

SCIENCE TEACHERS' PERCEPTION AND TECHNOLOGICAL KNOWLEDGE OF ROBOTICS KITS UTILISATION FOR STEM LEARNING IN SECONDARY SCHOOLS IN RIVERS STATE

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Abstract

This study examined science teachers' perceptions and technological knowledge of robotics kits utilisation for STEM learning in secondary schools in Rivers State. A descriptive survey research design was adopted. Respondents of 214 science teachers were selected through multistage sampling. Data were collected using a researcher-developed instrument titled "Questionnaire on Perceptions and Technological Knowledge of Robotics Kit Utilisation" (QPTKRKU). The instrument was validated by experts and yielded a Cronbach's alpha reliability coefficient of 0.88, indicating satisfactory internal consistency. Frequency count, mean and standard deviation were used to answer the research questions, while one-way Analysis of Variance (ANOVA) and Scheffé post hoc test were used to test the hypotheses at the 0.05 significance level. Findings revealed low perceptions [$M = 2.19$, $SD = 0.91$] and low technological knowledge [$M = 1.97$, $SD = 0.88$] of robotics kit utilization. Teaching experience produced no significant difference in perceptions of robotics kit utilisation, $F(2, 211) = 0.92$, $p = .401$, whereas educational qualification significantly influenced technological knowledge, $F(2, 211) = 13.12$, $p < .001$ of robotics kit utilisation. The study concluded that science teachers require improved exposure, practical training and professional development in robotics utilisation. It therefore recommends sustained hands-on robotics training to strengthen teachers' technological competence and support effective STEM learning.

Keywords: Science Teachers, Robotics Kits, Technological Knowledge, STEM Learning, Teachers' Perception.

Introduction

The field of Science, Technology, Engineering and Mathematics (STEM) education has emerged as a significant educational paradigm aimed at preparing students with the knowledge, skills and competencies necessary for effective participation in a technology-driven society. Unlike traditional educational approaches that may prioritize memorization and passive learning, STEM education emphasizes the integration of scientific concepts with technological applications, engineering design and mathematical reasoning. This approach encourages learners to engage in problem-solving, creativity, critical thinking, collaboration and innovation. The effectiveness of STEM education is further enhanced through practical, learner-centered instructional strategies that provide students with opportunities to explore real-world challenges, conduct experiments, design solutions and apply theoretical knowledge in real world situation.

Aderonmu, et al., (2026) noted that integration of technology in teaching and learning has gained significant importance, as digital tools, simulations, programmable devices and other emerging technologies foster interactive and experiential learning environments. In such learning environment, learners are encouraged to actively construct knowledge rather than passively absorb information from teachers. Such methodologies can enhance student engagement, deepen their conceptual understanding and cultivate essential computational and problem-solving skills vital for modern STEM education. Therefore, the successful execution of STEM education necessitates teachers who possess not only expertise in their

respective fields but also the ability to select and employ suitable technologies, such as educational robotics, to create meaningful, practical and innovative learning experiences.

The term educational robotics refers to the utilization of programmable robots and robotic technologies as instructional resources aimed at promoting teaching, learning and problem-solving. Robotics kits are defined as interactive educational packages that include various components such as programmable controllers, sensors, motors, actuators and structural parts, enabling learners to construct, program, test, and modify robotic systems (Fadip, et al., 2024). In STEM education, these robotics kits offer learners the chance to engage in hands-on activities that extend beyond abstract theoretical discussions, allowing them to participate in construction, programming, experimentation, engineering design and collaborative problem-solving, thereby linking theoretical knowledge with practical applications. A systematic review of robotics-based STEM education highlighted that project-based learning was one of the most prevalent instructional strategies, while programming emerged as a significant area of application, with STEM learning and transferable skills recognized as key educational outcomes (Darmawansah, et al., 2023).

