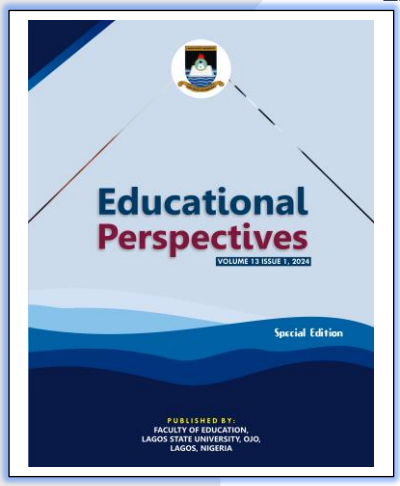

Issues and Challenges to the Successful Integration of ICT in Engineering/Technical Education in Secondary Schools: Teachers Perspective

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ABSTRACT

The Federal government of Nigeria and government of Delta state have made efforts to support secondary schools in integrating ICT tools into the technical educational curriculum, yet most schools only teach ICT as a separate subject. This study is aimed at assessing the availability, utilization, and challenges facing the integration of ICT in the teaching of engineering and technical subjects in Oshimili South Local Government Area of Delta State. These engineering subjects include wood work, technical drawing, and further mathematics, among others. A total of 140 respondents, drawn from ten public and private schools participated in the study. Purposeful sampling was used to select the respondents. The instrument used for data collection was a researcher-structured questionnaire titled Availability, Utilization, and Challenges of Integrating ICT in Teaching Technical Subjects in Secondary Schools (AUCIITT). The instrument was validated by two experts and administered by the researcher and three research assistants. The mean and standard deviation were used to analyze the data retrieved from the respondents. It was observed that teachers from private schools were more disposed to the integration of ICT resources in teaching all their subject areas. The study recommended that teachers to be employed must have ICT skills, among other requirements.

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Introduction

The benefit of integrating ICT into the school curriculum has become more obvious since the outbreak of COVID-19. Financial investment associated with the integration of technologies into the teaching curriculum makes it more challenging (Hassan & Geys, 2016). Some of these engineering subjects include those that prepare secondary school students for studying any of the engineering courses in higher institutions, such as, wood technology, technical drawing, and further mathematics, among others. The basic requirement for ICT integration includes, availability of the internet, hardware and software. Software ICT tools can be grouped under, Authorizing and computing tools, learning management tools, Communication tools, online knowledge databases, and Social networking. Hardware ICT tools among others includes, Computers (Laptop and Desktop), projector, Smart board, Smartphones, and Tablets. Apart from these basic requirement, the skills, attitudes and knowledge related to ICT classroom integration of those teachers involved in this digital transformation is necessary (Hamalainen et al., 2021; Makki et al., 2018). Research carried out by some researchers showed the importance of teachers efficacy in ICT resource use, professional development, availability of ICT and engineering equipment among others as necessary requirements for the integration of ICT resources in the school curriculum (Gerick et al., 2017; Spiteri & Chang Rundgren, 2020; Gil-Flores et al., 2017)

In considering differences in teacher's use of ICT resources, it is necessary to consider each teachers attitude and belief in these technologies (Schmid et. al. (2021); Kreijns et al., (2013); Schimd et al., 2021). Obviously, teachers with a positive view of these tools will readily integrate its use in their classes and will willingly attend professional classes to improve their use of them.

Information and Communication Technology (ICT) is a diverse set of technological tools and resources used to communicate, create, disseminate, store and manage information (Robertson et al., 2007). This definition shows two approaches to ICT; ICT for education and ICT in education. When ICT is "for education" it implies that ICT resources are developed for the purpose of teaching and learning while if ICT is "in education" it implies that all the components of ICT are adopted in teaching and learning (Watson, 2006). As ICT is becoming an integral part of every aspect of humans endeavor; educational, political, economic, and social institutions, teachers need to get themselves equipped and acquainted with this technology so as to bring about needed changes in education (Voogt, 2013)

