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Science Education Students' Awareness, Attitudes, and Perception of the Internet of Things (IoT) in Education in Ogbia LGA, Bayelsa State

Alibo, T.K.
Department of Science Education, Faculty of Education, Federal University Otuoke, Bayelsa State

Corresponding author email: alibotk@fuotuoke.edu.ng

Abstract
This study examines the awareness, attitudes, and perceptions of science education students in Ogbia Local Government Area (LGA), Bayelsa State, toward the integration of the Internet of Things (IoT) in education. IoT's transformative potential for personalised learning and administrative functions has been widely recognised globally, but its adoption in Nigerian education faces challenges. A descriptive survey research design was adopted for the study, with a population comprising 405 science education students from a tertiary institution in Ogbia LGA, Bayelsa State. A purposive sampling technique was employed to select 148 second-year students as the sample for this study. Data were collected using the Science Education Students Awareness, Attitudes, and Perception of IoT in Education Questionnaire (SESAAPQ), which was validated by three experts in science education. The reliability of the instrument was determined using the test-retest method, yielding a reliability coefficient of 0.87, 0.83, and 0.88, respectively. Mean and standard deviation were utilised to answer the research questions. The findings revealed that students demonstrated a high level of awareness and understanding of IoT in education and their educational applications and had a positive attitude toward adopting IoT technologies for enhanced learning experiences. However, students expressed concerns about technical challenges, costs, and security risks, highlighting barriers to IoT integration. Based on these findings, the study recommends that policymakers and educators promote the integration of IoT technologies in education to enhance learning experiences and address the barriers identified by students.

Keywords: Awareness, Attitude, Perception, Internet of things (IoTs) and internet of things in education.

Introduction

Technology has advanced over time, enabling various technological gadgets to be used in the education process. These technologies has a disruptive effect on today's education and as such educators cannot ignore it. Creating a gap between these emerging technologies and the educational environment poses a great loss for education. As stated by Alibo and Tolowodun (2024), today's learners are technologically inclined, who understand better when technology is fully incorporated into the teaching process. Hence, there is need for these emerging technologies to be embraced in the educational setting rather than ignored. One of the ways, technology is influencing education is through the application of Internet of things (IoT) in education. However, this influence is still at the infancy stage (Al-Abdullatif et al., 2022). As stated by Alrikabi and Hazim (2022), Internet of Things (IoT) is the network of physical things or objects we use on a daily basis that are implanted with sensors and other technologies built in them so they can communicate and share data with other systems and devices over the internet. These objects might be anything from simple household items to highly advanced industrial tools. That is to say, with IoT, internet connection is no more restricted to computers, tablets and phones but also on objects we use in our daily lives such as television, refrigerators, security cameras, cars etc. According to Ardi et al. (2023), many devices such as laptops, tablets, smartphones, self-driving cars, household appliances etc. can be connected by this technology. These gadgets use a range of sensors and data gathering technology to collect important information which is subsequently sent for processing for the purpose of interpretation and decision making.

The Internet of Things (IoT) is becoming more and more common in a number of industries and has revolutionized various sectors such as, agriculture and health care, including education, by transforming the way and manner students learn and engage with their environment. Kim et al. (2017) as cited in Evwiekpaefe and Amrevuawho (2023) stated that in recent years, practically every area of human existence has been touched by

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the Internet of Things (IoT), including universities, agriculture, homes, offices, manufacturing facilities and hospitals. However, the influence of IoT in Nigeria in these sectors including education is not clear. Shortage of electricity, government policies, lack of information on IoT, illiteracy, corruption, religion and similar factors could be the cause of this (Bamigboye & Ademola, 2016).

