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# Lecturers' Perception of Technological Pedagogical Content Knowledge in Nigerian Colleges of Education

*Aina Jacob Kola and Abdulwasiu Adebayo Azeez*

## Abstract

The study investigates lecturers' perception of Technological Pedagogical Content Knowledge (TPACK) in Nigerian Colleges of Education. This is a survey method of research, where a questionnaire was used to obtain data from teachers in three public Colleges of Education in a state. The questionnaire is a five-point Likert scale containing 29 items on technological pedagogical content knowledge (TPACK). The data obtained were analysed using descriptive statistics. Results show that teachers possess the technological knowledge required for their teaching profession and use various teaching pedagogies to teach. Besides, teachers integrate technologies to teach subject content using suitable teaching methods. Finally, teachers employed minimal technologies for their teachings, and only a few lecturers own personal technologies. One of the implications of the outcome of this research is the teacher's challenge to e-learning. This research indicates that Nigerian Colleges of Education teachers have not been adequately engaging students in online teaching during COVID-19.

**Keywords:** technology, technological knowledge, TPACK, pedagogical content knowledge, teacher self-efficacy

## 1. Introduction

The critical position of technologies in education in the twenty-first century [1] made it imperative for Nigerian Colleges of Education to play along. However, research studies indicate that teachers at different levels of education have problems integrating technologies into teaching [2]. The poor Nigerian teachers' experience with technology in teaching and learning is similar to Kafyulilo, Fisser, Pieters and Voogt [3] about the teachers in Tanzania.

A research study suggests that teachers are deficient in using technology in teaching [4, 5]. The entire world is in the era of digital teaching and learning. Thus, there is a need for teachers' competencies in all tertiary education in Nigeria, including the Colleges of Education.

The College of Education in Nigeria was born out of the government's passion for training qualified teachers after independence. The College began as a Teacher Training College (T.T.C.) to train Grade II teachers for primary schools. However, with the growing Nigerian economy, there was a hunger to produce human resources for the nation, which requires qualified teachers beyond primary school. In light of this, the T.T.C. metamorphosed into the College of Education [6]. The College was to train pre-service teachers for primary and junior secondary schools with the Nigerian Certificate in Education (N.C.E.) award. The National Commission for College for Colleges of Education (NCCE) supervised these Colleges. The world is in a digital age where all higher learning institutions, including Colleges of Education, require the knowledge of technologies in schools.

According to Barisic, Divjak and Kirinic [7], it is essential to consider digital competencies in teacher education and professional development. Today's vogue in Nigerian schools is information and communication technologies (I.C.T.). Moreover, with the ubiquitous I.C.T., integrating it into teaching and learning is a problem. Therefore, integrating I.C.T. in classrooms is an essential primary issue in educational institutions around the globe [8], not only in Nigeria.

Teachers are critical in any education system because they transmit the subject contents through pedagogical knowledge [9]. Hence, in this digital age, such is done effectively using I.C.T. Therefore, the concept of technological pedagogical content knowledge (TPACK) was born. The Technological Pedagogical Content Knowledge (TPACK) framework represents teacher knowledge of technology integration in teaching and has seven domains [7], as in **Figure 1**. According to Nordin, Davis and Ariffin [8], TPACK provides a model to guide the effective integration of I.C.T. into teaching. TPACK encompasses three core knowledge bodies: technology, pedagogy and content [11].

The roles of teacher TPACK are enormous and crucial to students learning. The most important of these roles is enhancing authentic learning in schools. Authentic learning is learning by doing. It is active learning, where students are actively involved in teaching and learning.

The TPACK model was conceived in 2006, which authors based on the study of teachers in different grade levels showing their classroom operations. The authors' TPACK Framework leveraged Shulman's 1986 work. Shulman's discussion was on teacher-specific knowledge of the teaching subject (content knowledge) and the specific teaching method (pedagogical knowledge). Shulman argued that any competent teacher should overlap the two knowledge – this is a set of knowledge about teaching their subject matter effectively. This is called pedagogical content knowledge (P.C.K.). The change that happened many years after Shulman was using technology in the classroom.

The technological knowledge was initially treated as knowledge outside the pedagogical content knowledge (P.C.K.). However, according to Mishra and Koehler [12], research that produced a TPACK framework added technology to pedagogical content knowledge, showing teachers' connections, interactions and constraints within all three knowledge areas.