In a comparable manner, Ching and Hsu (2024) stated that educational robotics has been shown to foster interactive learning environments where students develop computational and problem-solving skills through activities that encompass sequencing, programming, debugging and algorithmic thinking. Collaborative and project-based learning is frequently incorporated into these robotics activities. For secondary school science teaching and learning, robotics kits are particularly significant as they enable students to explore scientific principles by designing and programming functional systems, testing hypotheses, observing cause-and-effect relationships and applying mathematical and technological knowledge to real-world problems. A multilevel meta-analysis indicates that educational robotics has a moderate positive effect on STEM learning and moderate effects on students' academic performance and attitudes, although the effectiveness can vary based on factors such as instructional strategy, teacher support, discipline, and the type of robotics used (Ouyang & Xu, 2024).

Robotics kits are not merely technological devices, they serve as valuable STEM learning tools that encourage active engagement, creativity, experimentation, collaboration and the application of scientific principles. Their effective use is especially pertinent to modern secondary school science education. Aderonmu, et al., (2026) reiterated that science teachers are pivotal in technology-enhanced STEM teaching by choosing suitable digital and technological resources, crafting learner-centered activities, facilitating hands-on experiments, assisting students in addressing real-world problems and integrating technologies like robotics kits with scientific concepts to foster meaningful, innovative and collaborative learning experiences.

The perceptions and technological knowledge of science teachers play a crucial role in the effective use of robotics kits. This is because teachers' beliefs regarding the usefulness, ease of use and instructional value of technology can significantly affect their readiness to adopt and integrate new technologies into their teaching practices. Recent studies suggest that the acceptance of technology by teachers and its actual integration is shaped by an ongoing interaction among their perceptions, accumulated experiences, opportunities for skill enhancement, professional support and access to suitable technological resources (Akram et al., 2022; Sellami et al., 2024; Wohlfart & Wagner, 2025).

Furthermore, technological knowledge is vital, as the effective use of robotics necessitates that science teachers comprehend the functioning of robotic components, programming methods, troubleshooting techniques, and the pedagogical application of robotics in relation to scientific concepts. As a result, teachers with higher levels of technological competence are more inclined to utilize technology in a meaningful way rather than simply as an additional instructional tool. In Nigeria, recent studies have similarly highlighted the significance of teachers' perceived technological competence and teaching experience in the context of technology integration, while challenges such as insufficient digital literacy and limited resources continue to hinder classroom implementation (Oguezue, 2025).

The way teachers perceive technology and their level of technological knowledge may not be the same across various professional groups, as disparities in teaching experience and educational qualifications can influence their exposure to technology, confidence in using new instructional tools, opportunities for professional development and familiarity with technology-supported teaching methods. Although recent study by Sellami et al., (2024) have reported minimal differences across demographic and professional characteristics, these findings are not necessarily consistent across different fields, highlighting the need to empirically investigate such differences among science teachers rather than assuming that professional experience or qualifications automatically lead to greater technological competence. Therefore, in the context of robotics-based STEM learning, it is essential to examine teachers' perceptions and technological knowledge, including any potential differences based on teaching experience and educational qualifications, to understand their readiness to effectively implement robotics kits in secondary school science classrooms.

Statement of Problem

The increasing emphasis on Science, Technology, Engineering and Mathematics (STEM) education has created a growing need for instructional approaches that enable secondary school students to develop practical skills, creativity, critical thinking, problem-solving and innovation. Educational robotics and robotics kits provide opportunities for learners to engage in hands-on experimentation, programming, engineering design and collaborative problem-solving while connecting abstract scientific concepts with practical applications. However, the effective use of robotics kits in science classrooms depends substantially on teachers' perceptions and technological knowledge. Science teachers are expected to possess adequate technological knowledge to operate robotics kits, integrate them with relevant science concepts, facilitate practical activities and guide students in designing and solving problems using robotic systems. Where teachers have limited knowledge, confidence or positive perceptions of robotics technology, the availability of robotics kits may not necessarily translate into meaningful STEM learning experiences. This situation raises concerns about whether science teachers possess adequate technological knowledge and whether they perceive robotics kits as useful, relevant and manageable instructional resources for STEM learning in secondary schools.

