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Utilization of Internet of Things for Enhanced Teaching by Lecturers in Public Tertiary Institutions in Enugu State

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Abstract
Rapid paradigm shift has been on-going in education of recent due to the utilization of innovative Technologies such as Internet of Things (IoT) which has transformed the educational landscape and hold potentials for improving teaching and learning processes. The IoT technologies are nowadays assumed to be one of the key pillars of the fourth industrial revolution due to its significant potentials in innovations and useful benefits both education and other spheres. However, there are arguments that utilization of IoT in tertiary institutions in developing countries is lagging. The study investigated the utilization of IoT by lecturers in four public tertiary institutions in Enugu State, Nigeria. Mixed-method research design consisting of both quantitative and qualitative approaches was adopted for the study. The population of this study was 65 Computer Science Education Lecturers from the institutions and census sampling was used. The study was guided by three research questions and the instruments for data collection were a structured questionnaire and digital phone recorder. Cronbach Alpha reliability coefficient of 0.85 was established. Quantitative data were analyzed using mean and standard deviation while the qualitative data were analyzed according to the research questions. The results revealed that the level of utilization of IoT by lecturers in Public Tertiary Institutions in Enugu State was low. Also, there was a notable gap in awareness among the lecturers, with limited exposure to IoT technologies for educational purposes. However, lecturers' knowledge gap on the use of IoT, limited infrastructure, lack of training/skills and data privacy concerns were identified as the factors mitigating the utilization of IoT by Computer Education Lecturers.

KEYWORDS: Internet of Things, Computer Science Education Lecturers, Utilization, Teaching and Learning

Introduction

The proliferation of digital technologies has revolutionized various aspects of modern life, and education is no exception. However, the integration of digital technology in education has led to the emergence of innovative approaches that enhance teaching and learning experiences. One of such technology that has gained significant attention in the modern world including educational sector is the Internet of Things (IoT) (Timotheou et al., 2022). According to Yoo (2023), IoT has become one of the fastest developing technologies impacting every sphere of life in recent years. In Cisco (2015) IoT is noted as the intelligent connectivity of smart devices by which objects can sense one another and communicate, thus changing how, where and by whom decisions about our physical world are made. Showcasing IoT as the interconnectedness of everyday objects and devices through the internet, enabling them to collect, exchange, and act upon data, thereby creating a smart and interconnected environment, Timotheou et al. (2021) viewed it as a distributed network connecting physical objects that are capable of sensing or acting on their environment and able to communicate

with each other, other machines or computers. The main goal of IoT technologies is to simplify processes in different fields, to ensure a better efficiency of systems (technologies or specific processes) and finally to improve life quality (Nižetić, Šolić, Diego, and Patrono, 2019). Most importantly, IoT is progressively becoming an important aspect of our life that can be sensed everywhere around us. According to Frąckiewicz (2023), the IoT is used various industrial activities and in education sector.

This is because IoT hold great potential for improved educational activities. On the strengths and potentials of IoT in education, Zhihan (2022) states that IoT enables real-time collection of diverse types of information and facilitates connections among objects and people thus allowing for intelligent perception and processing of data. The IoT enhances the operational efficiency, improves decision-making, and fosters innovation across multiple sectors by leveraging interconnected devices and smart systems. In fact, IoT technologies are nowadays assumed to be one of the key pillars of the fourth industrial revolution due to its significant potential in innovations and benefits for education (Nižetićet al., 2020). Al-Emran et al. (2020) remarked that IoT technologies are used for education delivery. Likewise, Ramlowat and Pattanayak, (2019) opined that the IoT is cost effective because it enable learners take their classes anywhere and anytime. Furthermore, Villa-Henriksen et al. (2020) in concurrence of the potentials of IoT in education, pointed that it provides massive opportunities for higher education by bringing together independent control and provision of better infrastructure robustness, scalability, and agility. This is in line with the study of Madni et al. (2022) which remarks that IoT is used for students' attendance in lecture halls.