ICT has bridged the gap of distance. This was largely experienced during the COVID-19 crisis, when teachers all over the world, including developing countries like Nigeria, engaged their students via ICT resources (Binitie et al., 2020). Integrating ICT in education is the only way to improve the quality of education, because it is considered one of the pillars upon which quality education can become a reality. The very essence of introducing, ICT in the teaching and learning of engineering or technical subjects is to move away from a traditional teacher centered approach to learner centered approach (Voogt, 2013). For teachers to be able to ensure effective teaching and move with this new approach, they are expected to have good content knowledge about their subject area and also pedagogic knowledge. For students to adopt a learner centered approach, there is also a need to reform the curriculum to enable students to develop competencies that will help them. ICT tools are evolving, meaning that what is considered the latest resource today can become obsolete tomorrow. Therefore, there is need to have open mind and be ready to move along with the technological changes

that is going on in the world today. Reports has shown that the absence of right ICT development policies in most African countries including Nigeria has widened the information gap between developed countries and developing countries (UNDP,2021; Kennah, 2016)Nigeria has seen ICT as a tool to improve every aspect of the economy. UNESCO created and initiated a program of "One Child One laptop" to bridge this digital gap, but the actual implementation of this initiative has not been done as a result, there is no significant result in developing countries (Warschauer & Ames, 2010). Research has shown that despite the integration of ICT in many secondary schools, the practical use of these tools by teachers' remains in a preliminary stage with little significance in education (Howie, 2010). Teachers' continue to see ICT as a separate subject not as an integral part of education curriculum. Integrating ICT as part of education curriculum is still at the elementary stage in Nigeria secondary schools. Some teachers still reject the use of ICT tools in teaching their students, seeing no need for it (Ndibalema, 2014).Today's curricular emphasizes more on "ICT in education" rather than "ICT for education".

The purpose of this study is to assess the availability, utilization, and challenges facing the integration of ICT in teaching and learning technical/ engineering subjects in Nigerian secondary schools, using Oshimili South Local Government Area of Delta State as a case study. This study was guided by three research questions. The first research question focuses on finding out the available ICT tools in each school that are necessary for teaching and learning. Next, the study focused on finding out the level of utilization of the available tools in teaching. Finally, the study examined the challenges facing the integration of ICT tools in secondary schools.

Related Works

Many research has been carried out on integration of ICT in areas such as, teaching and learning, but this research work focus more on research work that considered integration of ICT in technical and engineering subjects such as, engineering graphics and design, technical and vocational skills, technical drawing, building drawing, mathematics, and others.

Research carried out by Hrbáček et al. (2014) presented a comprehensive overview of the use of information and communication technology (ICT) in technical subjects. The authors explored the potential of ICT to enhance teaching and learning, highlighting the benefits and challenges associated with its integration. Many benefits of integrating ICT in teaching technical subjects, includes, making learning more interactive and engaging, motivating students to explore and understand complex concepts, providing students with access to simulations, virtual labs, and other resources that can help them visualize and solve technical problems. Some of the challenges associated with ICT integration in technical subjects, includes, lack of necessary infrastructure and resources to support widespread ICT use in many schools, lack of necessary skills and knowledge to effectively integrate ICT into lessons by many teachers, and poor integration of ICT in curriculum (Simonics, 2017).

Though it has a lot of advantages, but it equally comes with numerous challenges. Barakabitze et al. (2019) discussed the challenges and opportunities of using ICTs to transform, Science, Technology, Engineering and Mathematics (STEM) education in African countries. The authors emphasized the role of ICT in enhancing teaching and learning experiences, particularly in engineering subjects. However, they also highlighted the lack of access to ICT infrastructure, limited teacher training, and inadequate resources as hindrances to effective

implementation. The study underscored the need for policy support, infrastructure development, and teacher capacity building to harness the potential of ICT in engineering education.

In order to enjoy these benefits, it is necessary to possess the needed skill. Adelabu and Adu (2015) reviewed the competence of teachers in using ict tools in teaching mathematics and discovered that many mathematics teachers in Nigeria lacked the necessary ICT competence. ICT tools, such as interactive simulations and multimedia resources, positively influence students' engagement, understanding, and performance in mathematics (Safdar et al, 2011). Before these skills are properly utilized in teaching, it must match with the requirement stated in the curriculum. Jaiyeola Onipede et al. (2021) evaluated the technical and vocational skills possessed by basic technology teachers in junior secondary schools in Lagos State, Nigeria in relation to the national curriculum and their ability to effectively deliver technical and vocational education and identified a mismatch between the teachers' skills and the curriculum requirements, leading to challenges in effectively teaching technical and vocational subjects.