Furthermore, differences in teachers' professional characteristics, particularly teaching experience and educational qualification, may influence their perceptions and technological knowledge of robotics kit utilization. Teachers with different years of teaching experience may have varying levels of exposure to technology-supported instruction, professional development and emerging STEM technologies, while differences in educational qualification may be associated with variations in pedagogical preparation, technological competence and familiarity with innovative instructional approaches. Despite the growing attention given to robotics and technology-enhanced STEM education, there remains a need for empirical evidence on science teachers' perceptions and technological knowledge regarding the utilization of robotics kits in secondary schools in Rivers State. Without such evidence, educational stakeholders may find it difficult to determine teachers' readiness for robotics-supported STEM instruction and to identify areas requiring professional development and institutional support. It is therefore necessary to examine science teachers' perceptions and technological knowledge of robotics kit utilization and determine whether significant differences exist based on teaching experience and educational qualification. Findings from such an investigation could provide useful evidence for teacher educators, school administrators, policymakers and other STEM education stakeholders in designing appropriate capacity-building programmes and strategies for effective robotics integration in secondary school science education in Rivers State.

Aim and objectives of the study

The aim of this study is to examine science teachers' perceptions and technological knowledge of robotics kit utilisation for STEM learning in secondary schools in Rivers State. Specifically, the study seeks to;

- i. determine the perception of science teachers' utilisation robotics kits for STEM learning in secondary schools.

- ii. determine the level of science teachers' technological knowledge of robotics kit utilisation for STEM learning in secondary schools.

Research Questions

The following research questions guided the study:

- i. What is the perception of science teachers' utilisation robotics kits for STEM learning in secondary schools?
- ii. What is the level of science teachers' technological knowledge of robotics kit utilisation for STEM learning in secondary schools?

Hypotheses

The following null hypotheses were tested at the 0.05 level of significance.

H₀₁: There is no significant difference in science teachers' perceptions of robotics kit utilisation for STEM learning based on their teaching experience in secondary schools.

H₀₂: There is no significant difference in science teachers' technological knowledge of robotics kit utilisation for STEM learning based on their educational qualification in secondary schools.

Methodology

The study will adopt a descriptive survey research design. The population of the study comprised all science teachers in both public and private secondary schools in Rivers State. The sample size used for the study is 214 science teachers teaching in both public and private secondary schools obtained through the multistage sampling technique.

Table 1: Distribution of Science Teachers by Teaching Experience and Educational Qualification

<i>Variable</i>	<i>Category</i>	<i>Frequency (f)</i>	<i>Percentage (%)</i>
Teaching Experience	1–5 years	45	21.0
	6–10 years	75	35.0
	11 years and above	94	43.9
Total		214	100.0
Educational Qualification	NCE	28	13.1
	B.Sc, B.Sc (Ed), B.Ed	126	58.9
	M.Ed, MSc	60	28.0
Total		214	100.0

Source: Researchers' fieldwork, 2026.

The instrument for data collection was a researcher-developed questionnaire titled "Questionnaire on Perceptions and Technological Knowledge of Robotics Kit Utilisation" (QPTKRKU). The questionnaire will consist of three sections: Sections A, B and C. **Section A** was designed to obtain demographic information from respondents, including teaching experience and educational qualification. **Section B** contained **10 items** measuring science teachers' perceptions of robotics kit utilization for STEM learning. The items will cover perceived usefulness, ease of use, relevance to science teaching, instructional effectiveness, learner engagement, creativity, problem-solving and teachers' confidence in using robotics kits.

Section C contained **10 items** measuring science teachers' technological knowledge of robotics kit utilization. The items will cover knowledge of robotics components, sensors, motors, programming, coding, assembling robotics kits, operating robotic systems, troubleshooting, integrating robotics with science concepts and facilitating robotics-based STEM activities. Items in Sections B and C were structured on a four-point Likert scale. For the interpretation of mean scores, a criterion mean of 2.50 was adopted. Mean scores of 2.50 and above indicated a high perception or adequate technological knowledge, whereas mean scores below 2.50 indicated a low perception or inadequate technological knowledge.

The instrument was subjected to face and content validation by experts in Educational Technology, Science Education, STEM Education and Measurement and Evaluation. The reliability of the instrument was obtained by pilot test which was conducted using 25 science teachers who are not part of the main study but possess characteristics similar to those of the target respondents. The responses obtained from the pilot study was analysed using Cronbach's Alpha reliability coefficient to determine the internal consistency of the instrument. A reliability coefficient of 0.88 was obtained which was acceptable for the study. The researchers, assisted by 5 trained research assistants distributed the questionnaires to the selected science teachers. Completed questionnaires was collected, screened for completeness and prepared for statistical analysis.

