can motivate students, foster innovation, and provide recognition	3.44	0.61	A
29.	Combine physical robotics with virtual robotics simulation tools. Simulators reduce the number of physical kits needed and can be used for early-stage training	3.32	0.55	A
30.	Use student-centered, personalized learning frameworks so that robotics	3.36	0.48	A

education adapts to student needs and resource constraints
Grand Mean

3.42

Table 3 showed that all the 10 items identified in the table had their mean ranging from 3.32 – 3.60, which is above the cut-off point of 3.00. This signifies that the sustainable ways outlined above can help in the effective integration of robotics into computer education curriculum in universities in Enugu State. The standard deviation ranged from 0.48 – 0.73, which shows that the respondents' responses were not far from each other.

Discussion of Findings

This section discussed the result of the study based on the research questions guiding the study. Results from research question one showed the degree of agreement of Computer Education students on how robotics based-learning can improve their skills. Findings from this research question showed the degree of agreement of items such as simulate real-world problems thereby fostering quick, data-driven decisions; explain technical ideas and robot behaviour which encourages clear communication; build analytical thinking by systematically isolating and fixing problems; understand the practical applications of programming concepts; analyse and debug technical systems effectively adapt to emerging technologies in the computing industry; collaborate in teams through group projects thereby cultivating awareness of others' perspectives and learning styles; understand how software interacts with hardware components like sensors and actuators and boosts self-efficacy and confidence improves their ability to design and develop solutions innovatively. This result aligns with recent research findings by Sadiku et al (2022), who noted that robotics based-learning supports deeper thinking and creativity thereby helping learners to turn abstract ideas into something real and fun. However, the result contradicts the findings of Liu et al. (2026), which reported that

robotics education does not automatically improve creativity. In the first phase of their study, students who participated in robotics learning showed no significant improvement in creativity or engineering design skills until the teaching strategy was redesigned. The researchers concluded that robotics education alone may be insufficient for enhancing creativity unless supported by effective pedagogical models.

Results from research question two showed that Computer education students strongly agree that poor infrastructure such as poor power supply and internet access; poor funding of education; lack of trained teachers / technical experts; lack of Government and Policy Support and sustainability and maintenance Issues are barriers that prevent effective integration of robotics into computer education programmes in Enugu State. This result agrees with Essien (2024), who stated that lack of trained teachers / technical experts can hinder the success of robotics integration into the curriculum. This finding disagrees with the findings of Kárpáti et al. (2021), which reported that teachers considered the lack of robotics tools and infrastructure, rather than insufficient teacher expertise, as the major obstacle to integrating robotics into classrooms. The findings suggest that even when teachers have limited technical expertise, robotics integration can still progress if schools provide adequate resources and equipment.

Results from research question three showed the degree of agreement of Computer Education students on sustainable ways to integrate robotics into computer education curriculum in universities in Enugu State. Findings from this research question showed the degree of agreement of items such as adopt open-source robots that are relatively

cheap but highly flexible; partner with industry, non-profits, and government agencies to secure funding, mentorship, and technical resources; invest in continuous professional development for lecturers so that instructors are comfortable with both the hardware and pedagogy of robotics; align robotics curriculum with national education policy priorities; and support robotics clubs or extracurricular robotics teams, which can serve as hands-on hubs for students without burdening formal course structures. This result aligns with recent research findings by Wang et al (2024), who noted that rather than treating robotics as a stand-alone course, integrating its activities into existing computer education courses will be less difficult in its implementation. Nevertheless, the result disagrees with the findings of El-Hamamsy et al. (2021), which argued that robotics often requires its own specialized curriculum structure because integrating it into existing computer education subjects can create curriculum overload, alignment difficulties, and reduced instructional depth. The study emphasized that robotics education involves interdisciplinary competencies that may be better addressed through dedicated robotics courses rather than embedding robotics into already crowded computer studies curricula.

The educational implication of this study is that universities should integrate robotics-based practical learning into computer education curricula to improve students' problem-solving, computational thinking, creativity, collaboration and employability skills needed in the modern digital workforce. Robotics activities can also promote active learning and bridge the gap between theoretical computer education and real-world technological applications.

Conclusion

In conclusion, integrating robotics into the computer education programmes of universities in Enugu State offers a good opportunity to transform how students learn

and grow. Robotics can help students gain real, hands-on technical skills like programming, working with hardware and solving complex problems, while also building important personal qualities such as teamwork, creativity, and resilience. When students learn by doing, they become more confident problem-solvers, better prepared for modern technology-driven careers, and more adaptable to future changes. However, for this vision to become reality, universities must address serious challenges: limited infrastructure, lack of trained teachers, and insufficient funding. Without tackling these barriers, robotics education risks remaining a niche or extracurricular activity instead of a core part of the curriculum. To succeed, universities need to adopt sustainable strategies such as using low-cost open-source robotics kits, building partnerships, training faculty and embedding robotics into existing courses. If done well, leveraging robotics in computer education could be a game-changer for Enugu State. It would not only make learning more engaging and meaningful but also help produce graduates who are technically skilled, creative, and ready to compete in a technology-rich world. This work can lay the foundation for a future where robotics education is not just a luxury, but a defining strength of its universities.

Recommendations

To effectively leverage robotics for skill and competence development in Computer Education students, here are some recommendations

1. **Robotics should be taught through practical projects**

Robotics education should focus more on hands-on activities and real-life projects rather than only theoretical teaching. Practical projects help students develop problem-solving, programming, teamwork, and creative thinking skills by allowing them to apply concepts in real situations.

2. **Functional Robotics Laboratory should be set up**
Universities should establish well-equipped robotics laboratories with modern tools, computers, sensors, and robotic kits. A functional laboratory will provide students with opportunities for experimentation, innovation, and practical skill acquisition necessary for technological development.
3. **Lecturers should be trained**
Lecturers need continuous professional training on robotics technologies and teaching methods. Training will improve their competence, confidence, and ability to effectively teach robotics-related courses and guide students in practical activities.
4. **Computer Education departments should partner with Industries and Tech Companies**
Collaboration with industries and technology companies can provide students with internship opportunities, mentorship, modern technological exposure, and access to current industry practices. Such partnerships can also support curriculum improvement and innovation.
5. **Government and NGOs should provide funds and resources**
Adequate funding from government agencies and non-governmental organizations is necessary to purchase robotics equipment, maintain laboratories, organize training programs, and support research activities. Financial support will help ensure successful implementation and sustainability of robotics education programmes.

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