Given this background, the current research is set to assess the lecturers' TPACK in the state's three public Colleges of Education. It is significant because it provides valuable information about these lecturers in domains of TPACK. The information obtained will adequately assist the Nigerian Colleges of Education programme stakeholders in planning this education level. Additionally, it compares the standard of Nigerian teacher education with the educationally advanced countries such as Finland,
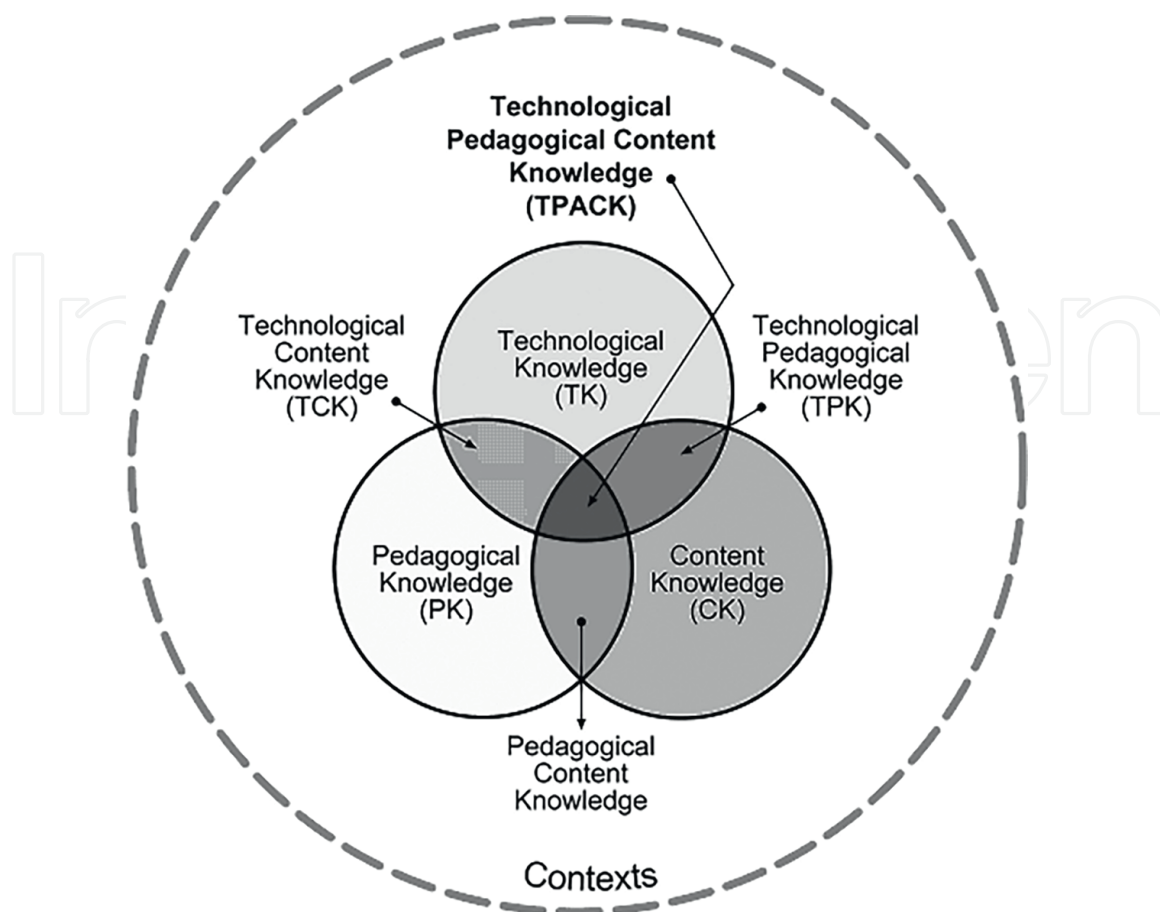
**Figure 1.**
*The TPACK Framework [10].*

Singapore, the USA and others. Finally, it would help Nigerian College of Education students to acquire the practical skill to function outside the teaching profession.

Educational systems worldwide are under increasing pressure to use information communication and technologies to teach students and advance their learning skills [13]. Moreover, students of many advanced countries are information technology-savvy and technologically inclined [14]. This implies that the teacher must be competent in using technology to teach any school subject as a critical factor in teaching-learning. However, observation and research studies show that most lecturers in Nigerian schools, including Colleges of Education, are not competent in using technologies to teach. Thus, this research investigates lecturers' perception of technological pedagogical content knowledge (TPACK) in Nigerian Colleges of Education.

