Undergraduates' Use of Internet of Things (IoT) Technologies in the Classroom in Ondo State, Nigeria

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Abstract
The Internet of Things (IoT) is a technological revolution that enables pervasive interaction between objects people and environments. The study investigated undergraduates' usage of the Internet of Things in the classroom in Ondo State, Nigeria. The descriptive survey was adopted for this study. The population comprised all undergraduates in the universities in Ondo State; the respondents were selected using clusters while a simple random sampling technique was used to select universities. The sample size consisted of 250 undergraduates selected from the three universities. The objectives of the study were to identify the most used IoT Technologies investigate the impacts derived by undergraduates' and identify the challenges and threats of using IoT in the classroom. Three (3) research questions were raised and answered. The title of the questionnaire used for the collection of data is Undergraduates' Usage of Internet of Things (UUOIoT)" Three experts from the Department of Educational Technology University of Ilorin, Kwara State, Nigeria validated the instrument to ensure content and face validity of the instrument. Cronbach's Alpha was used to find out the value of the reliability of the instrument and it yielded 0.78. Data collected were analysed using percentage, mean, and standard deviation to answer the research questions raised. The study concluded that tablets and mobile devices were mostly used and undergraduates benefit maximally from using IoT. It was recommended that undergraduates and lecturers should make adequate use of IoT for keeping records and their artworks.

Keywords: Internet of Things, Infrastructure, Undergraduates, Information, Communication.

Introduction
Internet of Things (IoT) technologies have attracted the attention of many researchers in educational technologies, Computer Science and other related disciplines, both scientific and human, due to their importance in various fields of life, especially educational ones, due to the importance services it provides to most educational institutions. (Jasim & Farhan, 2021). The Internet of Things means that all the devices and gadgets that we use in our daily lives can connect to the Internet and are managed through the mobile application of smartphones, through a computer, or through control devices that are also connected to the World Wide Web (WWW). This means that these devices collect data, learn about user decisions, are remotely managed, get updates and rely on the remotely managed, get updates and rely on the internet to communicate and function (Alaidi& Yahya, 2020). In other words, internet connectivity is no longer limited to smartphones and computers in its narrow and traditional sense, but rather includes televisions, surveillance cameras, house and room keys, home entertainment devices, sports equipment, electronic panels, cars and so on. The Internet of Things is a modern technology that aims to connect all electronic devices via the internet so that they can communicate with each other through special protocols, and also communicate with humans by sending text messages. In this technology, communication is a device with a human or A human with a device and often the human is the endpoint (Al-Malah, et al., 2020). The Internet of Things is an effective way to overcome some of the problems facing students helps them to overcome the banners of time and space and enables remote control of learning management successfully. (Al-Salmi et al., 2020). The Internet of Things helps to strengthen the relationship between the student and the teacher so that each of them can reach each other through IoT applications without the need for an actual interview. The teacher will be able to give an order for the textbooks or the instructional materials to move towards the side where students or students are in the classroom if the specialized robots that carry out the request are available (Khalid et al., 2021).

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The school can provide the opportunity for students and parents to communicate with the school via the internet and use its electronic resources, attend classes, participate, express an opinion, and give commands to stop devices available in the school to turn on or stop, or the like. (Fouad & Mujeeb., 2021). IoT can also help institutions to improve the quality of teaching and learning processes by providing a richer learning experience and real-time actionable insight into students' performance. It can create a smart learning environment where students can customize the environmental variables such as room temperature to their optimal choice (Simic et al., 2015). IoT devices such as e-books, tablets, sensors, fitness bands, and virtual can be used today to track and monitor students in different aspects such as understanding students' learning patterns. Llorente, (2019) presented the possibilities of using wearable technology to acquire and process data to enhance knowledge in higher institutions of learning. For instance, Google Classes and Sony smartwatches can be used to enable lecturers to collect important information regarding student knowledge-building processes. This improves learning efficiency by providing a personalized explanation to students. This application can help the lecturers to automatically change slides while speaking and to control the timing needed for each concept and also the time consumed by each activity. (Vhervaara, &Alapaholuomu, 2017)

