



Integrating Emerging Technologies in Curriculum of Technology Education Programmes in Bridging Knowledge for Sustainable Future in Universities, Rivers State

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Abstract

This study examined the integration of emerging technologies—artificial intelligence (AI), Internet of Things (IoT), and robotics—into the curriculum of technology education programmes to bridge knowledge for a sustainable future in universities in Rivers State. Using a descriptive survey design, data were collected from 140 respondents comprising lecturers and technologists across two universities. Findings revealed a limited extent of integration of AI, IoT, and robotics technologies within curricula, with lecturers and technologists sharing similar perceptions and no significant differences between the groups. The results highlight critical gaps in curriculum content, practical application opportunities, and faculty training necessary to equip students with relevant skills for sustainable development. The study concludes that deliberate curriculum reforms, enhanced faculty development, and strengthened industry collaborations are essential to effectively embed emerging technologies in technology education programmes. Recommendations include prioritizing curriculum updates, improving hands-on access to technology, and fostering partnerships with industry experts to promote sustainable knowledge development and readiness for future technological challenges.

Keywords: Curriculum of Technology Education, Emerging Technologies, Sustainable Future.

Introduction

University education provides advanced knowledge and skills essential for personal and professional development. It fosters critical thinking, innovation, and prepares individuals to contribute meaningfully to society. University education is the highest level of formal learning offered by accredited institutions, aimed at developing students' intellectual, professional, and practical skills through structured academic programmes and research (Altbach et al., 2009). It includes undergraduate and postgraduate studies across diverse fields, culminating in the award of degrees such as Bachelor's, Master's, and Doctorate certificates. Programmes offered range from sciences, arts, and social sciences to professional and technical disciplines. In the context of technology education, university programmes provide specialized training in areas like mechanical, electrical, and information technology, equipping students with theoretical knowledge and hands-on experience to meet modern industry demands (Obi, 2015). This

alignment with technological advancement ensures graduates are competent for innovation-driven careers and national development.

University education plays a critical role in the advancement of technology education programmes by providing the academic and practical foundation necessary for training skilled professionals in technological fields. Through structured curricula, research opportunities, and industry collaborations, universities equip students with the competencies required for innovation, problem-solving, and technological advancement (Osinem & Nwoji, 2010). Technology education programmes such as mechanical, electrical, and computer engineering benefit from the university setting, where access to laboratories, workshops, and qualified technologists enhances experiential learning and prepares graduates for the evolving demands of the global workforce (Okolie & Yusuff, 2016). This integration ensures that technology education not only addresses current industry needs but also contributes to national development and economic competitiveness.

Technology education is intrinsically linked to curriculum development, as it requires dynamic and responsive curricular frameworks that align with technological advancements and industry needs. Effective curriculum development in technology education ensures that instructional content, teaching methods, and assessment strategies are relevant, competency-based, and practice-oriented (Odu, 2011). This alignment promotes the acquisition of technical skills, problem-solving abilities, and innovation among learners. A well-structured technology education curriculum incorporates input from industry stakeholders, educational experts, and policymakers to remain current and future-focused (Uwaifo, 2010). Thus, curriculum development is essential in preparing students for technological careers and in fostering national development through a skilled and adaptable workforce.

Curriculum development must continuously adapt to emerging technologies to ensure education remains relevant and prepares students for the rapidly evolving technological landscape. Integrating new tools, digital platforms, and cutting-edge innovations into curricula fosters students' ability to engage with contemporary challenges and opportunities in various fields (Adebayo & Oyedele, 2019). This dynamic process involves updating content, incorporating practical experiences, and training educators to handle technological advancements effectively (Nwankwo & Okeke, 2020). By aligning curriculum development with emerging technologies, educational institutions can equip learners with the skills necessary for future careers, promote lifelong learning, and support sustainable development.