More so, Kassab et al. (2020) in their study saw IoT is emerging as a significant player in learning environments, particularly within Higher Education Institutions (HEIs) due to its capacity in enhancing interactivity and learning. The authors note IoT technology is increasingly focused on enriching classroom experiences, making learning more engaging and effective. Through smart devices and interconnected systems, IoT facilitates real-time data collection and analysis, personalized learning experiences, and seamless communication, thereby transforming traditional educational paradigms. Furthermore, the IoT facilitates changes in all facets of Higher Education Institutions (Madni, et. al., 2022). This creates new opportunities for innovative learning options, driven by shifts in concepts from ubiquitous computing and technologies. A smart learning framework is being employed in educational institutions for a variety of purposes, including administrative activities, monitoring, tracking, learning, and reporting (Madni, et al., 2022). This integration of IoT in education facilitates a more efficient and interactive learning environment, enhancing the overall educational experience and operational effectiveness. In the study on IoT-based e-l learning Kumar et al. (2018) observed that students can learn through different videos, meeting on websites, and apps, and also arrange tests online using IoT or smart devices. This approach leverages IoT technology to facilitate remote learning, providing flexibility and accessibility for both students and instructors. Notwithstanding, Frąckiewicz (2023) noted that despite the capability of IoT technologies in transforming education, it has some challenges which include concerns related to privacy, security, the digital divide, and the need for significant infrastructure investment.

The IoT has limitations. Most tertiary educational systems have not yet

adequately incorporated the latest IoT technology in the delivery of their programmes (Madni, et al., 2022). Also, noticing that IoT has successfully conquered some areas such as health industry, agriculture and finance, remains less popular in education is something of concern (Oliynyk, 2023); notwithstanding, technological backwardness is not something we can blame educators for. Another issue of concern is the level of utilization of IoT in developing countries when compared to developed countries. The above concern is supported by a study by Oliynyk in 2023, which showed that IoT is well-implemented and utilized in many developed countries while its utilization is still lagging in developing countries such as Nigeria, Saudi Arabia, Malaysia, Pakistan, Bangladesh, among others This disparity highlights the global digital divide and emphasizes the need for more efforts to integrate IoT technology in educational systems of developing nations to ensure equitable access to advanced learning opportunities. However, in the process of finding how IoT can be effectively utilized in developing countries, factors such as users' awareness, level of utilization and challenges facing it should be considered. This is because most times, it is noticed that IoT is not only facing challenges but also inadequate utilization and implementation in education (Oliynyk 2023).

Utilization is the means of making use of something by finding a practical and effective use of it or rather putting it into action or service for some purposes (Toner in Unegbu et al. 2019). Utilization also involves the act or process of using something and the method, manner and ways the thing is being used. Therefore, utilization of IoT in teaching implies the act or method of making use of IoT by finding its practical and effective use in order to achieve educational purposes. Moreover, the utilization of IoT in educational sector especially in high institutions where there serious hike in need to train students who can thrive in today's technology competitive world is something worth embarking on. Additionally, due to the transformation of education system to smart learning, it is increasingly imperative to adopt and utilize IoT in e-learning within higher learning institutions (Madni et al., 2022). Integrating IoT into E-Learning can enhance the educational experience by providing real-time data, personalized learning pathways, and interactive content delivery. This approach not only aligns with the technological advancements in other sectors but also prepares students for a digitally driven future, fostering innovation and efficiency in educational practices.