Some researchers focused on considering teachers view on the use of ICT tools to enhance teaching and learning process. Tunc and Bagceci (2021) investigated teachers' perspectives on the implementation of STEM education in secondary schools. The study examined the effects of STEM approaches on students' learning experiences. While not specific to ICT, the findings drew attention to the broader context of engineering education. The study highlighted the positive impact of STEM approaches on students' motivation, critical thinking, and problem-solving skills. Teachers recognize the importance of integrating ICT tools within the STEM framework to enhance engineering education. Also, Sithole and Hahlani (2022) explored the teachers' perceptions of the challenges and opportunities associated with integrating Auto-CAD into building drawing instruction in secondary schools and found a mismatch between the curriculum requirements and the capabilities of Auto-CAD as a serious challenge.

Therefore, possessing the requisite skills specified in the curriculum will increasing the learning outcome. Olabiyi (2023) investigated the perceptions of technical drawing teachers regarding the competencies required for effectively utilizing learning management systems (LMS) in their teaching and learning practices. The authors discovered that teachers perceived technological skills such as, skills in operating the LMS platform, creating and managing online content, and troubleshooting technical issues as the most important competency for using LMS effectively.

Incorporating these tools have proved to be of great benefit to both teachers and learners. Winston (2023) investigated the impact of using computer-aided design (CAD) software to enhance technical drawing skills practice among students in Uganda they discovered that using CAD software significantly improved students' technical drawing skills and students engagement in technical drawing classes. It is often easier to follow the requirement in curriculum if the teachers are willing to learn new methods. Mlambo et al. (2023) investigated the readiness of engineering graphics and design teachers in KwaZulu-Natal, South Africa, to integrate information and communications technology (ICT) into their teaching and learning practices and discovered that they generally lack both the needed skill and willingness to learn. Despite the potential benefits of ICT integration, issues such as high costs, inadequate infrastructure, lack of technical support, and limited teacher training hinder its effective use.

These research works considered the availability of ICT tools in teaching various subjects and their benefits, but it is a well-known fact that ICT tools are evolving. This means that what is considered a resource today can become obsolete tomorrow. Therefore, this research work focuses on the availability of innovative ICT tools, its level of utilization and factors militating against its implementation in teaching engineering subjects in secondary schools.

Statement of problem

Developed countries have integrated ICT tools into their education system, in order to make learning interesting to students and easier for teachers. Also, the Federal Government of Nigeria and Delta State Government in particular have made policies and effort to support secondary schools in integrating Information and communication technology (ICT) tools into educational curriculum. Despite these policies and effort by the government, ICT is yet to be integrated into technical and engineering education in most secondary schools in Africa (Barfi et al., 2020). Report also has shown that students' performance in some technical/ engineering subjects are below average. It was report that this was as a result of inadequate preparation (WAEC, 2023). Hence, the need to consider through research, the factors militating against the integration of ICT resources in the teaching and learning of engineering and technical subjects in secondary schools. Therefore, the purpose of this study is to find out the level availability, utilization, and challenges facing the integration of ICT in the teaching of engineering and technical subjects in Oshimili South Local Government Area of Delta State.

More specifically, the objectives of the research are to:

i. determine the availability of ICT tools in senior secondary schools for Engineering and technical education
ii. determine the level of utilization of these tools in teaching and learning.
iii. examine the challenges militating against the integration of ICT resource sin teaching and learning.

Research Questions

Three research questions guided this study:

1. What is the level of availability of ICT tools in teaching engineering/technical subjects in secondary Schools in Oshimili South LGA, Delta state?
2. To what extent do teachers utilize ICT tools in teaching engineering/Technical subjects in Secondary schools in Oshimili South LGA, Delta State?
3. What are the challenges militating against the integration of ICT resource in teaching engineering/technical subjects?