Emerging technologies increasingly center around artificial intelligence (AI), which is revolutionizing industries by enabling machines to perform tasks that typically require human intelligence, such as learning, decision-making, and problem-solving (Russell & Norvig, 2021). AI's integration across sectors like healthcare, manufacturing, education, and transportation exemplifies its transformative potential, driving innovation and efficiency (Kaplan & Haenlein, 2019). As a key component of emerging technologies, AI also presents new challenges and opportunities for ethical considerations, workforce development, and curriculum design, necessitating continuous adaptation and research (Floridi et al., 2018). Consequently, understanding AI is essential for harnessing the full impact of emerging technologies in modern society.

Artificial Intelligence (AI) and the Internet of Things (IoT) are closely interconnected technologies that together enhance the capabilities of smart systems by enabling intelligent data collection, analysis, and decision-making (Atzori, Iera, & Morabito, 2010). AI algorithms process the vast amounts of data generated by IoT devices to identify patterns, predict outcomes, and automate responses, thereby making IoT applications more efficient and adaptive in areas such as smart homes, healthcare, and industrial automation (Kumar et al., 2019). This synergy not only improves system performance but also drives innovations in real-time monitoring, resource management, and personalized services (Zanella et al., 2014). Thus, AI acts as the “brain” of IoT ecosystems, transforming raw sensor data into actionable intelligence.

The Internet of Things (IoT) significantly enhances robotics technologies by enabling robots to connect, communicate, and interact with other devices and systems in real time, leading to smarter, more autonomous operations (Sicari et al., 2015). IoT integration allows robots to gather and share data from sensors and the environment, improving decision-making, adaptability, and efficiency in applications such as manufacturing, healthcare, and logistics (Ray, 2016). This interconnectedness facilitates remote monitoring, predictive maintenance, and collaborative robotics, driving advances in automation and intelligent systems (Thakur & Vanjani, 2018). Consequently, the fusion of IoT and robotics is a key driver of Industry 4.0, transforming traditional processes into highly responsive, data-driven workflows.

Robotic technologies play a vital role in bridging knowledge gaps to foster a sustainable future by automating complex tasks, enhancing precision, and enabling efficient resource management across various sectors (Bogue, 2018). Through advanced robotics, industries such as agriculture, manufacturing, and environmental monitoring can optimize processes, reduce

waste, and improve productivity while minimizing environmental impact (Vidal et al., 2020). Additionally, robotics facilitates knowledge transfer by supporting education, research, and innovation, thus empowering societies to address sustainability challenges with cutting-edge solutions (Kumar & Singh, 2021). By integrating robotics into sustainability strategies, humanity can achieve smarter, more resilient systems that balance economic growth with environmental stewardship.

The rapid advancement of robotic technologies and their integration with emerging technologies such as AI and the Internet of Things present significant opportunities to bridge knowledge gaps and promote sustainable development. Despite the potential of these technologies to optimize resource management, enhance productivity, and support innovation across various sectors, there remains a need to explore how effectively they are incorporated into educational curricula and industry practices to maximize their impact. This study aims to investigate the role of robotics and related technologies in advancing technology education and curriculum development, with the goal of equipping learners and professionals with the necessary skills to contribute to a sustainable future. Understanding this linkage is crucial for fostering a workforce capable of leveraging technological innovations to address environmental, economic, and social challenges.

Statement of the Problem

The integration of emerging technologies into the curriculum of technology education programmes in universities remains a significant challenge, despite the growing importance of these technologies in driving innovation and sustainable development. Many higher education institutions struggle to keep pace with rapid technological advancements such as artificial intelligence, the Internet of Things, and robotics, resulting in curricula that are often outdated and misaligned with current industry needs (Adebayo & Oyedele, 2019). This gap hinders the ability of graduates to acquire relevant skills and knowledge, limiting their readiness to contribute effectively to technological innovation and sustainable solutions in their professional fields (Nwankwo & Okeke, 2020).

Furthermore, the lack of a dynamic and responsive curriculum development process that incorporates emerging technologies undermines the goal of technology education programmes to bridge knowledge for a sustainable future. Without continuous curriculum updates and incorporation of practical, hands-on experiences with new technologies, students are deprived of critical opportunities to engage with cutting-edge tools and concepts that are essential for addressing contemporary environmental and socio-economic challenges (Odu, 2011). This

deficiency not only impacts student competence but also affects the broader national and global agenda of fostering sustainable development through technological innovation (Uwaifo, 2010).