The usage of IoT devices in the education sector is a serious development across the globe. It provides an innovative approach to education and classroom control. Muhammad et al.,(2021) list some of the common IoT devices used in the classes. The devices are the interactive whiteboards, tablets and mobile devices, eBooks, 3-Dprinters, students ID Cards, attendance tracking systems, security cameras and video, wireless door locks room temperature sensors and electric lighting and maintenance. A great transformation can be observed in our daily routine life along with the increasing involvement of IoT devices and technology. (Noun, 2022). Some of the applications of IoT are the Smart Home System (SHS), Smart Health Sensing system (SHSS), Smart transportation smart cities, financial sector and industrial manufacturing, Also, mention some of the IoT devices such as smart fire alarms, smart refrigerators, smart bicycles, medical sensors, fitness trackers, smart security system and so on. Internet of Things (IoT) that are used all over the world are as follows: Google Home voice controller, Amazon Echo Plus voice controller, Amazon Dash button, August Doorbell Cam, August Smart Lock, Kuri Mobile robot, Belkin Wemo Smart Light Switch, Footbotair Quality Monitor, Flow by plume labs Air pollution monitor Nest smoke alarm, Ring doorbell, and Philip Hue bulbs and lightening system (Salazar & Silvestre, 2017). The environment of the universities can entirely change by using IoT-based smart facilities in the institutions. New technologies are changing the campus administration areas as well. (Gubbi et al., (2013). Advancements in technology are increasing the demand for higher educational institutions to digitize all contents and events. Institutions can now adopt IoT which allows academic and research-related members to work efficiently in a digital environment. (Sherson, 2020). An established physical campus integrating with technology can provide a digital university base, which provides appropriate settings and services for training, learning and research work. It provides support and inspires the ultimate learning (Verga, 2020). A digital campus for the universities must possess the technology to support teaching, education and cooperative research (Dong et al., 2020)

IoT contributes strongly to saving time, effort, and money by enabling the individual and the organization to completely control things to implement what is required of them accurately, in addition to the possibility of understanding things among themselves through sensors that communicate with each other via the internet. This achieved many results that contributed to saving time, effort and money (Jawad et al., 2021). Mahamad et al. (2021) identify the benefits of IoT such as education level and education subject, IoT can help to manage attendance of a class and availability of required equipment/devices for each student; learning principles such as student prior knowledge, knowledge organization, motivation, mastery, practice and feedback, course climate, and the self-directed learning and delivery mode that makes that contents of lesson to be delivered in one of three broad-based modes such as face-to-face remote or hybrid. The role of the Internet of Things in solving education problems (Jawal&Raheu, 2021; Al-Sairy& Faris, 2022). IoT makes education wired and wireless networks now cover most of the applications, creating, unlimited platforms that increase availability. Hence, IoT helps learners globally to make available locally and globally, whether with the appropriate content or by choosing teachers anywhere. IoT also offers educational alternatives anytime and anywhere, unlike traditional classroom. Teachers can use IoT technology to adapt education to each learner individually, unlike the one-to-many method that provides the average needs of the group and reduces the importance of adapting education to the group of learners, the Internet of Things helps to change that by enabling each student has his learning style and a different learning speed and also makes students to understand and apply concepts best through discussion and collaboration with their peers.