Hypothesis

The following hypothesis was formulated to be tested at 0.05 level of significance:

H_0: There is no significant difference between public and private school teachers' level of utilization of ICT resources.

Methodology

The study was carried out in ten secondary schools in the Oshimili South LGA. These schools were selected based on their proximity to the researchers and on the fact that they are considered among the leading public and private schools in the state. A total of 140 respondents, drawn from ten (10) public and private schools participated in the study. Out of the 140 teachers selected for the study, 42 were from private schools and 98 from public schools. The purposeful sampling technique was used to select respondents who would understand the research question thoroughly (Cresswell, 2014). The sample was made up of teachers of, engineering, technical

and science subjects. The choice was to capture how ICT is used "in education" not "for education".

The Study was based on descriptive survey research design and was conducted in Oshimili South Local Government Area. A total of 140 respondents, drawn from ten (10) public and private schools participated in the study. Out of the 140 teachers selected for the study, 42 were from private schools and 98 from public schools. Purposeful sampling was used to select the schools and the respondents.

The instrument used for data collection was a researcher-structured questionnaire titled Availability, Utilization, and Challenges of Integrating ICT in Teaching Technical Subjects in Secondary Schools (AUCIITT). The instrument was validated by two experts and administered by the researcher and three research assistants. The instrument consists of 4 parts. Part A consist of respondents' personal data. Part B finds out the level of availability of ICT tools. Part C elicits the extent of teacher's utilization of ICT tools. Part D seeks to find out the challenges militating against the integration of ICT resource in teaching technical subjects.

The respondents are required to fill in their response in part A. the response format of parts C,B, D with their nominal values are: Very High Extent (4), High Extent (3), Low Extent (2) ,and Very Low Extent(1). The instrument was administered on ten teachers from two different secondary schools within the proximity of the researchers that were not part of the sample, twice within three weeks intervals in a test re-test approach of establishing reliability. The reliability of the instrument was computed using Pearson Product Moment Correlation Formula and this gave a reliability coefficients: Part B, 0.78, Part C, 0.75, Part D, 0.65.

The questionnaire was distributed and collected by the researchers with the help of three research assistants. These assistants were trained well by the researchers on how to administer the questionnaire. The mean and standard deviation were used to analyze the data retrieved from the respondents while t-test was used in testing the null hypothesis at 0.05 level of significance. The decision rule is that a mean cut off point of 2.50 and above was an indication of acceptance (high extent) while 2.49 and below indicates rejection (low extent).

Result and Discussion

Demographic Characteristics of Respondents

This helps the researchers in determining the extent to which the responses provided will be relied upon. Out of the 160 teachers sampled for the study, 140 valid responses was retrieved.

Table1: Personal data

School	Number of schools	Number of teachers	Subject area
Private	5	42	3
Public	5	98	3
Total	10	140	3

Out of the 140 teachers selected for the study, 42 were from private schools and 98 from public schools. This shows that more teachers are available in a particular subject area in public school than in the private schools.

Table 2: Level of ICT training received

Institution	Frequency by Public school	Frequency by Private school
CoE/ ICT training center	6	3
Polytechnic	6	7
University	18	32
None	68	0

From table 2, 68 of the teachers in public school received no ICT training, while all the teachers employed in private schools received ICT training.

This shows that private schools lays emphasis on ICT skills before employing each teacher.

Description of main Results

Research Question 1: What is the level of availability of ICT tools in secondary Schools for teaching and learning?

Table 3: Means score of responses to the availability of ICT tools for use in education

S/N	Statement	N(PU)	X	S.D	Decision	N(PR)	X	S.D	Decision
1	Computers (desktops/laptops).	98	3.83	0.84	High Extent	42	3.87	0.45	High Extent
2	Phones, Ipad and other mobile devices	98	2.01	1.03	Low Extent	42	3.57	0.88	High Extent
3	Digital Projectors	98	3.51	1.08	High Extent	42	3.76	0.53	High Extent
4	Google classroom	98	2.19	0.85	Low Extent	42	3.81	0.81	High extent
5	School Internet	98	1.51	1.75	Low Extent	42	3.53	0.42	High Extent
6	Educational/ Social media software	98	1.06	0.98	Low Extent	42	3.67	0.83	High Extent
7	Virtual Lab software	98	1.41	1.83	Low Extent	42	2.43	0.91	Low Extent
8	Microsoft Teams	98	1.96	0.99	Low Extent	42	2.44	0.99	Low Extent
	Grand Mean		**2.19**				**3.39**		