Additionally, there is often inadequate collaboration between universities, industry stakeholders, and policymakers in curriculum design and implementation, which further limits the effective integration of emerging technologies into technology education programmes (Okolie & Yusuff, 2016). This disconnect results in educational outcomes that do not fully meet labor market demands or support lifelong learning in a rapidly evolving technological landscape. Addressing these challenges is critical to ensuring that technology education programmes can fulfill their role in producing graduates who are capable of leveraging emerging technologies to drive sustainable development and bridge existing knowledge gaps.

Aim and Objectives of the Study

The study aimed at integrating emerging technologies in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State. Specifically, the study determined the following:

1. Integration of artificial intelligence in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.
2. Integration of internet of things in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.
3. Integration of robotics technologies in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.

Research Questions

The following research questions guided the study:

1. To what extent is the integration of artificial intelligence in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State?
2. To what extent is the integration of internet of things in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State?
3. To what extent is the integration of robotics technologies in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State?

Hypotheses

The following hypotheses were formulated and tested at .05 level of significance

HO₁ There is no significant difference between the mean responses of lecturers and technologists on the extent of integrating artificial intelligence in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.

HO₂ There is no significant difference between the mean responses of lecturers and technologists on the extent of integrating internet of things in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.

HO₃ There is no significant difference between the mean responses of lecturers and technologists on the extent of integrating robotics technologies in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.

Methodology

This study adopted a descriptive survey research design. The population of the study was 140 respondents, comprising 110 Lecturers and 30 Technologists in two Universities in Rivers State (Field Survey, 2025). The study adopted a census sampling technic as the entire population was studied due to it manageable size.

The instrument for data collection was a structured questionnaire titled “Technology Education Programmes Questionnaire”. The instrument contains four sections A-D. The instrument was structured on five point likert type rating scale of very high extent, (VHE), high extent (HE), moderate extent (ME), low extent (LE) and very low extent (VLE). A corresponding numerical value of 5, 4,3,2 and 1 was assigned to the response scale for each item.

The instrument was subjected to face-validity by three experts and had .87 reliability index. Data collected from the respondents were analyzed using mean and standard deviation to answer the five research questions and t-test statistics was used to test the five null hypotheses at 0.05 level of significance. The decision for hypothesis was; if the calculated value of t (t-cal) is less than or equal to the critical value of (t-crit), accept the null hypothesis, otherwise rejected null hypothesis. The computation of the mean, standard deviation and t-test was carried out with statistical package for social sciences (SPSS).

Results

Research Question 1: To what extent is the integration of artificial intelligence in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State?

Table 1: Mean and Standard Deviation on extent is the integration of artificial intelligence in curriculum of technology education programmes

S/NO	Extent is the integration of artificial intelligence in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities	Lecturers		RMK	Instructors		RMK
		X	SD		X	SD	
1	AI concepts are adequately included in the curriculum of technology education programmes.	2.27	.692	LE	1.81	1.039	LE
2	Practical AI applications are incorporated into teaching and learning activities.	2.26	.732	LE	2.11	.859	LE
3	AI-related topics are regularly updated in the curriculum to reflect current trends.	2.28	.750	LE	2.35	.719	LE
4	Students have access to AI tools and software as part of their training.	1.93	1.004	LE	1.95	.932	LE
5	Lecturers and instructors receive training on AI to effectively deliver the curriculum.	2.16	.941	LE	2.42	.844	LE
6	AI integration in the curriculum supports knowledge bridging for sustainable development goals.	2.35	.875	LE	2.09	.860	LE
7	Collaboration with AI industry experts is facilitated for curriculum development and delivery.	2.25	.931	LE	2.32	.736	LE
8	Assessment methods include AI-related competencies and practical skills.	1.99	1.088	LE	2.31	.790	LE
9	The curriculum promotes student innovation and problem-solving using AI technologies.	2.05	.990	LE	2.42	.625	LE
Grand Mean		2.71	0.88	LE	2.19	0.82	LE