## 1.1 Statement of the problem

Technologies in schools globally make teaching and learning easy and also, in the era of COVID-19, prevent the spread of the virus among students and teachers. Every nation invests heavily in integrating technologies into teaching in its learning institutions. Teacher training institutions globally must prepare pre-service teachers who are sound in integrating technologies into teaching [15]. For lecturers of the tertiary institution to achieve excellence in teaching and learning depend on their use of I.C.T. in the classroom [16]. However, the situation in Nigerian schools is different because most teachers do not have adequate knowledge of integrating technologies into

learning. Research studies show inadequate I.C.T. devices and a low usage level among College of Education lecturers in Nigeria [17]. This challenge has created more problems for teacher training institutions such as colleges of education. Critical among these problems is the inability of the teachers to teach students effectively during the COVID-19 lockdown. In light of this, this study investigates lecturers' perception of Technological Pedagogical Content Knowledge in Nigerian Colleges of Education.

## 1.2 Purpose of the study

The kernel of this research is to assess lecturers' perceptions of Technological Pedagogical Content Knowledge (TPACK) of lecturers in Nigerian Colleges of Education. The study shall specifically investigate:

- Teachers' knowledge of understanding which technologies are suitable for teaching the specific subject matter

- Teachers' knowledge of effective use of technology suitable for teaching strategies

- Teachers' knowledge of effectively selecting and integrating relevant technologies in teaching content using appropriate pedagogical strategies and technologies teachers frequently use in their classes to teach.

## 1.3 Research questions

This study generated four research questions to assess lecturers' perceptions of technological pedagogical content knowledge (TPACK). The questions are stated below, and the research shall provide answers to the questions.

- **Q01:** Do lecturers have knowledge of the technology required for their professional assignments?

- **Q02:** Do lecturers have knowledge of using technology that is suitable for teaching pedagogies?

- **Q03:** Do lecturers have the knowledge to select and integrate technologies in teaching content using appropriate teaching methods?

- **Q04:** What are the frequently used technologies by Lecturers in Colleges of Education?

## 1.4 The scope of the study

The study focused on technology, subject content, pedagogical content, technological content and TPACK domains in three public Colleges of Education. The Colleges of Education programmes in Nigeria comprise courses in art and humanities, science and technology. Therefore, the participants for this study were sampled from all courses in the Colleges of Education programmes.

The College of Education in Nigeria was established to train teachers in the nation's primary and junior secondary schools [18]. The philosophy of this College is to train professional teachers competent to teach with sound content and pedagogical knowledge.

## 2. Methodology

This section explains in detail the methodology for this research. In addition, the research design, sampling and sampling techniques, instrumentation, data analysis and ethical consideration were discussed.

### 2.1 Research design

The research employed a survey method where the researchers adapted a validated questionnaire from Schmidt et al. [19]. The study targeted 200 lecturers, but the participants were 184 lecturers from three public Colleges of Education who returned the completed questionnaire. The data obtained from the questionnaire were analysed using descriptive statistics. For ethical consideration, the dignity and integrity of the participants are essential, and the researchers did not violate them. Furthermore, anonymity and confidentiality were respected. Therefore, for anonymity, the sampled Colleges' real names were not mentioned (pseudonyms) throughout the study.

## 3. Result and discussion

This section is about the results and discussion. **Table 1** presents the responses of the randomly sampled lecturers in the three public Colleges of Education to the TPACK questionnaire. The 29 items in the questionnaire with a five-point Likert scale were analysed and summarised in **Table 1**.

### 3.1 Results

**Table 2** shows technologies frequently used by lecturers in Colleges of Education. However, respondents show that these technologies were not possessed by 62% of the lecturers.

**Research question 1:** *Do lecturers have knowledge of the technology required for their professional assignments?*

|  | T.K. (Technology Knowledge) | Mean | S.D |
|---|---|---|---|
| 1 | I know how to solve my technical problems. | 3.9061 | .94105 |
| 2 | I can learn technology quickly. | 3.9451 | 1.05498 |
| 3 | I keep up with critical new technologies. | 3.9891 | .88943 |
| 4 | I frequently play around the technology. | 4.0223 | 1.02198 |
| 5 | I know about a lot of different technologies. | 3.9500 | 1.06899 |
| 6 | I have the technical skills I need to use technology. | 3.8402 | 1.08201 |
| 7 | I have had sufficient opportunities to work with different technologies. | 3.6524 | 1.27551 |
|  | **CK (Content Knowledge)** |  |  |
| 8 | I have sufficient knowledge about my subject area. | 4.2527 | .92352 |
| 9 | I can use a scientific way of thinking. | 3.9887 | .92925 |
| 10 | I have various ways and strategies for developing my understanding of science. | 3.9205 | .89725 |