The Result presented in Table 3 from the respondents showed that the public school scored above 2.50 of acceptable mean score in items 1 and 3, while the Private school scored above 2.50 in item 1, 2, 3, 4, 5, and 6. For public school, items, 2, 4, 5, 6, 7, and 8 scored below 2.50 of the acceptable standard while the Private school scored below 2.50 in items 7 and 8. The grand mean score of 2.19 for Public schools response indicates low extent, while the grand mean score of 3.39 for private schools indicates high extent. Obviously, ICT resources are made available in both public and private schools, but it can be seen that these private schools are making use of the new ICT gadgets while public schools are stuck with the regular ICT gadgets in Oshimili South LGA, Delta State.

Research Question 2: To what extent do teachers utilize ICT tools in teaching engineering/Technical subjects in Secondary schools in Oshimili South LGA, Delta State?

Table 4: Mean scores of respondent's responses on utilization of ICT tools in teaching Engineering/Technical Subjects

S/N	Statement	N(PU)	X	S.D	Decision	N(PR)	X	S.D	Decision
9	Computers (desktops/laptops).	98	2.84	0.71	High Extent	42	3.88	0.52	High Extent
10	Phones, Ipad and other mobile devices	98	1.53	1.01	Low Extent	42	3.33	0.68	High Extent
11	Digital Projectors	98	2.34	1.10	Low Extent	42	3.56	0.45	High Extent
12	Google classroom	98	1.23	1.85	Low Extent	42	3.89	0.72	High extent
13	School Internet	98	1.13	0.95	Low Extent	42	3.77	0.31	High Extent
14	Educational/ Social media software	98	1.01	0.96	Low Extent	42	3.45	0.71	High Extent
15	Virtual Lab software	98	1.23	1.24	Low Extent	42	2.31	1.20	Low Extent
16	Microsoft Teams	98	1.37	0.87	Low Extent	42	2.34	0.98	Low Extent
	Grand Mean		**1.59**				**3.32**		

Result presented in table 4 from the respondents from public school scored below 2.50 of the acceptable mean score in item 10, 11, 12, 13, 14, 15 and 16, while the respondents from private school scored above 2.50 of the acceptable mean score in items, 9,10,11,12,13,and 14. This showed a decline in the utilization of the available tool in public school, because it was indicate that digital projector is available in these schools but the extent of usage is indicated "low". For private schools, it is obvious that these available tools are fully put to use. The grand mean of 1.59 and 3.32 for public and private schools respectively showed that public school do not fully utilize the available tools while the private schools utilize the available tools in senior secondary schools in Oshimili South LGA, Delta State.

Research question 3: What are the challenges militating against the integration of ICT resource in teaching and learning.

Table 5: Challenges militating against the integration of ICT resources engineering/technical education.

S/N	Statement	N(PU)	X	S.D	Decision	N(PR)	X	S.D	Decision
17	Limited ICT facilities	98	3.76	0.63	High Extent	42	2.18	1.04	Low Extent
18	Insufficient up-to date ICT tools	98	3.51	0.49	High Extent	42	2.23	0.82	Low Extent
19	Insufficient Competent teachers	98	3.34	0.90	High Extent	42	1.36	0.95	Low Extent
20	Insufficient effective training	98	3.12	0.82	High Extent	42	2.41	0.76	Low extent
21	Resistance to change	98	2.56	1.15	High Extent	42	2.37	0.47	Low Extent
22	Lack of time	98	2.67	0.91	High Extent	42	2.53	0..83	High Extent
23	Insufficient technical support	98	3.53	0.57	High Extent	42	2.33	0.59	Low Extent
24	Insufficient power supply	98	3.41	0.59	High Extent	42	3.34	0.72	High Extent
	Grand Mean		**3.24**				**2.34**		

Result presented in table 5 shows that, respondents from public school view all the itemized challenges from 17 to 24 as challenges they are facing in integrating ICT in Engineering/Technical education, while the respondents from private school view 22 and 24 as the challenges that they are facing. This shows that while private school teachers are facing lots of challenges, private school teachers are provided with most of the needed tools in senior secondary schools in Oshimili South LGA, Delta State. This confirms the report of Ghavifekr, et al. (2016) that lack of access to basic resources can hinder effective integration of ICT in Engineering/technical Education.