Judging from the above point, lecturers in tertiary institutions are required to be using IoT tools for educational objectives like in teaching and learning, assessment of learning progress and outcome in other to effectively achieve expected goals of IoT utilization. For the interest of this study computer education lecturers are cited for their duty in achieving the above purpose as asserted by Frąckiewicz (2023) & Craven (2017). Also, Onyeidu (2019) opined that online learning/smart learning and assessment platform as an offshoot of computer and ICT learning, should be pioneered by computer science education lecturers. This is because computer education lecturers are the educators that are supposed to be handling the higher education courses that have the objectives of training students in skill acquisition in the use of computer and ICT resources Onyeidu (2019) (which Internet of Things is one of) to solve problems. However, in proper monitoring of how IoT tools are utilized in learning and assessment computer education lecturers should be in forefront. Furthermore, while studying the utilization of IoT for enhanced teaching, some factors like lectures' awareness and level of utilization of IoT and challenges

facing its utilization should be put into consideration which this study is aimed at. Also, existing studies revealed significant advancements in the utilisation of IoT in education in advanced countries. However, it has been noted that there are insignificant research on the use of IoT in tertiary institutions in developing countries, including Nigeria (Oliynyk, 2023). This gap underscores the need for more studies and initiatives to explore the integration of IoT technologies in E-Learning contexts within developing nations. Understanding the unique challenges and opportunities in these regions can pave the way for tailored solutions that promote inclusive and effective educational practices leveraging IoT. Therefore, this study investigated the computer education lecturer's level of awareness and utilization of IoT for enhanced teaching and learning as well as challenges facing the utilization of IoT in Public Tertiary Institutions in Enugu State.

Statement of problem

Internet of things (IoT) provides massive opportunities for higher education institutions by allowing students to learn within or outside the environment of their institutions at their convenient time. However, despite the potentials of IoT in advancing educational system, it (IoT) has not yet been effectively incorporated and utilized in higher institutions in developing countries; they are still backward in using IoT in education systems. Also, the study of Sani (2019) shows that utilization IoT tertiary institutions in Nigeria is still low. In addition there are few research papers which focus is on the utilization of IoT in the tertiary institutions in Enugu State. Therefore, this study investigated utilization of IoT towards enhancing teaching and learning in Public Tertiary Institutions in Enugu State

Objectives of the study

The objective of the study was to determine the extent of utilization of IoT for enhanced teaching and learning by Computer Education Lecturers in Public Tertiary Institutions in Enugu State. Specifically, the study:

1. determined the extent of awareness of the lecturers that IoT facilitates enhanced teaching and learning in the institutions in Enugu State.
2. determined the extent to which the lecturers currently utilize IoT technologies for enhanced teaching and learning in the institutions in Enugu State.
3. identified challenges faced by the lecturers utilizing IoT for enhanced teaching and learning in the institutions in Enugu State

Research questions

1. To what extent are the lecturers aware that IoT facilitates enhanced teaching and learning in the institutions in Enugu State?
2. To what extent do the lecturers utilize IoT technologies for enhanced teaching and learning in the institutions in Enugu State?
3. What are the challenges faced by the lecturers in utilizing IoT for enhanced teaching and learning in the institutions in Enugu State?

RESEARCH METHODS

Mixed method of qualitative and quantitative research design was adopted for the study. A total of 60 lecturers drawn from four public tertiary institutions in Enugu State formed the population of the study. The population comprises of 43 male and 22 female lecturers from two Faculties of Education and two Science Education Departments of public tertiary institutions in Enugu State of Nigeria where Computer Science Education Lecturers can be accessed. Purposive and census sampling techniques were used and the sample constituted the whole 65 Computer Science Education lecturers comprising of 26 Computer Education lecturers from the department of Computer and Robotics Education, University of