| | T.K. (Technology Knowledge) | Mean | S.D |
|---|---|---|---|
| | **P.K. (Pedagogical Knowledge)** | | |
| 11 | I know how to assess student performance in the classroom. | 4.3111 | .90491 |
| 12 | I can adapt my teaching based on what students currently understand or do not understand. | 4.1768 | .79002 |
| 13 | I can adapt my teaching style to different learners. | 4.2320 | .68416 |
| 14 | I can assess student learning in multiple ways. | 4.3056 | .90373 |
| 15 | I can use various teaching approaches in a classroom setting (collaborative learning, direct instruction, inquiry learning, problem/project-based learning, etc.). | 4.1848 | .79520 |
| 16 | I am familiar with common student understandings and misconceptions. | 4.0659 | .92602 |
| 17 | I know how to organise and maintain classroom management | 4.3204 | .78675 |
| | **P.C.K. (Pedagogical Content Knowledge)** | | |
| 18 | I know how to select practical teaching approaches to guide student thinking and learning in my specialised area. | 4.1413 | .85035 |
| | **T.P.K. (Technological Pedagogical Knowledge)** | | |
| 19 | I can choose technologies that enhance the teaching approaches for a lesson. | 4.2143 | .78888 |
| 20 | I can choose technologies that enhance students' learning for a lesson. | 4.1093 | .99949 |
| 21 | My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom | 4.1148 | .80038 |
| 22 | I am thinking critically about how to use technology in my classroom. | 4.0330 | .96857 |
| 23 | I can adapt the use of the technologies that I learned to different teaching activities. | 4.1038 | .88027 |
| | **T.C.K. (Technological Content Knowledge** | | |
| 24 | I know about technologies that I can use for understanding and doing science. | 4.0615 | .93714 |
| | **TPACK (Technology Pedagogy and Content Knowledge)** | | |
| 25 | I can teach lessons that appropriately combine science, technology, and teaching approaches. | 4.1038 | .92886 |
| 26 | I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn. | 4.2582 | .91296 |
| 27 | I can use strategies that combine content, technologies, and teaching approaches that I learned about in my coursework in my classroom. | 4.0335 | .96512 |
| 28 | I can provide leadership in helping others coordinate my school's content, technologies and teaching approaches. | 4.1278 | .87823 |
| 29 | I can choose technologies that enhance the content of a lesson. | 4.2303 | .96713 |

**Table 1.**
*TPACK domains.*

From **Table 1**, items 3–7 show lecturers have knowledge of technology (T.K.) with means above 3.0.

**Research question 2:** *Do lecturers have knowledge of using technology that is suitable for teaching pedagogies?*

**Table 1** shows that lecturers have technological pedagogical knowledge. Items 19–23 offer a means of above 4.0. The table indicates that the lecturers have proper pedagogical knowledge with a mean value above 4.1413.

**Research question 3:** *Do lecturers have the knowledge to select and integrate technologies in teaching content using appropriate teaching methods?*

**Table 1** indicates that Colleges of Education lecturers use appropriate teaching methods to select and integrate technologies in their teaching. From **Table 1**, items 25–29 have a mean above 4.0.

**Q04:** *What are the frequently used technologies by Lecturers in Colleges of Education?*

**Table 2** shows that teachers frequently used laptops, desktops, projectors, mobile phones, auto cards, Smartboards, digital cameras, tablets, whiteboards and calculators. The table also indicates that 38% of the lecturers possessed these technologies, suggesting that 68% may not have technologies for teaching. It shows that the lecturers used hardware technologies only and are indigent with relevant technologies for education.

## 3.2 Discussion

Technology is critical in any nation's education, making it mandatory for teachers at all levels to have adequate knowledge of it. Scholars advocated for digital literacy of the twenty-first-century teachers, which according to Ortega-Sánchez, Gómez-Trigueros, Trestini and Pérez-González [20], could be achieved if universities' teachers have digital teaching repertoire.