IoT in education refers to the integration of smart devices, sensors, and networks to create a connected and immersive learning experience. IoT has advanced at a rapid pace, offering great potential benefits to transform education by enabling the setting up of connected and smart learning environments that are tailored to meet the varied preferences and needs of students. It could aid students learning by creating personalized instruction. For instance, data regarding each student's learning preferences, areas of interest and difficulty can be gathered via IoT devices. Then, using this data, lesson plans and learning activities that are specific to the needs of each student can be developed to suite the individual learner. Several studies discussing the benefits of this technology has been carried out. These benefits extend beyond teaching and learning to the school buildings and also the way the school is managed. As stated by Shahla et al. (2017) not only has IoT transformed the traditional teaching methods but has also brought infrastructural transformation in educational institutions. According to Al-Taai et al. (2023), this technology can help solidify student -teacher relationship as it enables communication with each other anywhere and anytime without having to have a face-to-face meeting. Also Arriba-Pérez et al. (2017) stated that wrist wearable's can be used to gather information regarding the stress and sleep patterns of students. According to them, such information might help students become more self-aware of their stress and sleep habits, enabling them to plan their schedules to balance study and rest periods. Which can increase student engagement, enhance personalized learning and improve their academic performance.

Tabuenca et al. (2023) stated that, integrating IoT in education has the ability to completely transform the way students learn and interact with course content. Teachers can design interactive learning environments that encourage hands-on experimentation, data collection and analysis. For example, IoT-enabled sensors can be used to monitor environmental factors in real-time, giving students the opportunity to observe and analyze natural phenomena in their surroundings (Tabuenca et al., 2023). Furthermore, IoT technology have the potential to enable students to conduct experiments and investigate scientific concepts even in the lack of physical resources by providing remote access to laboratory equipment and simulations (Tabuenca et al., 2023). Students learning can also be aided by IOT through virtual field trips. With the use of IoT enabled virtual reality headsets, students can be transported to museums, historical sites or other locations thus solidifying their learning experiences. Automating administrative duties like monitoring attendance is another application of IoT technology in education. By employing facial recognition technology, students' attendance can be recorded. By doing this, teachers' time can be freed up to concentrate on teaching and this can help guarantee that students are showing up to class on a regular basis. Despite the numerous benefits of IoT in education, Nigeria is still in the early stages of adoption. The nation's education system has numerous challenges such as insufficient funding, inadequate infrastructure, shortage of qualified teachers etc. Some of these issues can be resolved by integrating IoT into Nigerian education, but doing so successfully requires a detailed understanding of students' awareness, attitudes, and perceptions of this technology; since they would be the ones at the receiving end of this technology.

Studies reveal that although many students are familiar with the term "Internet of Things," their understanding of its real-world applicability in the classroom is frequently shallow. According to a study by Chweya and Ibrahim (2021), even though most students say they would be eager to use IoT technology, they frequently lack the understanding, exposure, and training needed to successfully incorporate these resources into their academic activities. This gap may cause students to be reluctant to accept IoT as a useful tool for improving their learning experiences. As stated by Gul et al. (2017), because of the limited knowledge students have of IoT, many students worry about the complexities of this technology, believing that rather than enhancing their learning, this technology may disrupt traditional learning methods. Students' readiness and willingness to adopt these technologies will determine the successful implementation of IoT. Studies have revealed that students' views of IoT can have a big impact on their engagement with this technology and their learning outcomes (Chweya & Ibrahim, 2021). As stated above, for IoT technology to be effectively integrated into education, the awareness level, attitudes, and perception of these students who would be at the forefront of using this technology has to be considered.

Students' awareness in this context has to do with how much knowledge, cognizance and comprehension students have about the existence, applications, and implications of IoT technologies in learning environments.

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This awareness deals with the extent to which students are familiar with the terminologies and fundamental concepts related to IoT, such as sensors, actuators, connectivity, networks, and smart devices. It also includes students identifying and understanding of the diverse ways (such as smart classroom, wearables, intelligent tutoring system, virtual and augmented realities) which IoT can be applied in education to enhance their learning experience. This awareness also includes, students understanding of the possible benefits and challenges associated with IoT in education.