For successful integration of IoT devices in the campus, education institutions may face numerous threats and challenges Muhammad et al. (2021) were of the opinion that most of the Universities are using a hybrid cloud to host IoT applications as their enterprise architecture. The millennial generation which is studying in Universities, is using a tablet or mobile technology. It opens new methods to upsurge the enterprise architecture effectiveness, instructional technology, research and educational environment. Cloud provides us with seamless connections and IT services. Enterprise architectures used in universities depend upon hybrid cloud setups with computing podiums on private clouds. There is significant demand for content because of the substantial growth of audio and video instructions; therefore, it needs to reduce latency time in the institutions' enterprise architecture. Also, the use of e-learning management systems such as blackboard and Moodle generates a considerable amount of data in audio and videos. IoT-based classrooms and labs furnished with the latest equipment used for lecture recording and web streaming allow students to access this data when requested. IoT must deliver extra agile and form service level agreements to handle this data during online courses. (Ahmed et al., 2020). Dlodlo et al. (2019) discuss costs as one of the threats and challenges of IoT in educational institutions. The researchers opined that the overall cost of IT technologies is increasing every year because of content and application stacks increase. Most of the institutions have no strategy for sharing the cost of overall IoT infrastructure. They have budget constraints as well. Therefore, the higher education sector must emerge with new finances, IT infrastructure and devices. Data integrity, accuracy and authenticity are another challenge in successfully implementing IoT in the higher institution of learning. Teachers need to work with government agencies to ensure the development of IoT in this section. There is inadequate robust policy in the adoption of technology in the classroom. Therefore, an effective integration into the program is required. (Yu et al., 2010).

The successful implementation of IoT technologies in higher institutions of learning involved different security and privacy challenges. Although some work is done on IoT infrastructure and its security still, no strategy is defined to identify business risks related to data breaches. Therefore, the higher institutions of learning need to develop some standards to secure these IoT-supported applications, and collaborative methods for the safety, security and privacy of valuable data. (Xu et al. 2019). Gubbi et al., (2013) describe the use of IoT-based applications and the integration of mobile learning applications for the student's evaluation. These typical applications can support students to learn resources cope with assignments and work on projects. Teachers use some of the other apps to demonstrate technical concepts, simulation and others. Preet, (2022) noticed that sometimes there are devices and applications, which are incompatible with building an IoT set up in educational institutions. Its equipment and teaching methods must support the IoT technology on the campus. Therefore, high risk and some other barriers are involved while going for IoT options. Also, IoT offers exceptional opportunities to deliver digital courses while maintaining the quality of instructions. This digital instruction highlights students' different ethics, academic honesty, plagiarism and data fraud in scientific societies. Therefore, IoT-based informative applications, various tools and technologies for the teachers and scientific communities develop to improve research work and address these ethical issues in higher institutions of learning (Preet, 2022).

Statement of The Problem
In the past teaching and learning took place only in the classroom, where teachers faced large numbers of students at a time. All the activities such as marking, recording, marking of students' attendance and so on were done manually in the classroom. But the advent of new technologies such as the Internet of Things made teaching and learning more interesting, lively and interactive. The Internet of Things has played a significant role in connecting and educating students at all levels. Students are increasingly moving away from paper documentation toward smartphones, tablets and laptops that offer them the necessary information at their fingertips and also the possibility to learn at their own pace. The use of the Internet of Things provides convenience for teachers because teaching activities become more efficient and student–centred. Teachers can collaborate, using IoT-connected devices, with each of the students, adapting their course and practical activities. Mobile devices and Tablets Educational Apps changed the methods of teaching and learning and can be considered as power tools to create 3D graphics presentations and textbooks featuring videos. Also, mobile devices allow students access to eBooks, quizzes, and projects to watch the labs and courses in video format, which are very attractive learning methods for students and new teaching opportunities for teachers. Therefore, this paper investigated undergraduates' usage of Internet of Things (IoT) Technologies in the classroom in Ondo State, Nigeria.

Objectives of The Study
The objectives of the study are to:
1. Identify the most used Internet of things devices among undergraduates.

2. Assess the impacts derive from using the Internet of Things among undergraduates.
3. Identify the threats and challenges of using the Internet of Things in the classroom.

Research Questions
In order to achieve the objectives of the study, the following research questions were raised;
1. What are the most used Internet of Things Technologies among the undergraduates in the classroom?
2. What impacts do the undergraduates derive from the usage of Internet of Things Technologies?
3. What are the threats and challenges of using Internet of Things technologies in the classroom?