The outcome of this study is not consistence with Ifinedo, Saarela and Hämälänen [21]. Ifinedo et al., in their study, faulted the weak pre-service teachers'

| s/n | Technology |
|-----|------------|
| 1 | Laptop |
| 2 | Desktop Computer |
| 3 | Auto card |
| 4 | Projectors |
| 5 | Mobile Phone |
| 6 | Smartboard |
| 7 | Tablets |
| 8 | Digital Camera |
| 9 | Whiteboard |
| 10 | Calculator |
| Ownership of the technology devices | |
| 38% owned by Lectures | |
| 62% owned by others (Government, College management, Department/Unit, etc.) | |

**Table 2.**
*Frequently used technologies.*

understanding of I.C.T. in Nigerian Colleges of Education. The finding of this study regarding adequate knowledge of technologies by the teachers has divergent research perspectives across African schools. Aina and Ogundele [22] opined that Nigerian Colleges of Education lecturers had an inadequate understanding of the technologies required for teaching. Adeoye and Ojo [23] argued that teachers' knowledge of technology is insufficient in Nigerian schools. Umugiraneza, Bansilal and North [24] submitted that teachers' I.C.T. knowledge in Kwazulu-Natal schools in South Africa is based on demographic factors such as experience and gender. Similarly, Makgato [25] once queried that teachers in rural South Africa have challenges with school technology. Hennessy, Harrison and Wamakote [26] have related results with the present finding that teachers in Sub-Saharan Africa are I.C.T. literates. Similarly, Bingimilas [27] submitted that many Saudi Arabian teachers have average knowledge of technology and confidence in its uses. The outcome of this study may not be on the same page as Opoku, Pobee and Okyireh [28] that many West African countries have insufficient knowledge of technologies.

The knowledge of using technologies appropriately in the classroom is critical in this age. The finding of the current study on technological pedagogical knowledge is inspiring. This result is consistent with Harris and Hofer's [29] previous study where teachers' T.P.K. enhances authentic assessment of students' learning. Kurt, Mishra and Kocoglu [30] observed that English teachers have a high level of T.P.K. in a Turkish University. However, the current study is not on the same page as Hosseini and Kamal [4]. The authors observed that the pre-service teacher in a university showed inadequate knowledge of using technology for instructional purposes. In a related perspective, Heitink, Voogt, Fisser and van Braak [31] argued that teachers sparingly use T.P.K. to promote teaching-learning strategies but primarily for classroom management and others.

The present study's finding on the TPACK has some variances with the existing literature and is parallel with many. Tseng [11] shows that teachers in Taiwan have adequate knowledge of content than TPACK. Kafyulilo, Fisser, Pieters and Voogt [3] observed poor teachers' understanding of integrating technology among Tanzania teachers. According to Bingimilas [27], there are differences in teacher TPACK in Saudi Arabian schools based on gender, experience and teaching. Hosseini and Kamal [4] observed that teachers integrating technologies into their teaching is low in a university. Kirikçilar and Yildiz [32] said teachers have difficulty integrating pedagogical knowledge into technologies. Omoso and Odindo [15] found that teachers already know TPACK in a Kenyan public university but show concern for technological knowledge and technological content knowledge. Surahman, Thaariq, Qolbi and Setiawan's [33] findings showed that teachers in Indonesian schools had adequate TPACK.

The outcome of this study on the frequently used technologies in schools is problematic because the technologies used in Colleges are too small and inadequate. Numerous I.C.T. tools could be employed in classroom teaching [1] far beyond the result of this study. Similarly, Aina and Ogundele [22] listed technologies such as Twitter, virtual interactive classroom, course management software, etc. used for teaching that is missing here. The finding is consistent with Oyediran and Dick [34] that teachers do not possess laptops for teaching in a Nigerian Federal College of Education. In related research, Tella [17] observed the non-availability of I.C.T. tools for teaching at Southwest Colleges of Education in Nigeria. The study's findings revealed that these teachers have a long way to go regarding using technologies in Colleges of Education.

Technologies have occupied a critical position in our global educational system [35]. To succeed in the profession, every institution must have adequate knowledge of technology [8, 36]. A proper understanding of technologies is not enough, but integrating them into teaching is critical to teachers (Agormedah, Henaku, Ayite, & Ansah [37]. Due to this, Abdalla and Ali [38] opined that teachers should integrate technologies into their teaching because of their numerous benefits. According to Gur and Karamete [39], the integration of technology into education has many advantages, such as creating learning interest for learners [40] and changing the ways teachers think in teaching [39].

The current study's findings suggest that teachers in these Colleges have adequate knowledge of pedagogy, content and technology because, according to Abdalla and Ali [38], these are the three components of the TPACK. The technological pedagogical content knowledge framework is critical because of its various features, as shown in **Figure 1**. According to Koehler [10], the TPACK framework has a focal point where T.K., P.K. and C.K. intercept, suggesting their critical positions in TPACK. The implication is that no teacher can have adequate TPACK when a teacher is deficient in T.K., P.K. or C.K.