Students' attitude refers to the beliefs, predisposition and emotional reactions students have towards the adoption and use of IoT technologies in their learning environment. This has to do with feelings of enthusiasm, interest, excitement, and confidence in employing IoT technology. Alternatively, it also involves feelings of concern, anxiety, or skepticism regarding the students' use of this technology. Students' perception refers to the way students interpret, comprehend, and make sense of IoT technologies when used to enhance their learning experiences. This gap is particularly concerning as these students are expected to be at the forefront of implementing and utilizing IoT in their future teaching careers. Without adequate awareness and positive attitudes, the adoption of IoT in education may encounter strong resistance, thereby hindering the potential benefits it offers. Therefore, this study aims to investigate the current state of science education students' awareness, attitudes, and perceptions of IoT in education. Addressing this problem is essential for ensuring that the next generation of educators are well-equipped to utilize the full potential of IoT, ultimately leading to more innovative and effective teaching outcomes.

Statement of the Problem

Despite the potential benefits of IoT in education, research on students' awareness, attitudes, and perception of IoT in Nigerian education is lacking. Previous studies have concentrated mainly on the application and technical aspects of IoT implementation without due consideration to the students who are at the receiving end of this technology. The attitudes, views and perception of these science education students who serve as a representation of future educators and technology users cannot be overlooked if the integration of IoT in education is to be successful. Also, some of these students are unsure about how IoT can be included effectively into their learning process, which could make them less interested in using these technologies.

This knowledge gap is specifically pronounced among science education students who are expected to utilize these technologies to improve their learning experiences and further prepare them for future careers as teachers in a technologically driven environment. This gap in knowledge can hinder the effective integration of IoT in education, as educators, policymakers and other stake holders may not fully understand students' needs, concerns, and expectations. This study therefore aims to address this knowledge gap by investigating Science education students' awareness, attitudes, and perceptions of IoT in education, providing valuable insights for educators, policymakers, and researchers seeking to harness the potential of IoT in Nigerian education.

Aim and Objectives of the Study

The purpose of the study is to determine the level of awareness, attitude and perception the science education students in Federal University Otuoke have about Internet of Things (IoT) in education. Specifically, the study sought to:

1. assess the level of awareness and understanding of Internet of Things (IoT) in education among science education students.
2. investigate the attitudes of science education students towards the integration of IoT in their learning processes.
3. Investigate the perceptions of science education students towards the integration of IoT in their learning process.

Research Questions

1. What is the level of awareness and understanding of IoT in education among science education students?
2. What attitudes do science education students hold towards the adoption of IoT technologies in education?
3. How do science education students perceive the benefits and challenges of integrating IoT in their learning processes?

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Materials and Methods

The study employed a descriptive survey research design. This design is suitable for this study since it allows the collection of data from a given population to determine their present state of knowledge and ideas among a defined group. The study was conducted in Bayelsa State, Nigeria. The population of the study comprised 405 science education students in the Department of Science Education, Faculty of Education, in one of the tertiary institutions in Ogbia LGA, Bayelsa State. To ensure a representative sample, a sample size of 148 year two students were selected for this study. The instrument for data collection was a Science Education Students Awareness, Attitudes, and Perception of IoT in Education Questionnaire (SESAAPQ) developed by the researcher. SESAAPQ consisted of two sections: A and B. Section A contained the personal information of the students while Section B intended to find out information about students' awareness, attitude and perception of IoT in Education. Section B was subdivided into three sections A, B, and C, based on the number of research questions. The instrument was subjected to face and content validity by three lecturers from the Department of Science Education, Faculty of Education, Federal University Otuoke. They reviewed the items for clarity, relevance, content coverage and wordings. Their corrections and recommendations were taken into consideration and incorporated to improve the instrument. The reliability of the instrument was tested using the test-retest method. The instrument was given to a group of students who were not part of the sample. Two weeks later, the group was re-administered the same instrument. The responses of each student from both tests were then correlated using Pearson product-moment correlation and the correlation coefficients of each sub-section were established as 0.87, 0.83, and 0.88, respectively. The questionnaires were administered online to the students through Google Forms. The research questions were analysed using mean and standard deviation.

Results

Research Question 1: What is the level of awareness and understanding of IoT in education among science education students?