Methodology
The study used a quantitative research design based on a survey method through a questionnaire. The survey method was employed in this research study because it is an efficient way to collect information from a large number of respondents. The sampling technique used for this study was cluster sampling and the population consisted of all undergraduates from both the state and federal universities in Ondo State, Nigeria. From the cluster three (3) universities were selected from the three (3) senatorial districts of Ondo State. From the Ondo Central district, Ondo North and Ondo South senatorial districts one (1) University was selected for each of the senatorial districts. In order to give all the respondents equal opportunity to being selected, a random sampling technique was adopted to select eighty-two (82) from the Federal University of Technology, Akure, represent Ondo Central of Senatorial district, eighty-three (83) from Olusegun Agagu University of Science and Technology from Ondo South Senatorial district, eighty-five (85) respondents were selected from Adekunle Ajasin University, AkungbaAkoko from Ondo North Senatorial district. In all, two hundred and fifty (250) were selected from the three universities regardless of their gender and courses.The main instrument for this study is the researcher's designed questionnaire titled "Undergraduates usage of Internet of Things (IoT) technologies" (UUITTs). The questionnaire consists of two sections: Section "A" Demographic data of respondents and Section "B" contains undergraduates' usage of Internet of Things (IoT) technologies in the classroom. The researcher administered copies of the questionnaire within two months by visiting the respondents in their various institutions with the help of research assistants. Section "B" was made of a 4-point, Likert Scale which strongly disagreed, disagree, agree and strongly agree. Copies of the questionnaire were presented to two experts from Adeyemi Federal Universities of Education, Ondo, Department of Educational Psychology and Counselling (EFC) for appropriateness and adequacy of the content of the instrument. To determine the reliability of the instrument a pilot study was conducted among undergraduates from Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria not part of the main sample. The two (2) results of administration were compared using the Cronbach Alpha Coefficient and 0.76 was obtained. This indicated that the instrument was reliable for the study. At the end of the exercise, two hundred and fifty (250) valid copies of the questionnaire were retrieved from the respondents upon which analysis of the results was carried out using percentage, mean and standard deviation, to answer the research questions for the study.

Results
Research Question 1: What are the most used Internet of Things (IoT) technologies among undergraduates in the classroom?

Table 1: *Most Used Internet of Things (IoT) Technologies among Undergraduates.*

IoT Technologies	Multiple Responses	
	Frequency (N)	Percent (%)
Interactive whiteboard	106	17.5
Tablet and mobile devices	142	23.5
eBooks	66	10.9
3-Dprinters	31	5.1
Students ID	98	16.2
Attendance tracking systems	28	4.6
Security cameras and videos	73	12.1
Wireless door locks	19	3.1
Room temperature sensor	29	4.8
Electric lighting and maintenance	12	2.0

Table 1 above shows the most used Internet of things technologies among undergraduates. Overall, tablets and mobile devices were indicated as the most used IoTs (23.5%), followed by interactive whiteboard (17.5%), students' ID (16.2%), security cameras and videos (12.1%) and eBooks (10.9%). 3-D printers had (5.1%), room temperature sensors (4.8%), attendance tracking systems (4.6%), and wireless door locks (3.1%) while the least used IoT is electric lightening and maintenance (2.0%). Therefore, the most used internet of Things technologies among undergraduates in the classroom are tablets and mobile devices, interactive whiteboards, students' IDs, security cameras and videos and eBooks. Figure 1 further presents the result from the table in a bar chart.

