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Awareness of Internet of Things (IoT) Applications for Learning Enrichment among Undergraduate Students

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ABSTRACT

The shift from traditional to technology-driven learning has brought numerous advantages, with the Internet of Things (IoT) emerging as a promising avenue for enhancing educational experiences. Despite its potential, undergraduates have not fully embraced IoT for learning, primarily due to a lack of awareness. This study investigates the awareness of IoT among undergraduates, considering gender and area of specialization. Using a descriptive survey method, the research focuses on undergraduates in Kwara State universities, employing random and stratified sampling. Data collection utilized a validated questionnaire, and analysis involved percentages, mean scores, t-tests, and Analysis of Variance (ANOVA). Findings revealed smartphones as the most widely used IoT devices. Gender significantly influenced IoT awareness. However, the area of specialization did not significantly impact awareness. Conclusively, undergraduates are employing IoT devices for learning, emphasizing the need for heightened awareness among female students and encouraging widespread utilization of these technologies for improved educational experiences.

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1. INTRODUCTION

The impact of technology on accessing information and electronic resources, particularly in the educational sector, has been significant. This influence has led to higher education institutions, educators, and students embracing the opportunities presented by technology (Camilleri & Camilleri, 2017). Information and Communication Technology (ICT) plays a crucial role in advancing education, facilitating the easier and faster transmission and dissemination of information. The widespread use of ICT globally has made it an essential tool in various aspects of human activities, including education, commerce, agriculture, and health (Raab *et al*., 2001).

The utilization of ICT in education is closely associated with internet applications, as the internet connects different computers globally through communication channels to share information and resources. The integration of digital tools not only makes education more widespread but also enhances the efficiency and inclusivity of traditional educational systems (Muraina & Popoola, 2022). The realm of online education has expanded, providing students with more effective means to attain their learning objectives (Fernández-Caramés & Fraga-Lamas, 2019).

Acknowledging shortcomings in the education system, ranging from student boredom in classrooms to security issues within school premises, the incorporation of the Internet of Things (IoT) is suggested as a remedy. IoT presents a comprehensive strategy for tackling issues such as student disinterest, negative attitudes toward learning, and instances of bullying in educational settings (Padgett & Notar, 2013; Al-Malah *et al*.., 2020).

A noteworthy application of the IoT in education involves the utilization of wearable devices, such as smartwatches, headgear, fitness trackers, and other accessories designed to be worn on the body.

These devices can monitor students physical activities and health, enabling teachers to observe learners' progress and provide personalized guidance and support (Goodyear *et al.*, 2019). Additionally, IoT finds application in education through smart classroom technology, encompassing interactive whiteboards, smart desks, chairs, and other devices that facilitate student collaboration and engagement (Kaur *et al.*, 2022). These technologies offer real-time data on students' performance, empowering teachers to customize their instruction based on individual student needs (Haleem *et al*., 2022). The integration of IoT in education further extends opportunities to students with disabilities, ensuring inclusivity (Rajeshwari *et al*., 2021).

Nowadays, the internet has significantly shaped the landscape of teaching and learning within the education system. Virtually every topic or subject is now accessible online, providing the most up-to-date information from any location globally (Makinde & Bolaji, 2019). The internet serves as a platform that facilitates interaction, collaboration, and business partnerships on a global scale (Olota *et al*., 2023). Numerous advantages are associated with internet usage, including unrestricted access to information and resources, online commerce, collaborative opportunities, and, notably, access to the IoT, enabling the control of home appliances and devices through computers or smartphones (Miorandi *et al.*, 2012).

The IoT concept involves linking various devices and gadgets used in daily activities to the internet. In the context of Nigerian tertiary institutions, the internet has played a pivotal role in supporting educational systems. Significant investments by administrators in internet infrastructure have profoundly impacted university operations, organizational processes, and teaching methods, fostering global connectivity among computers (Adebayo & Ochayi, 2023). Students benefit from connecting their devices to the IoT, managing these objects through mobile applications on smartphones, computers, or other control devices (Tan *et al.*, 2018).