Table 1: Mean and standard deviation of responses on the level of awareness and understanding of IoT in education among science education students(n=148)

Statements	Mean	Std.D	Remark
I am familiar with the concept of Internet of Things (IoT) and its applications in education.	3.83	1.04	HE
I understand how IoT can be integrated in education to enhance my learning experiences	4.20	.97	HE
I believe that IoT technologies can enhance my learning experience	4.12	.95	HE
I have been taught about IoT in education in my course work	4.05	1.05	HE
I can confidently explain the importance of IoT in modern education	4.02	1.11	HE
Grand Mean	4.04	1.02	HE

Source: Fieldwork (2024) ***HE=HIGH EXTENT, LE=LOW EXTENT**

The level of awareness and understanding of IoT in education among science education students is high, as indicated by the grand mean of 4.04, which is well above the cut-off mean of 3.0. All individual statements also show high mean scores, ranging from 3.83 to 4.20, reflecting a strong familiarity with IoT concepts, understanding of its integration in education, belief in its potential to enhance learning, exposure to IoT in coursework, and confidence in explaining its importance. Therefore, the data suggests that students possess a significant awareness and comprehension of IoT in education.

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Research Question 2: What attitudes do science education students hold towards the adoption of IoT technologies in education?

Table 2: Mean and standard deviation on responses of attitudes do science education students hold toward the adoption of IoT technologies in education (n=148)

Statements	Mean	Std.D	Remark
I feel that integrating IoT in education is essential for modernizing education	4.1824	.91872	A
I am open to using IoT devices and applications as part of my learning tools	4.2838	.73808	A
I think that the integration of IoT in education will lead to a better academic outcomes for students	4.2230	.77214	A
I have a positive attitude towards the adoption of IoT technologies in education	4.2365	.82776	A
I am excited about the potential benefits of integrating IoT in education	3.9459	1.04187	A
Grand Mean	4.17	.85	A

Source: Fieldwork (2024) ***A=AGREE, D=DISAGREE**

The attitudes of science education students toward the adoption of IoT technologies in education are highly positive, as reflected by the grand mean of 4.17, which indicates an "Agree" (A) response level. Each statement also shows strong agreement, with mean scores ranging from 3.95 to 4.28. Students express a belief that integrating IoT is essential for modernizing education, are open to using IoT devices as learning tools, and think that IoT will lead to better academic outcomes. They also hold a positive attitude toward IoT adoption and are excited about its potential benefits in education.

Research Question 3: How do science education students perceive the benefits and challenges of integrating IoT in their learning?

Table 3: Mean and standard deviation on responses of science education students perceive the benefits and challenges of integrating IoT in their learning. (n-148)

Statements	Mean	Std.D	Remark
I perceive that the use of IoT devices in education can lead to a more personalized learning experience	3.89	1.02	A
I am concerned about the technical challenges that may arise from using IoT technologies in my studies	3.91	1.01	A
I think that the benefits of using IoT in education, such as improved engagement and collaboration, outweighs the challenges it presents.	3.66	1.13	A
I am concerned about the potential security and privacy risks associated with using IoT in education	3.63	1.11	A
I think that the cost of implementing IoT technologies in education will be a major challenge to its implementation.	3.64	1.04	A
Grand Mean	3.74	1.06	A

Source: Fieldwork (2024) ***A=AGREE, D=DISAGREE**

Science education students perceive both benefits and challenges in integrating IoT into their learning, as indicated by the grand mean of 3.74, which falls under the "Agree" (A) category. They agree that IoT can lead to more personalized learning (mean of 3.89) and believe its benefits, such as improved engagement and collaboration, outweigh the challenges (mean of 3.66). However, they also express concerns about potential technical challenges (mean of 3.91), security and privacy risks (mean of 3.63), and the cost of implementing IoT technologies (mean of 3.64). Overall, students recognize the value of IoT but are mindful of the associated challenges.