Nigeria, Nsukka, 11 Computer Education lecturers from Department of Mathematics and Computer Education, Enugu State University of Science and Technology (ESUT), 17 Science and Computer Education lecturers from Science Education Department, Federal College of Education, Ihe-Amufu and 11 Computer Education Lecturers from Science Education Department, Enugu State College of Education Technical (ESCET). The instruments for data collection were questionnaire titled "Extent of utilization of Internet of Things for enhanced teaching and learning by Computer Education Lecturers in Public Tertiary Institutions in Enugu State" (EUITETLL) and guided interview on the utilization of Internet of Things for enhanced teaching and learning. The questionnaire was used to collect quantitative data while oral interview was used to obtain qualitative data. The questionnaire and the interview constituted five parts: Parts A, B, C, D and E. Part A is on the bio-data of each respondent while Parts B, C and D consist of structured items to be responded to using a four-point Likert scale of Very Great Extent (VGE) (4), Great Extent (GE) (3), Little Extent (LE) (2), Very Little Extent (VLE) (1) and Strongly Agree (SA) (4), Agree (A) (3), Disagree (D) (2) and Strongly Disagree (SD) (1). The Part B is on the extent of awareness of the lecturers on utilization of use IoT for enhanced teaching and learning while Part C is on the extent to which the lecturers utilize IoT technologies for enhanced teaching and learning. The Part D is the challenges faced by the lecturers in utilizing IoT for enhanced teaching and learning. Then Part E is the interview part which was constructed with three open-ended interview questions. The three interview questions were also constructed in relation to the three research questions on the utilization of Internet of Things for enhanced teaching and learning by Lecturers in Public Tertiary Institutions in Enugu State. Thus the interview questions:

1. Are you aware that Internet of Things can be used to enhanced teaching and learning? If "Yes", can you identify those areas you know IoT can be used?
2. What IoT tools have used in teaching of your students for enhanced teaching and learning?
3. Do you think there are challenges facing the use of IoT in public tertiary institutions in Enugu State? If yes, kindly identify any of these challenges?

However, 4 Computer Science Education Lecturers (1 from each sampled institutions) were interviewed and their responses were recorded and their responses were represented by R1, R2, R3, and R4 respectively. The questionnaire was validated by experts and total Cronbach Alpha reliability coefficient of 0.89 was established. The copies of the instrument were administered and retrieved by the researchers. The quantitative data were analyzed using descriptive statistics of mean and standard deviation while qualitative data (from the interview) were analyzed thematically.

FINDINGS

Research Question 1: To what extent are computer education lecturers aware that IoT facilitates enhanced teaching and learning in the institutions in Enugu State?

Table 1: **Mean Scores and Standard Deviations on the extent of awareness of computer education lecturers on the use IoTs for enhanced teaching and learning in the institutions in Enugu State**

Lecturers

S/N	Questionnaire items	$\overline{X}$	SD	DEC
1	IoT facilitates communication and information sharing between students and lecturers	2.71	0.57	GE
2	IoT enhances safety in tertiary institutions by enabling real-time monitoring	2.80	0.51	GE
3	IoT allows parents get immediate feedback on their children's performance in their respective institutions	3.28	0.45	GE
4	It can provide immediate feedback on academic performance	2. 67	0. 63	GE
5	It can alert administrators to security threats within the school environment	2.16	0.82	LE
6	IoT is used to effect rules and regulation in institutions such as skipping lectures, cheating, and plagiarism	3.18	0.85	GE
7	It is used in tracking students' academic progress	2.83	0.57	GE
8	IoT facilitates personalized learning	3.07	0.60	GE
9	It helps students with special needs to learn more effectively	2.00	0.89	LE
10	It provides real-time access to teaching resources	3.26	0.54	GE

Grand mean 3.46

Keys: $\overline{X}$ =Mean, SD= Standard Deviation, Dec=Decision, LE=Little Extent, GE=Great Extent

Table 1 shows the Mean Scores and Standard Deviations on the extent of awareness on the use of IoT by the lecturers for enhanced teaching and learning in public tertiary institutions in Enugu State. The results showed that the extent of awareness on items 5, and 9 which have mean scores that are less than 2.50 was little while the extent of awareness on items 1, 2, 3, 4, 6, 7, 8 and 10 which have mean scores greater than 2.50 was great. Moreover, the overall mean score of 3.26 indicates that the extent of awareness of use of IoT by the lecturers' for enhanced teaching and learning in public tertiary institutions in Enugu State was great.

Interview question 1 ***to the four lecturers as sampled from the four institutions.***

Question: Are you aware that Internet of Things can be used to enhanced teaching and learning? If "Yes", can you identify those areas you know IoT can be used?