Given this, the present study indicates that teachers in the sampled schools are perceived to be adequate in T.K., P.K. and C.K., as **Table 1** reveals. Several studies documented the critical position of technology in teaching and learning in schools globally [41]. Therefore, teachers in all levels of education must possess adequate T.K., as recorded in this study. Technological knowledge makes problem-solving seamlessly accessible, and teachers impart knowledge to students instantly and effectively using appropriate strategies [42]. However, teachers' P.K. and C.K. are essential, but it is more critical to be adequate in P.C.K. [43] . P.C.K. is a unique feature of teaching the subject matter [44]. Aina and Olanipekun [9] argued that P.C.K. is essential for all teachers because content knowledge alone is insufficient, except the teacher has proper strategies for students' understanding. The current study shows that teachers have adequate P.C.K., as shown in **Table 1**.

Teachers in this study employing limited technologies for teaching might be due to their capability of using some I.C.T., which is self-efficacy. Self-efficacy is a belief in an individual ability to perform a particular task [45]. Scholars averred that self-efficacy correlates to the P.C.K. [9]. For instance, Pendergast, [46] argue in linked research that a high self-efficacy teacher would be resilient and be able to handle difficult situations, which is a direct effect of the P.C.K. According to de Oliveira, Ferreira, Souza, Furtado and Ramos [47], teachers with high levels of self-efficacy are more likely to use active teaching techniques that help students become more problem-solving adept. Using or integrating technologies limits teachers' I.C.T. use in classes [48]. The use of technology increases teacher self-efficacy [49]. TPACK strengthens and is a source of teacher I.C.T. self-efficacy [49, 50].

In light of the above, the summary of the findings of this study are as follows:

- Lecturers in Colleges of Education possess knowledge of the technology required for their teaching profession.

- Colleges of education lecturers can use technologies with various teaching pedagogies to teach their courses.

- Colleges of Education Lecturers know about integrating technologies to teach subject content using suitable teaching methods.

- Colleges of Education lecturers employed minimal technologies for their teachings, and only a few lecturers owned personal technologies to teach.

## 4. The implication of the finding

The finding of the study has some implications for teacher education in Nigeria. Teacher education in Nigeria is critical to the nation's development [51, 52]. However, teacher education in Nigeria is facing many challenges such as curriculum [53, 54], poor pedagogy [55, 56], low enrolment [57], poor teachers' welfare [58], insufficient funding [59], low societal value [6] and recently, COVID-19 [60]. Critical among these challenges is the issue of Information Communication and Technology [61, 62]. This finding implies that these Colleges' lecturers are not engaging in electronics learning because they do not have the required devices. The teaching paradigm has shifted from face-to-face classrooms to mobile electronic learning because of the COVID-19 pandemic [53, 63]. Students were engaged in remote learning at their homes during the international lockdown. Given this, students in many Colleges of Education in Nigeria must have missed a lot because lecturers do not have the technologies for this teaching mode. Technologies have replaced the conventional method of teaching and learning worldwide.

Therefore, this research implies that the Nigerian Colleges of Education stakeholders should inject more funds into mobile and e-learning. The emergence of COVID-19 has brought changes to education globally [64–68]. Teachers and students are adopting online content delivery modes in schools because of COVID-19 [69]. However, teaching and learning during this period may not be possible in Colleges of Education through the online paradigm [53, 70–73].

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## Author details

Aina Jacob Kola[1]* and Abdulwasiu Adebayo Azeez[2]

1 Physics Education Department, Kwara State College of Education, Nigeria

2 Building Technology Education Department, Kwara State College of Education, Nigeria

*Address all correspondence to: akoja64@gmail.com

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## References

[1] Sumathi K, Selvarani K. Relevance of I.C.T. tools in teaching-learning exploiting flipped classroom. Journal of Critical Reviews. 2020;**7**(13):1048-1051

[2] Irele AO. Digital integration into the Nigerian educational system: Challenges and prospects. Texila International Journal of Academic Research. 2021;**2021**:17-23

[3] Kafyulilo A, Fisser P, Pieters J, Voogt J. ICT use in science and mathematics teacher education in Tanzania: Developing Technological Pedagogical Content Knowledge. Journal of Educational Technology. 2015;**31**(4):381-399