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Diverse technologies, such as Ethernet, Embedded Systems, Wireless Sensor Networks (WSN), Radio Frequency Identification (RFID), cloud computing, and telecommunication transmission methods, collaborate to form applications and systems for the IoT. The telecommunication network serves as the channel for device communication and interaction through servers (Kandris *et al.*, 2020). These connected objects possess unique capabilities, including communication with each other, interaction with the environment, recording and storing information, and sensing and performing actions at the right time. The scope of internet connectivity has expanded beyond smartphones and computers to include various items, such as TVs, cameras, door locks, home appliances, headgear, electronic displays, and vehicles (Al-Taai *et al*., 2023).

In the realm of education, e-learning has become prevalent, particularly in developed countries, facilitated by internet education platforms like Coursera, Udemy, Skillshare, Udemy, Codecademy, Edx, Pluralsight, Future Learn, Moodle, Google Classroom, Flipped classroom, among others (Adekunle *et al*., 2021; Makinde *et al*., 2024). These platforms foster easy interaction between learners and tutors, facilitating collaborative work and aiding in assignments and coursework (Wang, 2014).

The IoT is already making an impact in various sectors, prompting schools and academic institutions to explore its integration into educational activities. The widespread use of IoT in education necessitates a careful examination of how its distinctive functions, such as sensing and decision-making, can both support and challenge pedagogical processes for all stakeholders, including faculty, students, and staff, as well as associated assets like libraries, classrooms, and labs (Kassab *et al*. 2020; Luckyardi *et al*., 2022; Anh, 2022; Thapwiroch *et al*., 2021; Jebur, 2023; Pantjawati *et al*., 2020). Individuals, including students, researchers, instructors, and library professionals, can harness the potential of IoT technology by gaining a better understanding of its adaptability, simplicity, and the benefits it brings to the field of education (DaLbehera, 2018).

In adopting any technological tool, including IoT, awareness plays a crucial role. The initial step in embracing new technology involves awareness of its advantages, return on investment, and potential drawbacks (Mathews, 2002).

Other literatures (Mylonas *et al.*, 2018) emphasize that awareness is the foundational phase in the acquisition and application of technology, defining it as the state of being conscious of a new trend or technology, such as the IoT.

Moreover, gender has been identified as a significant factor influencing the adoption rate of devices. Suggest that the natural tendencies of females make them more inclined to use various technological tools for different purposes, often at a different rate compared to their male counterparts (Czaja *et al.*, 2006; Vadlamudi & Hargrove, 2021). Opined that the area of specialization or field of study has less influence on the rate of use of ICT tools like IoT. Asserted that there are differences in the rate at which students of different areas of specialization utilize IoT for learning because they source different types of information (Danner & Pessu, 2013). In line with this is that some students' specialization requires fetching of information alone, while some require more than that, including detecting, tracking, and monitoring as well as analyzing the information collected (De Fazio *et al.*, 2020).

During this digital age, one of the appropriate tools that can be employed to achieve effective transfer of knowledge to a large number of students near or far, present or absent in the learning environment, is internet-based tools such as IoT (Hajian, 2019). However, evidences abound that undergraduates possess techno-logical devices that are IoT-enabled, but very few of them use these devices for educational purposes due to a lack of awareness. Researchers have carried out studies on the application of IoT in many areas, including education, but none of the researchers

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has scrutinized the awareness of IoT for learning enrichment, which is the area of great concern in this study. This is the digital era during which learners, especially undergraduates, should be technologically literate to be able to meet the challenges ahead of them and deliver as expected shortly (Timmis *et al.*, 2016; Makinde & Bolaji, 2019). Hence, this study examined the awareness of the IoT for learning enrichment by undergraduates in Kwara State.The specific objectives of this study are to:

(i) Examined the extent of awareness of IoT for learning enrichment among undergraduates in Kwara State;
(ii) Determined the influence of gender on awareness of IoT for learning enrichment among undergraduates in Kwara State; and
(iii) Assessed the influence of students' area of specialization on awareness of IoT for learning enrichment among undergraduates in Kwara State.

This research question was raised and answered in the study: What is the extent of awareness of IoT for learning enrichment among undergraduate students in Kwara State? The following null hypotheses were tested in the study:

(i) $H_0$1: There is no significant difference among undergraduates in Kwara state in their awareness of IoT for learning enrichment based on gender.
(ii) $H_0$2: There is no significant difference among undergraduate students in Kwara state in their awareness of IoT technology for learning enrichment based on area of specialization.