H_0: There is no significant difference between public and private school teachers' level of utilization of ICT resources

Table 6: Summary of T-test Analysis of utilization of ICT resources between teachers in both Public and private secondary schools

Group	N	X	SD	Df	t-cal	t-crit	Inference
Private	42	26.56	5.57	138	1.656	1.977	Significant
Public	98	12.72	8.69		9.508		

The t-cal score belongs to the critical region, so there is enough evidence to reject H_o. This shows the null hypothesis is rejected. The t-calculated value is 9.508 and t-critical value of 1.977 at 0.05 level of significance and degree of freedom 138. Since t-calculated is greater than t-critical, that is, t-cal 9.508>t-crit 1.977, the null hypothesis is rejected. This shows that teachers in private schools integrate ICT in their teaching of engineering related subjects more than their counterpart in Public schools in senior secondary schools in Oshimili South LGA, Delta State.

Discussion of Findings

The results obtained from research question one show that ICT resources are made available in senior secondary schools in Oshimili South LGA, Delta State. It was revealed that teachers rated the availability of some ICT tools to a "high extent". It was equally observed that public secondary schools have regular ICT resources like, computers and digital projector while lacking modern technological tools like, Google Classroom, Microsoft Teams, virtual lab software, and the use of phones in classroom as an education tool, among others. In the case of private school, they are equipped with both regular and modern ICT resources. This finding confirms the report of (Binitie et al, 2020) that stated that basic ICT tools like computers flash disk, printers are available in secondary schools.

Result from research question 2 also shows that integration and utilization of ICT tools are more common in private school than in public schools. The result shows that computer are highly used but available digital projector is not highly utilized in teaching and learning in public school. Private school teachers highly utilize ICT tools in teaching. This finding confirms the report of Cachia and Ferrari (2010) which showed that teachers do combine different resources in their teaching, as well as utilizing various modes of ICT.

The result from research question 3 shows that there are different kinds of challenges facing the integration of ICT in teaching engineering and technical subjects, which includes among others, some teachers' resistance to change. Some teachers preferred the traditional method of teaching and have resented the integration of ICT resources in their teaching. This observation confirms the report of

(Bingimals et al., 2009) that shows resistance to change as one of the barriers to ICT integration in secondary school. Insufficient power supply, lack of internet access, lack of time on the part of teachers also contributes to the challenges. Teachers who have a lot to cover and are not very fast in the use of ICT resources in teaching see it something that will delay them in covering their scheme of work for the term. This confirms the report of Simonics (2017).

Conclusion

The findings of the study indicate that private schools include ICT competence as a basic requirement in employing teachers and they ensure that teachers employed are ICT compliant while the private school has it in its policy but does not insist on the employed teachers being ICT compliant. The findings also show that the major barriers were lack of competence and resistance to change. Also, it has been seen that availability of these resources and willingness to adapt to new changes are critical components of the integration of ICT in schools, other necessary requirement include, technical support, software tools and sufficient time. No single tool is self-sufficient to produce good result, therefore all the necessary components must be available for effective achievement of the goal of the integration of ICT in senior secondary school.

Recommendation

Based on the findings, the following recommendations are made;

1. School authorities should ensure that the teachers to be employed are ICT literate.
2. School authorities should ensure adequate provision of technical support while teachers are making use of these tools.
3. The Government should go back and understand the barriers that prevent full integration of these policies to enable them to decide on how to tackle it.
4. Government, teachers, school authorities need to collaborate to overcome any barriers in order to achieve meaningful integration of ICT in the teaching and learning of engineering subjects.
5. To motivate teachers to integrate ICT into their teaching, school authorities should boost their confidence by increasing their skill and satisfaction with modern technologies through sufficient training.

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