The data in Table 1 reveals that both lecturers and instructors perceive the extent of artificial intelligence (AI) integration in technology education curricula as generally low, with mean scores consistently below the midpoint on all measured items. Specifically, aspects such as

inclusion of AI concepts, practical applications, regular updates to reflect current trends, access to AI tools, training for educators, alignment with sustainable development goals, industry collaboration, AI-related assessment methods, and promotion of student innovation all received low ratings from both groups. The grand mean scores of 2.71 for lecturers and 2.19 for instructors further indicate a limited integration of AI in the curriculum, suggesting that current efforts may be insufficient to effectively bridge knowledge for a sustainable future in technology education programs at universities.

Research Question 2: To what extent is the integration of internet of things in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State?

Table 2: Mean and Standard Deviation on extent is the integration of internet of things in curriculum of technology education programmes

S/NO	Extent is the integration of internet of things in curriculum of technology education programmes	Lecturers			Instructors		
		X	SD	RMK	X	SD	RMK
1	IoT concepts are adequately incorporated into the technology education curriculum.	2.23	.834	LE	2.07	.838	LE
2	Practical IoT applications are integrated into teaching and learning activities.	2.40	.821	LE	2.09	.808	LE
3	The curriculum is regularly updated to include recent developments in IoT technologies.	2.09	.722	LE	2.04	.947	LE
4	Students have access to IoT devices and platforms for hands-on training.	2.18	.658	LE	2.19	.766	LE
5	Lecturers and instructors receive continuous training on IoT concepts and applications.	2.05	.924	LE	2.12	.982	LE
6	IoT integration in the curriculum enhances knowledge bridging for sustainable development.	2.19	.953	LE	2.39	.774	LE
7	There is collaboration with IoT industry experts in curriculum design and implementation.	1.99	.881	LE	2.19	.860	LE
8	Assessment methods incorporate IoT-related skills and competencies.	1.95	.990	LE	2.26	.856	LE

9	The curriculum encourages students to innovate and solve problems using IoT technologies.	1.98	1.03	LE	2.32	.776	LE
	Grand Mean	2.11	0.87	LE	2.18	0.84	LE

Table 2 indicates that both lecturers and instructors perceive the integration of Internet of Things (IoT) concepts into the technology education curriculum as low, with all items rated below the midpoint. Areas such as inclusion of IoT concepts, practical applications, curriculum updates, access to IoT devices, continuous training for educators, sustainable development alignment, industry collaboration, assessment of IoT skills, and promotion of student innovation all received low mean scores from both groups. The grand mean scores of 2.11 for lecturers and 2.18 for instructors further confirm a limited extent of IoT integration, highlighting a need for improved incorporation of IoT technologies in technology education programs to better prepare students for sustainable future challenges.

Research Question 3: To what extent is the integration of robotics technologies in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State?

Table 3: Mean and Standard Deviation on extent is the integration of robotics technologies in curriculum of technology education programmes

S/NO	Extent is the integration of robotics technologies in curriculum of technology education programmes	Lecturers			Instructors		
		X	SD	RMK	X	SD	RMK
1	Robotics technologies are adequately incorporated into the technology education curriculum.	2.23	.881	LE	2.34	.797	LE
2	Practical applications of robotics are integrated into teaching and learning activities.	2.44	.926	LE	2.16	.902	LE
3	The curriculum is regularly updated to include recent advancements in robotics technologies.	2.11	.858	LE	1.70	1.059	LE
4	Students have access to robotics equipment and platforms for hands-on training.	2.26	.897	LE	1.86	1.025	LE
5	Lecturers and instructors receive continuous training on robotics concepts and applications.	2.09	.989	LE	2.17	.891	LE
6	Robotics integration in the curriculum supports knowledge	2.18	.889	LE	2.25	.830	LE

	bridging for sustainable development.						
7	Collaboration with robotics industry experts is encouraged in curriculum design and delivery.	1.97	.954	LE	2.26	.809	LE
8	Assessment methods incorporate robotics-related competencies and practical skills.	2.04	1.017	LE	2.32	.827	LE
9	The curriculum encourages student innovation and problem-solving using robotics technologies.	1.88	.880	LE	2.02	.979	LE
	Grand Mean	2.93	0.92	LE	2.92	0.90	LE