2. METHODS

This study is a descriptive study of the survey method. The population of the study is undergraduates who are located in Kwara State, Nigeria. However, the target population was students from 3 tertiary institutions (comprising Federal, state, and privately owned Universities) in the State.

The sample in this study was undergraduates in three universities in Ilorin, Kwara State. To achieve a fair representation, the universities from which samples were selected were stratified (federal, state, and private). Two of these universities were purposively selected, while a random sampling technique was employed to select the remaining university (private). A stratified random technique was used to divide respondents along gender and area of specialization to obtain the desired data.

The instrument for the study was a researcher-designed questionnaire entitled: Questionnaire on Awareness of IoT application on learning enrichment among Undergraduates in Kwara State. The questionnaire was divided into 2 sections (A and B). Section A of the questionnaire dealt with the biodata of the respondents (gender and students' area of specialization). Section B sought to find out the level of awareness of the IoT on learning enrichment.

The instrument was validated by three experts who assessed it for content and face validity, and a reliability test was carried out on the instrument to achieve the purpose of the study using the split-half method. Thereafter, the data collected was subjected to statistical analysis using Cronbach's alpha, and a 0.71 reliability coefficient was obtained at the 0.05 level of significance.

3. RESULTS AND DISCUSSION

The results and discussion should be presented in the same part, clearly and briefly. The discussion part should contain the benefit of the research result, not the repeated result. The research results could be supplemented with tables, figures, or graphs (separate writing terms) to clarify the discussion. Avoid presenting similar data in a separate table. The analysis should answer the gap stated. The qualitative data, e.g., interview results, is discussed in paragraphs.

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The references contained in the introduction should not be rewritten in the discussion. A comparison to the previous studies should be presented.

The data collected was analyzed using descriptive and inferential statistics such as frequency counts, percentages, mean, t-test, and ANOVA. Duncan's multiple range test was further used to determine the difference that existed among the groups. All the hypotheses were tested at the 0.05 level of significance.

Table 1 shows the demographic data of the participants: 285 (63.3%) male and 165 (36.7%) were female; respondents from Art related courses had 63 (14%), Engineering respondents were 104 (23.1%), 194 (43.1%) were from science, 50 (11.1%) were from Social Science and 39 (8.7%) are from Education.

Table 1. Presentation of demographic data.

Sex	Frequency	Percentage (%)
Male	285	63.3
Female	165	36.7
Total	**450**	**100.0**
Students' Specialization		
Arts	63	14
Engineering	104	23.1
Science	194	43.1
Social Science	50	11.1
Education	39	8.7
Total	**450**	**100.0**

3.1. Research Question 1: What is The Extent of Awareness of IoT for Learning Enrichment Among Undergraduates in Kwara State?

Figure 1 shows the frequency distribution of the extent of awareness, Smartphone had the highest number of respondents, 369 (82%), connected headgear had the least respondents of 89(19.6%), on awareness about learning enrichment. In all, 1728 (34%) of respondents showed highly aware of the IoT devices that are used for learning enrichment in higher institutions. 1353(30.1%) are moderately aware, 923 (20.5%) are lowly aware, and 496 (11%) picked not aware. Hence, undergraduates were highly aware of the common IoT-enabled devices.