[4] Hosseini Z, Kamal A. A survey on pre-service and in-service on teachers' perceptions of technological pedagogical content knowledge (TPACK). The Malaysian Online Journal of Educational Technology. 2013;**1**(2):1-7

[5] Mormah FO, Bassey BA. Teacher education in Nigeria and the emerging technologies in the 21st century classroom. African Educational Research Journal. 2021;**9**(3):641-647

[6] Akindutire IO, Ekundayo HT. Teacher education in a democratic Nigeria: Challenges and the way forward. Educational Research. 2012;**3**(5):435

[7] Barisic KD, Divjak B, Kirinic V. Validation of survey of pre-service teachers' knowledge of teaching and technology in the context of Croatian educational system. 2017. Retrieved from: http://archive.ceciis. foi.hr/app/public/conferences/2017/02/ CECIIS-2017_paper_6_final.pdf. [Accessed: August 27, 2018]

[8] Nordin H, Davis N, Ariffin TFT. A case study of secondary pre-service teachers' technological pedagogical and content knowledge mastery level. Procedia – Social and Behavioural Sciences. 2013;**103**(2013):1-9

[9] Aina JK, Olanipekun SS. A review of teacher self-efficacy, pedagogical content knowledge (P.C.K.) and out-of-field teaching: Focusing on Nigerian teachers. International Journal of Elementary Education. 2015;**4**(3):80-85

[10] Koehler M. Pedagogical Knowledge. 2011. Available from: http://mkoehler. educ.msu.edu/tpack/pedagogical-knowledge-pk/. [Accessed: August 1, 2014]

[11] Tseng J-J. Investigating EFL teachers' technological pedagogical content knowledge: Students' perceptions. In: Jager S, Bradley L, Meima EJ, Thouësny S, editors. CALL Design: Principles and Practice; Proceedings of the 2014 EUROCALL Conference. Groningen, The Netherlands; 2014. pp. 379-384

[12] Mishra P, Koehler MJ. Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record. 2006;**108**(6):1017-1054

[13] Sayan H. Affecting higher students learning activity by using WhatsApp. European Journal of Research and Reflection in Educational Sciences. 2016;**4**(3):88-93

[14] Shariffuddin SA, Shaaidi WRW, Hashim SM. Social networks as instructional tools beyond a classroom. International Journal of Advanced and Applied Sciences. 2017;**4**(12):185-192

[15] Omoso E, Odindo F. TPACK in teacher education: Using pre-service teachers' self-reported TPACK to improve pedagogic practice. International

Journal of Education and Research. 2020;**8**(5):125-138

[16] Tor FS, Liviticus A, Oluwafemi SJ. I.C.T. skills application in teaching and research by lecturers in some selected universities in Nigeria. Covenant Journal of Library & Information Science (CJLIS). 2020;**3**(1):2682-5295

[17] Tella A. Availability and Usu of I.C.T. in South-Western Nigeria Colleges of Education. African Research Reviews. 2011;**5**(5):315-331

[18] Egede BAY. Expansion in academic programmes in the colleges of education through the dual-mode: A stitch in time. International Journal of Scientific & Engineering Research. 2020;**11**(5):40-47

[19] Schmidt DA, Baran E, Thompson AD, Mishra P, Koehler MJ, Shin TS. Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for pre-service teachers. Journal of Research on Technology in Education. 2009;**42**(2):123-149

[20] Ortega-Sánchez D, Gómez-Trigueros, IM, Trestini M. y Pérez-González C. Self-Perception and Training Perceptions on Teacher Digital Competence (TDC) in Spanish and French University Students. Multimodal Technologies and Interaction. 2020;4(4):74. DOI:10.3390/mti4040074

[21] Ifinedo E, Saarela M, Hämälänen T. Analysing the Nigerian teacher's readiness for technology integration. International Journal of Education and Development using Information and Communication Technology (IJEDICT). 2019;**15**(3):34-52

[22] Aina JK, Ogundele AG. The use of technology for teaching and learning in science and technical

education in Colleges of Education, Nigeria. Integrated Journal of British. 2014;**1**(3):57-64

[23] Adeoye BF, Babatunde YO. Pre-service teachers' perceived technological pedagogical content knowledge at selected Colleges of Education in Lagos State, Nigeria. African Higher Education Review (AHER). 2014;**8**(2):4-16

[24] Umugiraneza O, Bansilal S, North D. Exploring teachers' use of technology in teaching and learning mathematics in KwaZulu- Natal schools. Pythagoras. 2018;**39**(1):a342. DOI: 10.4102/pythagoras