R1: (A Computer Education Lecturer from a Federal University in Enugu state). *Yes, I know that Internet of Things can be applied in education for enhanced teaching and learning but the aspect I am familiar with, is the use of IoT in tracking students' academic progress.*

R2: (A Computer Education Lecturer from a State University in Enugu state). *My answer is "Yes" because I have come across some articles that discussed the use IoT in teaching and learning and found out that IoT is a great tool that will take today's education to purely technological driven education that it is supposed to be.*

R3: (A Computer Education Lecturer from a Federal College of Education in Enugu state).

It is true that Internet of Things is a novel area, but I know that it can be used for enhanced teaching and learning because I see it as part of ICT tools or resources. Therefore, I know that it can provide the students with real-time access to teaching resources.

R4: (A Computer Education Lecturer from a State College of Education in Enugu state).

In my own understanding, this Internet of Things is not yet well provided in most schools in Nigeria but I know it can be used to do many things in education such as allow parents to receive real-time updates on their child's progress, facilitate information sharing between students and lecturers among others.

Research question 2: To what extent do computer education lecturers utilize IoTs technologies for enhanced teaching and learning in public tertiary institutions in Enugu State?

Table 2: **Mean Scores and Standard Deviations on the extent of utilization of IoTs technologies by computer science education lecturers for enhanced teaching and learning in the institutions in Enugu State**

Lecturers S/N	Questionnaire items	$\overline{X}$	SD	DEC
1	Azure IoT	1.43	.89	LE
2	Raspberry Pi	1.38	.88	LE
3	Arduino Microcontrollers	2.58	.56	GE
4	Google Cloud IoT	2.62	.58	GE
5	Cisco Packet Tracer	1.22	.48	LE
6	Apache Kafka,	0.71	. 85	LE
8	TensorFlow	2.07	.50	LE
9	RIOT OS	1.38	.68	LE
10	FreeRTOS	1.26	.84	LE

Key: $\overline{X}$ =Mean, SD= Standard Deviation, Dec=Decision, LE=Little Extent, GE=Great Extent

Table 2 shows the Mean Scores and Standard Deviations on the extent of utilization of IoT by Computer Science Education lecturers' for enhanced teaching and learning in public tertiary institutions in Enugu State. The results showed that items 1, 2 and 5 to 10 have mean scores that are less than 2.50 while items 3 and 4 have mean scores that are above the decision point of 2.50. Therefore, the extent of utilization of items 1, 2, 5 to 10 were little extent while those of 3 and 4 items are considered great. Also, the overall mean score of 2.18 indicates that the extent of utilization of IoT technologies for enhanced teaching and learning by Computer Science Education Lecturers was little.

Interview question 2 to the four lecturers as sampled from the four institutions.

Question: What IoT tools have you used in teaching of your students for enhanced teaching and learning?

R1: *Sincerely speaking I have only come across Google Cloud IoT but have not used it in teaching my students.*

R2: *I know some educational IoT tools like Arduino and Google Cloud IoT but they are not adequately used currently in teaching the students for enhanced teaching and learning in our institution.*

R3: *I am not very conversant with IoT tools because they are not provided in the institution to be used by lecturers. Therefore, I suggest that since the importance of using IoT in teaching and learning are known to be massive, it should be made available for lecturers because I cannot say that I have used any.*

R4: *I have used Google Cloud IoT but it was not adequately used because some challenging factors such as poor network service, inadequate provision of electricity among others.*

Research question 3: What are the challenges of adopting and utilizing IoT for enhanced teaching and learning in public tertiary institutions in Enugu State?