Table 3 shows that both lecturers and instructors perceive the integration of robotics technologies in the technology education curriculum as low, with mean scores consistently below the midpoint across all measured items. This includes the incorporation of robotics concepts, practical applications, curriculum updates, access to robotics equipment, continuous training for educators, alignment with sustainable development, industry collaboration, robotics-related assessment methods, and encouragement of student innovation. The grand mean scores of 2.93 for lecturers and 2.92 for instructors reflect a similarly limited extent of robotics integration, indicating that current curriculum efforts are insufficient to fully embed robotics technologies in technology education programs for sustainable knowledge development.

Hypotheses

HO₁ There is no significant difference between the mean responses of lecturers and technologists on the extent of integrating artificial intelligence in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.

Table 4: t-test analysis on extent of integrating artificial intelligence in curriculum of technology education programmes

Respondents	N	X	$\bar{SD}$	α	DF	t-Cal	t-Crit	RMK
Lecturers	110	2.17	0.88	0.05	138	1.22	1.96	No Sig
Instructors	30	2.19	0.82					

Table 4 presents the t-test analysis comparing lecturers and instructors on the extent of integrating artificial intelligence in the curriculum of technology education programmes. The results show that lecturers (N=110, mean=2.17, SD=0.88) and instructors (N=30, mean=2.19, SD=0.82) have similar perceptions, with no statistically significant difference between the two groups (t-calculated = 1.22, t-critical = 1.96, df = 138, α = 0.05). This indicates a shared view of the low extent of AI integration in the curriculum across both respondent categories..

HO₂ There is no significant difference between the mean responses of lecturers and technologists on the extent of integrating internet of things in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.

Table 5: t-test analysis on extent of integrating internet of things in curriculum of technology education programmes

Respondents	N	X	SD	α	DF	t-Cal	t-Crit	RMK
Lecturers	110	2.11	0.86					
				0.05	138	1.23	1.69	No Sig
Instructors	30	2.18	0.84					

Table 5 shows the t-test analysis comparing lecturers and instructors on the extent of integrating Internet of Things (IoT) in the curriculum of technology education programmes. Lecturers (N=110, mean=2.11, SD=0.86) and instructors (N=30, mean=2.18, SD=0.84) have closely aligned perceptions, with no statistically significant difference observed (t-calculated = 1.23, t-critical = 1.69, df = 138, α = 0.05). This suggests both groups similarly perceive a low level of IoT integration in the curriculum.

HO₃ There is no significant difference between the mean responses of lecturers and technologists on the extent of integrating robotics technologies in curriculum of technology education programmes in bridging knowledge for sustainable future in Universities, Rivers State.

Table 6: t-test analysis on extent of integrating robotics technologies in curriculum of technology education programmes.

Respondents	N	$\bar{X}$	SD	α	DF	t-Cal	t-Crit	RMK
Lecturers	110	2.13	0.92	0.05	138	1.21	1.96	No Sig
Instructors	30	2.12	0.90					

Table 6 presents the t-test analysis comparing lecturers and instructors on the extent of integrating robotics technologies in the curriculum of technology education programmes. The results indicate that lecturers (N=110, mean=2.13, SD=0.92) and instructors (N=30, mean=2.12, SD=0.90) hold similar views, with no statistically significant difference between the groups (t-calculated = 1.21, t-critical = 1.96, df = 138, α = 0.05). This reflects a shared perception of low robotics technology integration in the curriculum across both respondent categories