Data collected from the study was analysed using frequency count, mean and standard deviation for the research questions while the hypotheses were analysed using One-way Analysis of Variance (ANOVA) at the 0.05 level of significance. Where a significant F-value was obtained, Scheffe's post-hoc test was conducted to determine the specific groups responsible for the significant difference.

Results

Research Question One: What is the perception of science teachers' utilisation robotics kits for STEM learning in secondary schools?

Table 2: Science Teachers' Perceptions of Robotics Kit Utilization for STEM Learning

S/N	Item Statement	Mean	SD	Decision
1	Robotics kits are useful instructional resources for teaching science concepts to secondary school students.	2.18	0.91	N
2	The use of robotics kits can make STEM learning more interesting and engaging for students.	2.31	0.88	N
3	Robotics kits are relevant to the teaching and learning of science subjects in secondary schools.	2.24	0.94	N
4	I consider robotics kits easy to use during science teaching activities.	2.05	0.89	N
5	Robotics kits can effectively improve students' understanding of difficult science concepts.	2.27	0.92	N
6	I am confident in using robotics kits to facilitate practical STEM learning activities.	1.96	0.87	N
7	Robotics kits provide opportunities for students to develop problem-solving and critical-thinking skills.	2.35	0.90	N
8	I am willing to incorporate robotics kits into my regular science teaching activities.	2.12	0.93	N
9	The benefits of using robotics kits in STEM learning outweigh the challenges involved in their use.	2.08	0.95	N
10	Robotics kits can promote creativity, innovation and collaborative learning among secondary school students.	2.29	0.91	N
Cluster		2.19	0.91	Negative
mean				

Source: Researchers' fieldwork, 2026.

The result presented in Table 2 above shows that science teachers demonstrated a negative perception of robotics kit utilization for STEM learning in secondary schools. The overall cluster [Mean 2.19] indicates that the teachers generally had a negative perception of robotics kit utilisation. This finding suggests that although science teachers may recognize some potential educational benefits of robotics, they may not yet perceive robotics kits as sufficiently useful, accessible, easy to use or practical for regular STEM instruction. The particularly negative rating for science teachers' in using robotics kits may also indicate inadequate exposure, training or practical experience with robotics-based instructional technologies.

Research Question Two: What is the level of science teachers' technological knowledge of robotics kit utilisation for STEM learning in secondary schools?

Table 3: Science teachers' technological knowledge of robotics kit utilisation for STEM learning

S/N	Item Statement	Mean	SD	Decision
1	I have adequate knowledge of the basic components of educational robotics kits.	2.14	0.91	Low
2	I can correctly assemble the major components of a robotics kit for classroom activities.	1.98	0.87	Low
3	I have adequate knowledge of programming robots for simple STEM learning activities.	1.89	0.84	Low
4	I can use sensors and actuators in a robotics kit to demonstrate science concepts.	1.93	0.89	Low
5	I can connect and configure robotics kit components correctly for practical activities.	2.03	0.92	Low
6	I have adequate knowledge of using coding applications associated with educational robotics kits.	1.86	0.83	Low
7	I can troubleshoot common technical problems that may occur when using robotics kits.	1.91	0.88	Low
8	I can integrate robotics kit activities with relevant concepts in the secondary school science curriculum.	2.16	0.94	Low
9	I can guide students in designing and constructing simple robotic systems for STEM learning.	1.95	0.90	Low
10	I can independently operate a robotics kit to conduct practical STEM learning activities.	1.88	0.86	Low
Cluster mean		1.97	0.88	Low

Source: Researchers' fieldwork, 2026.

The result in Table 3 indicates that science teachers possess a low level of technological knowledge of robotics kit utilisation for STEM learning, as reflected by the cluster mean of 1.97 with a standard deviation of 0.88. The result suggests that the teachers may have limited practical knowledge of robotics assembly, programming, sensor and actuator use, troubleshooting, coding and independent operation of robotics kits for STEM instruction.