Figure 1: Bar Chart showing the Usage of IoTs
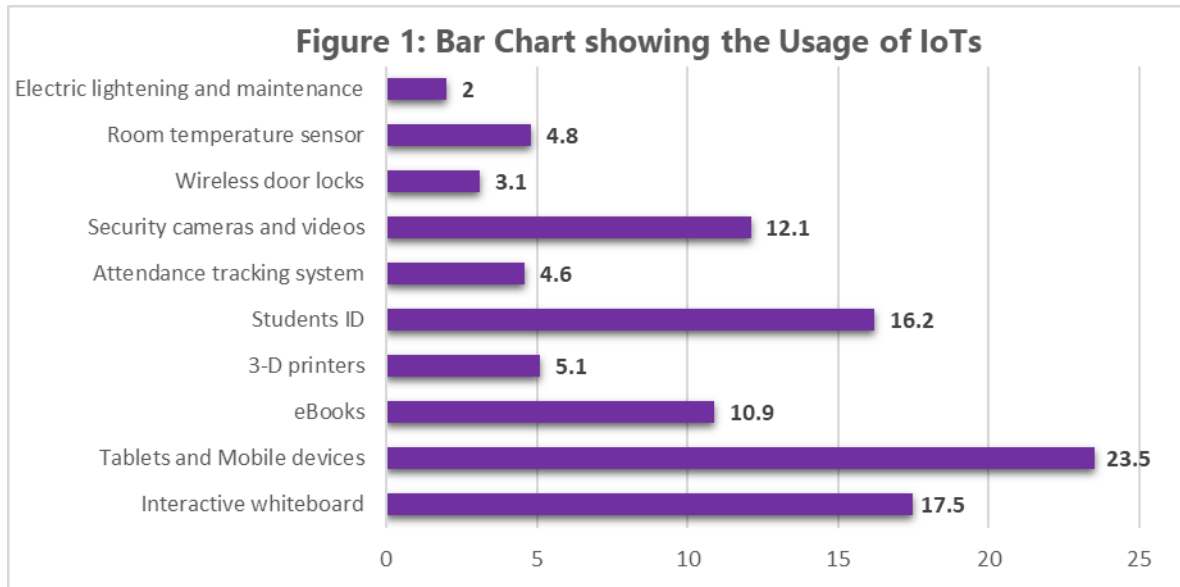
Research Question 2: What impacts do the undergraduates derive from the usage of Internet of Things Technologies?

Table 2: *Impact of Internet of Things (IoTs) Technology Usage*

Item	SA	A	D	SD	Mean	Std.D	Remark
IoT provides students with courses and resources.	174	25	24	27	3.38	1.04	Accepted
It gives electronic lectures at the appropriate time.	100	61	24	65	2.78	1.22	Accepted
IoT provides an effective presentation of educational content using modern presentation technologies.	71	72	62	45	2.68	1.07	Accepted
Ensure speed performance of assessment, tests and obtaining immediate results.	90	63	62	35	2.83	1.07	Accepted
Allows effective presentation of electronic lectures	73	82	58	37	2.76	1.03	Accepted
Enables recording of lectures and making them available to students.	94	68	47	41	2.86	1.09	Accepted
IoT provides digital simulation for all the students regardless of where they reside.	91	85	36	38	2.92	1.06	Accepted
It provides effective participation of all students in the lectures.	46	50	72	82	2.24	1.10	Not Accepted
It enables active participation of all students in groups and making the educational materials available to them.	50	41	61	98	2.17	1.15	Not Accepted
IoT allows students' participation in various electronic and interactive educational activities	117	60	25	48	2.98	1.16	Accepted

Key; *SD* = Strongly Disagree, **D** = Disagree, **A** = Agree, **SA** = Strongly Agree

Decision Value for Remark:*Not Accepted* =0.00-2.44, *Accepted* = 2.45-4.00

Table 2 shows the impacts undergraduates derive from the usage of internet of Things technologies. The table shows that the respondents agreed to the following items: IoT provides students with courses and their resources($\bar{x}$ = 3.38), it gives electronic lectures at the appropriate time ($\bar{x}$ = 2.78), IoT provides effective presentation of educational contents using modern presentation technologies ($\bar{x}$ = 2.68), ensure speed performance of assessment, tests and obtaining immediate results ($\bar{x}$ = 2.83), allows effective presentation of electronic lectures ($\bar{x}$ = 2.76), enables recording of lectures and making them available to students ($\bar{x}$ = 2.86), IoT provides digital simulation for all the students regardless of where they reside ($\bar{x}$ = 2.92), and IoT allows students' participation in various electronic and interactive educational activities ($\bar{x}$ = 2.98). The table further shows that: IoT provides effective participation of all students in the lectures ($\bar{x}$ = 2.24) and enables active participation of all students in groups and making the educational materials available to them ($\bar{x}$ = 2.17). Based on the result from this table and mean score acceptance by the decision rule, it can be concluded that the impacts undergraduates derive from the usage of Internet of Things technologies are: IoT provides students with courses and their resources, gives electronic lectures at the appropriate time, provides effective presentation of educational contents using modern presentation technologies, ensure speed performance of assessment, tests and obtaining immediate results, allows effective presentation of electronic lectures, enables recording of lectures and making them available to students, provides digital simulation for all the students regardless of where they reside, and allows students' participation in various electronic and interactive educational activities.