Table 3: **The Mean Scores and Standard Deviations the challenges of adopting and utilizing IoT for enhanced teaching and learning in the institutions in Enugu State**

Lecturers S/N	Questionnaire items	$\overline{X}$	SD	DEC
1	Lecturers' unwillingness adopt IoT-based learning	2.01	0.67	D
2	Limited exposure of lecturers to IoT technologies for educational purposes.	3.38	0.49	A
3	Lecturers' knowledge gap on the use of IoTs related tools and devices	3.26	0.54	A
4	High cost of provision and maintenance of IoTs devices and tools needed in schools.	3.48	0.51	A

5	Network/internet not adequately suitable/provided	3.23	0.57	A
6	Unacceptance of IoTs technology by both lecturers and students	2.17	0.58	D
7	Inadequate provision of digital developmental support for lecturers.	3.48	0.59	A
8	Data security issues for protecting the whole system from threats and risks	3.12	0.67	A
9	The use IoTs devices and technology has not been introduced in schools	3.45	0.55	A
10	Lack of Infrastructure to Store and Process Data	3.76	0.43	A

Table 3 shows the Mean Scores and Standard Deviations the challenges of adopting and utilizing IoT for enhanced teaching and learning in public tertiary institutions in Enugu State. The results showed that respondents agreed that items 2 to 5, 7 to 10 which have mean scores that are higher than 2.50 are challenges facing the integration of IoT for enhanced teaching and learning while the respondents did not agree that items 1 and 6 which have mean scores that are lower 2.50 are part of the challenges facing the integration of IoT for enhanced teaching and learning. Moreover, the overall mean score of 3.26 indicates that the integration of IoT for enhanced teaching and learning in public tertiary institutions in Enugu State is still facing a lot of challenges.

Interview question 3 to the four lecturers as sampled from the four institutions.

Question: Can you identify any challenges that impede the utilization of IoT for enhanced teaching and learning in Public Tertiary Institutions in Enugu State?

R1: *The challenges are enamors and I don't think that the challenges are limited to Enugu State. I think the challenges are affecting all the institutions in Nigeria especially public institutions. Challenges like lack of awareness/knowledge of this Internet of Things and how it can be used in teaching and learning is a very big challenge that needs to be addressed. Also, those IoT tools are not provided in schools.*

R2: *Like every other ICT resources, IoT is faced with many challenges such as poor network provision because IoT should be Internet-based, IoT not introduced in various institutions as teaching and learning tool and lack of proper training of lecturers on how to use the IoT tools. I think if these issues are looked into, the challenges would reduce.*

R3: *Talking of challenges facing the use of ICT is something I can relate to those challenges facing every other educational ICT tools. Take for instance, Smart-Learning which is faced with challenges like high cost of its tools and resources, inadequate network availability, poor electricity provision, lack of proper training of educators on how to use those tools and many more. I can say that the same challenges are affecting the use of IoT in institutions in Enugu State and Nigeria at large.*

R4: *My take on the challenges facing the use of IoT is that as a developing country, it is clearly known that ICT and online integration in education are still not well implemented in greater percentage of institutions in Nigeria as a whole, Enugu State not left out. I can say that these challenges are related to lack of provision of required tools for proper implementation of ICT educational based concepts, inadequate awareness on the part of lecturers, lack of training of educators on how to use those tools even when they are poorly provided and other issues like inadequate power supply.*

Discussion

From the findings in Table 1, the lecturers are aware that IoT has much educational potential like facilitating communication and information sharing between students and lecturers as well as provision of immediate feedback on students' academic performance. The high level of awareness of the lecturers in Enugu State on the use of IoT in teaching and learning is obvious

as all the computer science education lecturers in the institutions used for this study responded thus. This result was corroborated with the remark of Zhihan (2022) who discussed how IoT applications enable the connection of any sensing device to the Internet. This connectivity facilitates transmission of data and enables intelligent functionalities. Through IoT technology, devices can interact with each other and with centralized systems, facilitating real-time data analysis and decision-making based on the collected information. This capability enhances various industries by providing efficient management, predictive maintenance, and enhanced operational insights.