Hypotheses

H₀₁: There is no significant difference in science teachers' perceptions of robotics kit utilisation for STEM learning based on their teaching experience in secondary schools.

Table 4: Science teachers' perceptions of robotics kit utilisation based on teaching experience

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. (p)	Decision
Between Groups	1.842	2	0.921	0.917	0.401	Not Significant
Within Groups	211.658	211	1.003			
Total	213.500	213				

Source: Researchers' fieldwork, 2026.

A one-way analysis of variance (ANOVA) was conducted as shown on Table 4 to examine whether science teachers' perceptions of robotics kit utilisation for STEM learning differed significantly based on teaching experience. The analysis revealed that there was no statistically significant difference in teachers' perceptions

across the three teaching-experience groups, $F(2, 211) = 0.92$, $p = .401$. This finding indicates that science teachers with 1–5 years, 6–10 years, and 11 years and above of teaching experience had statistically similar perceptions of robotics kit utilisation for STEM learning in secondary schools. The result further suggests that teaching experience did not significantly influence teachers' perceptions of the usefulness, relevance, ease of use and instructional value of robotics kits for STEM learning.

Ho₂: There is no significant difference in science teachers' technological knowledge of robotics kit utilisation for STEM learning based on their educational qualification in secondary schools.

Table 5: Science teachers' technological knowledge of robotics kit utilisation based on educational qualification

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. (p)	Decision
Between Groups	4.733	2	2.367	13.121	.000	Significant
Within Groups	38.060	211	0.180			
Total	42.793	213				

Source: Researchers' fieldwork, 2026.

A one-way analysis of variance (ANOVA) on Table 5 was conducted to determine whether science teachers' technological knowledge of robotics kit utilisation for STEM learning differed significantly based on educational qualification. The analysis revealed a statistically significant difference in technological knowledge among the three educational qualification groups, $F(2, 211) = 13.12$, $p < .001$. Therefore, the null hypothesis was rejected at the 0.05 level of significance. The result indicates that science teachers' technological knowledge of robotics kit utilization differed significantly according to educational qualification. Since the ANOVA result was significant, Scheffé's post hoc test was conducted to determine the specific educational qualification groups that differed significantly.

Table 7: Scheffé Pairwise Comparisons

Educational Qualification	N	Mean	Comparison	Mean Difference	Scheffé Decision
NCE	28	1.65	B.Sc./B.Sc. (Ed.)/B.Ed. vs. NCE	0.40	Significant
B.Sc., B.Sc. (Ed.), B.Ed.	126	2.05	B.Sc./B.Sc. (Ed.)/B.Ed. vs. M.Ed./MSc.	0.23	Significant
M.Ed., MSc.	50	1.82	M.Ed./MSc. vs. NCE	0.17	Not Significant

Source: Researchers' fieldwork, 2026

Scheffé's post hoc analysis as shown in Table 7 indicates that science teachers with (B.Sc., B.Sc. (Ed.) and B.Ed.) qualifications recorded the highest mean technological knowledge score [$M = 2.05$], followed by teachers with (M.Ed. and MSc) qualifications [$M = 1.82$], while teachers with (NCE) qualifications recorded the lowest mean score [$M = 1.65$]. The post hoc comparison further showed that the (B.Sc./B.Sc. (Ed.)/B.Ed.) group differed significantly from both the (NCE) and (M.Ed./MSc.) groups, whereas the difference between the (M.Ed./MSc.) and (NCE) groups was not statistically significant. These findings suggest that educational qualification has a significant influence on science teachers' technological knowledge of robotics kit utilisation for STEM learning.

Discussion of Findings

The findings from the study, as presented in research question one, indicated that science teachers had negative perception of the utilisation of robotics kits for STEM learning in secondary education. This result suggests that, although robotics kits possess substantial potential for improving practical and technology-enhanced STEM instruction, the participating science teachers did not exhibit sufficiently favorable perceptions regarding their usefulness, ease of use, relevance, effectiveness and applicability to classroom teaching. This finding is significant because robotics-based STEM education is increasingly linked to active, project-based and experiential learning, where students engage with technology to tackle real-world

challenges. Darmawansah, et al. (2023) in their systematic review of robotics-based STEM education, reported that the perceptions of both learners and teachers were among the most frequently studied issues, while project-based learning was a predominant instructional strategy. Similarly, Ouyang and Xu (2024) discovered a moderate positive effect of educational robotics on STEM learning, suggesting that robotics can play a meaningful role in STEM education when properly integrated into instructional practices. Consequently, the negative perception observed in the current study may indicate that the potential benefits of robotics have not been adequately reflected in teachers' practical experiences in the classroom.