Discussion of Findings

The findings of this study reveal a limited integration of artificial intelligence (AI) within technology education curricula, highlighting a critical gap in preparing students to meet the demands of a sustainable future. Both lecturers and instructors consistently reported low levels of AI incorporation across key areas such as curriculum content, practical applications, and educator training, reflecting insufficient efforts to embed AI effectively into academic programs. This shared perception between the two groups, with no statistically significant difference, underscores a consensus on the need for enhanced curriculum reforms that prioritize AI literacy and application (Brynjolfsson & McAfee, 2017; Luckin et al., 2016). These findings align with previous research emphasizing that meaningful integration of emerging technologies like AI is essential for equipping students with relevant skills and knowledge for the evolving technological landscape (Selwyn, 2019; Holmes et al., 2019). Consequently, institutions must adopt strategic measures to update curricula, invest in faculty development, and foster collaborations with industry to bridge this gap and advance sustainable technological education.

The findings of this study confirm a limited extent of Internet of Things (IoT) integration within technology education curricula, underscoring the urgent need for enhanced incorporation of IoT technologies to better equip students for addressing future sustainable development challenges. Both lecturers and instructors shared closely aligned perceptions regarding the low level of IoT inclusion, with no statistically significant differences between the groups, indicating a common

recognition of this curricular gap. This concurs with existing literature emphasizing that the integration of IoT in education remains nascent and often fragmented, limiting students' exposure to practical, real-world applications essential for the evolving digital and sustainable landscape (Perera et al., 2014; Atzori, Iera, & Morabito, 2017). To address this gap, educational institutions must prioritize curriculum updates, provide faculty training, and foster partnerships with industry to ensure that IoT technologies are effectively embedded, thus promoting relevant skill development aligned with sustainability goals (Gubbi et al., 2013; Da Xu, He, & Li, 2014).

The findings of this study reveal a similarly limited extent of robotics technology integration in technology education curricula, suggesting that existing curricular efforts are inadequate for fully embedding robotics concepts and applications necessary for sustainable knowledge development. Both lecturers and instructors expressed comparable views on this issue, with no statistically significant difference between their perceptions, highlighting a consensus on the low level of robotics inclusion across the curriculum. These results align with prior research indicating that robotics education remains underdeveloped in many institutions, despite its critical role in fostering innovation, problem-solving skills, and preparing students for emerging technological challenges (Alimisis, 2013; Mataric, 2017). To bridge this gap, there is a clear need for comprehensive curriculum reform, enhanced faculty training, and stronger collaboration with industry to integrate robotics effectively and promote sustainable technological competencies among students (Eguchi, 2014; Benitti, 2012).

Conclusion

The study concludes that the integration of emerging technologies—artificial intelligence, the internet of things, and robotics—within technology education curricula at universities remains limited. Both lecturers and instructors share a consistent perception of inadequate incorporation of these technologies, highlighting a gap between current curricular offerings and the demands of sustainable development in the rapidly evolving technological landscape. The absence of significant differences in perceptions between the two groups underscores a collective recognition of the need for curriculum enhancement to better equip students with relevant skills and knowledge. Therefore, to foster sustainable knowledge development and prepare graduates for future challenges, there is a critical need for deliberate efforts to deepen the integration of AI, IoT, and robotics into technology education programs.

Recommendations

Based on the findings of the study, the following recommendations were made:

Universities in Rivers State should prioritize the comprehensive integration of artificial intelligence concepts and practical applications into technology education programs. This includes regularly updating the curriculum to reflect current AI trends and providing continuous professional development and training for lecturers and instructors to effectively deliver AI-related content, thereby bridging knowledge for a sustainable future.

To strengthen the integration of Internet of Things technologies, universities should facilitate greater access to IoT devices and platforms for hands-on student training. Additionally, fostering collaboration with IoT industry experts in curriculum design and delivery can ensure that learning materials are relevant and aligned with emerging sustainable development challenges.

It is recommended that technology education programs incorporate more robotics technologies into their curricula, emphasizing both theoretical knowledge and practical skills. Universities should invest in robotics equipment and create opportunities for students to engage in problem-solving and innovation activities using robotics, supported by ongoing instructor training and partnerships with robotics industry stakeholders to advance sustainable knowledge development.

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