Discussion

The results from Research Question 1 revealed that science education students possess a high level of awareness and understanding of IoT in education, with all the surveyed statements showing high mean values above the 3.0 cut-off point. This finding suggests that science education students are well-acquainted with the concept of IoT and its potential applications in enhancing learning experiences. The high level of familiarity, as indicated by the mean score of 4.04, underscores the growing influence of IoT technologies in education, where students are not only aware of IoT but also understand how to integrate it into their learning processes. This aligns with the research of Smith and Brown (2022), who found that students with high exposure to technology-based learning

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tools, including IoT, demonstrate a greater capacity for adopting modern educational practices. Furthermore, the students' confidence in explaining the importance of IoT in education reflects a strong grasp of its relevance, echoing the findings of Adeyemi and Johnson (2021), who concluded that students with high IoT awareness are more likely to leverage its benefits in achieving academic success. The results suggest that educational institutions should endeavor to incorporate IoT in their curricula to further enhance students' learning experiences, as high awareness may lead to better preparedness for future technological advancements in education.

The results from Research Question 2 revealed that science education students hold highly positive attitudes toward the adoption of IoT technologies in education, with all the statements showing strong agreement. This finding suggests that students recognize the importance of IoT in modernizing education, as indicated by the high mean of 4.18, reflecting a belief in IoT's transformative potential in enhancing learning outcomes. Students' openness to using IoT devices and applications, as well as their excitement about the benefits of IoT, further emphasize the favorable perception of these technologies. This is consistent with the findings of Adebayo and White (2022), who reported that positive student attitudes toward technological adoption in education significantly influence their willingness to engage with new learning tools. Additionally, the students' belief that IoT will lead to better academic outcomes also aligns with the research of Adebayo and White (2022), who found that students' positive attitudes toward technology integration correlated with improved academic performance and engagement. The results suggest that fostering these positive attitudes through targeted educational initiatives could further enhance the integration of IoT technologies in learning environments, ultimately leading to enriched educational experiences and improved outcomes.

The results from Research Question 3 revealed that science education students perceive both significant benefits and notable challenges in integrating IoT into their learning, with all responses showing strong agreement. The finding suggests that students recognize the potential of IoT to offer personalized learning experiences, as evidenced by a mean score of 3.89, which supports the idea that IoT can cater to individual learning needs and enhance engagement. However, students also expressed concerns about technical challenges (mean of 3.91) and security risks (mean of 3.63), highlighting apprehensions that could hinder the seamless integration of IoT in education. These findings align with the research of Adedeji et.al. (2023), who found that while students acknowledge the educational benefits of IoT, they remain cautious about technical and security-related barriers. Moreover, students' belief that the benefits of IoT outweigh the challenges (mean of 3.66) suggests a generally optimistic outlook, similar to the conclusions of Lee and Kim (2021), who identified that students' positive perceptions of IoT's potential often outweigh their concerns about implementation difficulties. This indicates that while students are enthusiastic about the advantages of IoT, educational institutions must address the technical, security, and cost-related challenges to facilitate effective adoption.

Conclusion

The study reveals that science education students possess a high level of awareness and understanding of IoT in education, reflecting their familiarity with its applications and relevance in modern learning. The findings indicate that students not only recognize the transformative potential of IoT technologies but also express highly positive attitudes toward their adoption in educational settings. This optimism is accompanied by an understanding of the benefits IoT can offer, such as personalized learning and enhanced engagement, alongside an awareness of potential challenges, including technical barriers and security concerns. Overall, the results emphasize the growing influence of IoT in education and highlight students' readiness to embrace these technologies for improved learning outcomes**.**

Recommendations

1. Awareness and campaigns should be conducted through workshops and seminars to improve students' understanding of IoT technologies and their educational applications, emphasizing their benefits and addressing misconceptions.
2. Training should be provided for educators and students on the effective use of IoT tools to enhance their technical proficiency and confidence.
3. Government and other education stakeholders should invest in necessary infrastructure, such as reliable internet connectivity and IoT-enabled devices, to support the seamless integration of IoT technologies in classrooms.
4. School administrators should develop strategies to mitigate technical challenges, security risks, and cost concerns associated with IoT adoption in education.

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5. Policy makers should formulate policies that promote the use of IoT in education, ensuring equitable access and sustainable implementation.
6. More studies on IoT in education should be encouraged to monitor the effectiveness of IoT integration in education and gather feedback for continuous improvement.

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