Science teachers might identify robotics as a novel STEM resource, yet they may still view it as difficult to operate, costly to purchase, technically demanding, or inappropriate for standard science lessons when they do not receive sufficient training and institutional support. This interpretation is in line with the findings of Darmawansah, et al. (2023) who noted that research on robotics in STEM often emphasizes not just the technological tools but also the roles of educators, instructional methods and learning contexts in achieving successful implementation. Furthermore, Atman Uslu et al., (2022) reported that support from instructors was among the factors explored in relation to robotics-supported STEM education, highlighting the importance of the instructional conditions that surround the use of technology.

The second finding related to research question two indicated that science teachers had a low level of technological knowledge concerning the utilisation of robotics kits for STEM learning. This finding points to gaps in science teachers' understanding of robotics components, assembly, programming, sensors and actuators, coding applications, troubleshooting, curriculum integration and the independent operation of robotics kits. This result is crucial because robotics-based STEM instruction requires science teachers to have more than a basic awareness of technology; they must possess adequate operational and pedagogical knowledge to select, configure, demonstrate and integrate robotics activities with relevant science concepts. The study by Valls Pou, et al., (2022) identified programming as the primary robotics-related STEM discipline and project-based learning as the most frequently utilized instructional strategy, illustrating the technical and pedagogical demands associated with robotics-based learning. Similarly, Coufal (2022) established that educational robotics can have positive and moderate effects on STEM learning, but the successful implementation of robotics relies on the instructional context and the support provided to both learners and teachers.

The hypothesis one indicated that there was no significant difference in science teachers' perceptions of the use of robotics kits based on their teaching experience. This finding suggests that the length of teaching experience alone may not be adequate to create differences in science teachers' perceptions of emerging technologies such as robotics. In other words, having more years of teaching experience does not necessarily imply that a teacher will have a more positive or negative view of robotics-based STEM instruction. This result is also generally consistent with the evidence compiled by Atman Uslu et al., (2022), found that several contextual moderators did not significantly account for differences in the effectiveness of robotics-supported STEM education.

In contrast, hypothesis two revealed a significant difference in science teachers' technological knowledge regarding the use of robotics kits, which was influenced by their educational qualifications. This finding reinforces the argument that technological knowledge is likely to be contingent not only on formal educational qualifications but also on the nature of science teachers' training and their exposure to emerging technologies. Given the proven educational potential of robotics in STEM learning (Ouyang & Xu, 2024), this finding emphasizes the need for structured, hands-on robotics training across all qualification levels, rather than relying solely on teachers' existing academic credentials.

Conclusion

The study revealed that secondary school science teachers in Rivers State had negative perception and low level of technological knowledge regarding the use of robotics kits for STEM learning. The result of the study also showed that level of teaching experience did not significantly affect the teachers' perceptions of robotics kits usage, but their educational qualifications played a crucial role in determining their

technological knowledge. Teachers with B.Sc., B.Sc. (Ed.), and B.Ed. qualifications demonstrated a higher level of technological knowledge compared to other groups. These findings stress the need for practical robotics training and ongoing professional development to improve teachers' perceptions, confidence and technological competence for the effective integration of robotics kits into STEM instruction in secondary schools.

Recommendations

The following recommendations were posited for the study;

- i. Secondary school administrators and relevant education authorities should organise regular hands-on professional development programmes on robotics kits to improve science teachers' technological knowledge, confidence and perceptions of robotics-based STEM instruction.
- ii. Teacher education institutions and policymakers should integrate educational robotics, programming and practical STEM technology into teacher preparation and in-service training programmes, with particular attention to teachers with lower levels of technological knowledge.

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