Also, the result of this study was supported by Frąckiewicz (2023) who argued that one of the advantages of the Internet of Things (IoT) in education is its ability to enhance the learning experience for students through collection and analysis of data on student performance. IoT allows educators to personalize learning plans and provide targeted support. By leveraging IoT technologies, educational institutions can create more adaptive and responsive learning environments that cater to individual student needs, ultimately fostering a more effective and fulfilling educational experience. Tancock et al. (2018) highlighted that IoT devices allow lecturers to promptly identify areas where students need remediation and adjust their lecturing methods accordingly, thereby improving the overall learning experience. By continuously monitoring student performance through IoT-enabled devices, educators can provide timely interventions and personalized support, thus optimizing the learning experience and improving educational outcomes. This real-time feedback mechanism contributes to a more adaptive and responsive educational environment, enhancing both teaching effectiveness and student learning. Table 2 showed that the level of utilization of IoT for enhanced teaching and learning, by the lecturers was low. This implies that many IoT tools such as Azure IoT, Raspberry Pi, Cisco Packet Tracer, Apache Kafka, RIOT OS, TensorFlow etc are not always used by the lecturers. Few lecturers only admitted that they have come across Google Cloud IoT and Arduino Microcontrollers both from the questionnaire items and interview. This indicates poor utilization of IoT by lecturers in the tertiary institutions in Enugu State which some of the lecturers pointed out in the interview part that this does not only affect institution in Enugu State but Nigeria at large. However, this finding is in supports of the study of Madni, et.al in (2022), and Sani, (2019) which showed that utilization of IoT in Nigeria is still low.

The table 3 showed responses of lecturers on the questionnaire and interview on challenges facing the use IoT in tertiary institutions. The responses identified such factors as limited exposure of lecturers to IoT technologies for educational purposes, lecturers' knowledge gap on the use of IoTs related tools and devices, high cost of provision and maintenance of IoTs devices and tools needed in schools, network/internet not adequately suitable/provided, inadequate provision of developmental support/training for lecturers, data security issues for protecting the whole system from threats and risks among others. This study was corroborated with the findings of Frąckiewicz (2023) which pointed out the challenges facing the use of IoT in education to include the issue relating to data security and the cost of adopting the technoloy.

To substantiate the above findings, many authors identified some challenges that affect the use of IoT as data privacy and security issue, higher cost of IoT equipment and technology compared to that of conventional learning, iadequate number of qualified personnel to use IoT, lack of computer and Internet skills needed in using IoT by lecturers, poorly provided

internet speed etc. (Saadé, Kira, Mak, & Nebebe, 2017; Zahedi & Dehghan, 2019; Agabi, 2019; Nie et al., 2020). (Hadullo et al., 2018).

Conclusion

The study investigated the Utilization of Internet of Things for enhanced teaching and learning by Computer Education Lecturers in Public Tertiary Institutions in Enugu State, Nigeria. The result of this study showed that their level of awareness of using IoT for enhanced teaching and learning is high. The study also found out that even though the lecturers are highly aware of the potentials of IoT for enhanced teaching and learning, they have not adequately utilized the IoT technologies in their teaching. Also, many challenges such as limited exposure of lecturers to IoT technologies for educational purposes, lecturers' knowledge gap on the use of IoTs related tools and devices, high cost of provision and maintenance of IoTs devices and tools needed in schools among other challenges were identified by the lecturers to be affecting the use of IoT not only in Public Tertiary Institution in Enugu State but Nigeria at large.

Recommendation

Based on the findings and conclusion of this study, the following recommendations are made:

1. Regular seminars and workshops on the potentials of IoT should be organized for lecturer of Comuter education in the tertiary institutions in enugu state.
2. Advocay and sensitization activities for the purpose of creating awareness on the utilization of IoT tools should be organized.
3. The IoT should and incorporated as a part of the academic curriculum in the tertiary institutions in the state.
4. Government should adequately provide needed infrastructures and resources for proper utilization of those IoT tools.

Limitation of the study

The limitations of this study are as follows:

1. Studying only Utilization of Internet of Things for enhanced teaching by Lecturers in Public Tertiary Institutions in Enugu State without extending the study to both private and public tertiary institutions as this may affect generalization of findings.
2. None inclusion of the students in the study to ascertain their opinion on the utilization of Internet of Things for enhanced teaching is another limitation of this study.

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