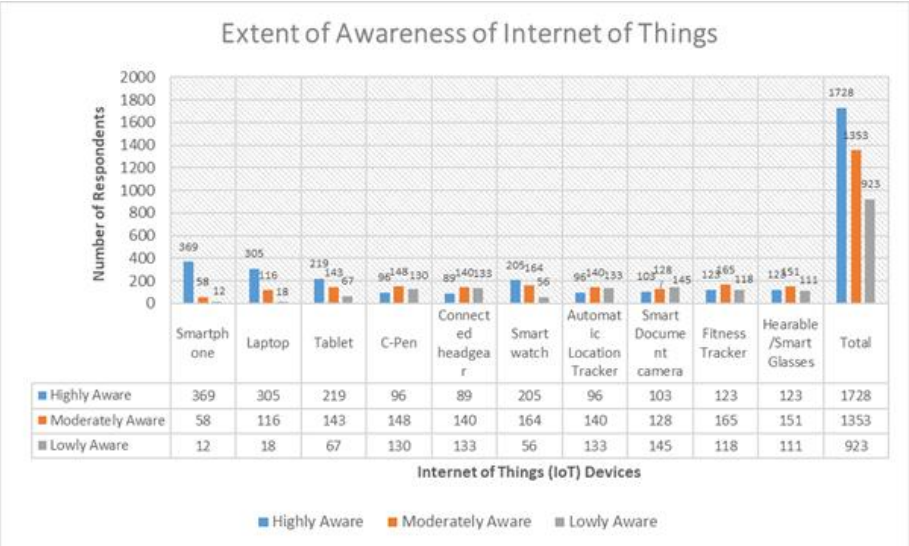

Figure 1. Extent of awareness of this set of IoT devices for learning enrichment.

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3.2. Hypothesis 1 ($H_0$1): There is No Significant Difference Among Undergraduates in Kwara State in Their Awareness of IOT For Learning Enrichment Based on Gender.

Table 2 shows the awareness of IoT for learning enrichment; the total number of participants is t (450) = 3.786 and p = 0.000. This means that the stated null hypothesis was rejected. This is because the t-value of 3.786 resulting in 0.000 is less than the 0.05 alpha value. This indicated that the null hypothesis was established that there was a significant difference among undergraduates in Kwara State in their awareness of IoT for learning enrichment based on gender. This showed that male undergraduates are more aware of IoT devices than females.

Table 2. T-test of Male and Female Awareness of IoT for learning enrichment among undergraduates in Kwara State.

	Gender	N	Mean	SD	SEM	T	df	Sig. (2-tailed)
Awareness	Male	285	30.3895	6.19568	0.36700	3.786	448	0.000
	Female	165	28.1939	5.43576	0.42317			

3.3. Hypothesis 2 ($H_0$2): There is No Significant Difference Among Undergraduates in Kwara State in Their Awareness of Iot For Learning Enrichment Based on Undergraduates' Area of Specialization.

Table 3 shows a significant difference in the Awareness of IoT for learning enrichment based on undergraduates' area of specialization. On the awareness of IoT for learning enrichment and according to the information in the table above, {F (4, 445) = 1.099, p=.357.

This implies that the null hypothesis was not rejected because the significance value (.357) was found to be greater than the alpha value (0.05). This means that the null hypothesis was able to establish that there was no significant difference among Sciences, Education, Engineering, Arts, and Social Sciences students' awareness of IoT for learning enrichment.

Furthermore, an examination of the group difference was carried out using Duncan's Multiple Range Test (DMRT). Hence, all undergraduates in different areas of specialization are aware of IoT devices for learning enrichment.

Table 3. Analysis of variance statistics of undergraduates' area of specialization on awareness of IoT for learning enrichment.

ANOVA		Sum of Squares	Df	Mean Square	F	Sig.
Awareness	Between Groups	158.953	4	39.738	1.099	.357
	Within Groups	16092.338	445	36.163		
	Total	**26685.164**	**449**			

Table 4 revealed the magnitude of difference in the Undergraduates' awareness of IoT devices for learning enrichment based on Students' Specialization. The information on the table revealed close marks of 28.9485, 29.8205, 29.9423, 29.9683, and 30.6400 for Sciences, Education, Engineering, Arts, and social Sciences, respectively. Therefore, it can be deduced that undergraduates from different specializations are generally aware of IoT for learning enrichment.

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Table 4. Duncan multiple range test showing the magnitude of difference in undergraduates' awareness of IoT for learning enrichment based on students' specialization.

Duncan[a,b] Awareness		
Student's Specialization	**N**	**Subset for Alpha = 0.05**
Sciences	194	28.9485
Education	39	29.8205
Engineering	104	29.9423
Arts	63	29.9683
Social Sciences	50	30.6400

4. CONCLUSION

The research investigated the awareness of IoT for learning enrichment among undergraduates in Kwara State, Nigeria. The results from this and other research reviewed revealed the potential benefits of using IoT for learning enrichment among undergraduates in Nigerian universities. Awareness of IoT encourages its usage by undergraduates, which could lead to positive productivity and students' engagement, leading to learning enrichment and positive learning outcomes in this technology-enhanced environment.

5. AUTHORS' NOTE

The authors assert that there are no conflicts of interest related to the publication of this article. Additionally, they have verified that the paper is original and does not contain any instances of plagiarized content.

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