Research Question 3: What are the challenges of using Internet of things technologies in the classroom?

Table 3: Challenges of Using Internet of Things (IoT) Technologies in Classroom

Item	SA	A	D	SD	Mean	Std. D	Remark
Costs	102	62	25	61	2.82	1.21	Accepted
Security	115	74	37	24	3.12	.99	Accepted
Reliability and hardware	54	59	62	75	2.37	1.13	Not Accepted
Ease of integration	47	59	79	65	2.35	1.06	Not Accepted
Connectivity	74	75	36	65	2.63	1.16	Accepted
Development skill set	90	98	24	38	2.96	1.03	Accepted
Quality control	31	82	34	103	2.16	1.10	Not Accepted
Design	43	60	74	73	2.29	1.07	Not Accepted
Inability to link all the data together	136	32	38	44	3.04	1.18	Accepted
Inability to deal with security and data privacy threats.	106	78	42	24	3.06	.98	Accepted

Key; *SD* = Strongly Disagree, **D** = Disagree, **A** = Agree, **SA** = Strongly Agree
Decision Value for Remark: *Not Accepted* =0.00-2.44, *Accepted* = 2.45-4.00

Table 3 shows the challenges of using Internet of Things technologies in the classroom by undergraduates. The table shows that the respondents agreed to the following items: costs($\bar{x}$ = 2.82), security ($\bar{x}$ = 3.12), connectivity ($\bar{x}$ = 2.63), development skill set ($\bar{x}$ = 2.96), inability to link all the data together ($\bar{x}$ = 3.04) and inability to deal with security and data privacy threats ($\bar{x}$ = 3.06). Also, the table shows that the respondents disagreed to these: reliability and hardware ($\bar{x}$ = 2.37), ease of integration ($\bar{x}$ = 2.35), quality control ($\bar{x}$ = 2.16), and design ($\bar{x}$ = 2.29). Based on the result from this table and mean score acceptance by the decision rule, it can be concluded that the challenges of using Internet of things technologies in the classroom are: costs, security, connectivity, development skill set, inability to link all the data together and inability to deal with security and data privacy threats.

Conclusion

The Internet of Things is a new revolution of the Internet. The use of technology and especially IoT in the field of education has opened the doors for new and innovative ideas to bring ease and betterment in the lives of both the students and lecturers. It was concluded that the most used Internet of Things technologies among undergraduates in the classroom were tablets and a mobile device, interactive whiteboards, students' identity cards, security cameras videos and e-books respectively. Also, it was concluded that the impacts undergraduates derived from the usage of Internet of Things Technologies were to provide students with courses and their resources give electronic lecturers at the appropriate time, provide effective presentation of educational contents using modern presentation technologies, and ensure speed performance of assessment. Lastly, it can be concluded that the challenges and threats of using Internet of Things technologies in the classroom were costs, security, connectivity and mobility to link all the data
together. All these can affect the use of the Internet of Things in the classroom by the students and lecturers.

Recommendations

     Based on the findings of the study, the following recommendations are made:
(1)   Undergraduates should be courageous enough to use other Internet of Things (IoT) technologies instead of Interactive whiteboards Tablets and mobile phones and IoT infrastructure should be installed in the Universities for undergraduate use.
(2)   Undergraduates should make adequate and effective use of IoT so as to derive efficient benefits.
(3)   Government, Non-governmental Organizations and Institutions should support financially by allocating funds for the provision of IoT in lecture halls.

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