[25] Makgato M. The challenges of teaching and learning technology subject at schools in South Africa: A case of INSET teachers in Mpumalanga Province. Procedia - Social and Behavioral Sciences. 2014;**116**(2014):3688-3692

[26] Hennessy S, Harrison D, Wamakate L. Teacher factors influencing classroom use of I.C.T. in Sub-Saharan Africa. Itupale Online Journal of African Studies. 2010;**2**(2010):39-54

[27] Bingimlas K. Investigating the level of teachers' Knowledge in Technology, Pedagogy, and Content (TPACK) in Saudi Arabia. South African Journal of Education. 2018;**38**(3):1-12

[28] Opoku D, Pobee F, Okyireh RF. Determinants of e-learning system adoption among Ghanaian university lecturers: An application of information system success and technology acceptance models. American Journal of Social Sciences and Humanities. 2020;**5**(1):151-168

[29] Harris JB, Hofer MJ. Technological pedagogical content knowledge (TPACK) in action: A descriptive study of secondary teachers' curriculum-based,

technology-related instructional planning. Journal of Research on Technology in Education. 2011;**43**(3):211-229

[30] Kurt G, Mishra P, Kocoglu Z. Technological pedagogical content knowledge development of Turkish pre-service teachers of English. In: Paper presented at the meeting of the Society for Information Technology and Teacher Education. New Orleans, LA; 2013

[31] Heitink M, Voogt J, Fisser P, Verplanken L. Eliciting teachers' technological pedagogical knowledge. Australasian Journal of Educational Technology. 2017;**33**(3):96-109

[32] Kirikçilar RG, Yildiz A. Technological pedagogical content knowledge (TPACK) craft: Utilisation of the TPACK when designing the GeoGebra activities. Acta Didactica Napocensia. 2018;**11**(1):101-116

[33] Surahman E, Thaariq Q, Setiawan A. Investigation of the high school teachers TPACK competency in South Garut, West Java, Indonesia. Advances in Social Science, Education and Humanities Research. 2020;**501**(2020):461-466

[34] Oyediran WO, Dick TT. Use of Information Communication Technology (I.C.T.) in teaching profession in Ogun State, Nigeria. International Journal for e-Learning Security (IJeLS). 2018;**7**(1):549-555

[35] Talan T. The effect of computer-supported collaborative learning on academic achievement: A meta-analysis study. International Journal of Education in Mathematics, Science, and Technology (IJEMST). 2012;**9**(3):426-448

[36] Adhikary MC. Role of teachers in quality enhancement education and human development. International Journal of Humanities and Social Science Invention (IJHSSI). 2018;**7**(12):34-41

[37] Agormedah EK, Henaku EA, Ayite DMK, Ansah EA. Online learning in higher education during covid-19 pandemic: A case of Ghana. Journal of Educational Technology & Online Learning. 2020;**3**(3):183-210

[38] Abdalla AM, Ali AM. EFL Teachers' Technological Pedagogical Content Knowledge (TPACK): Practical perspectives. Red Sea University Journal Human Science. 2017;**2017**(4):7-38

[39] Gür H, Karamete A. A short review of TPACK for teacher education. Educational Research and Reviews. 2015;**10**(7):777-789

[40] Sahin I. Development of survey of technological pedagogical and content knowledge (TPACK). TOJET: The Turkish Online Journal of Educational Technology. 2011;**10**(1):97-105

[41] Raja R, Nagasubramani PC. Impact of modern technology in education. Journal of Applied and Advanced Research. 2018;**3**(1):33-35

[42] Harris JF, Al-Bataineh M, Al-Bataineh A. One to one technology and its effect on student academic achievement and motivation. Contemporary Educational Technology. 2016;**7**(4):368-381

[43] Shulman LS. Knowledge and teaching: Foundations of the new reform. Harvard Educational Review. 1987;**57**:1-22

[44] Koh JHL, Chai CS, Tsait CC. Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. Journal of Computer Assisted Learning. 2010;**26**:563-573

[45] Bandura A. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice-Hall; 1986

[46] Pendergast D, Garvis S, Keogh J. Pre-service student-teacher self-efficacy beliefs: An insight into the making of teachers. Australian Journal of Teacher Education. 2011;**36**(12):46-58

[47] de Oliveira FAP, Ferreira HRM, Souza CSS, Furtado NKC, Ramos PFA. Overview of research on teacher self-efficacy in social cognitive perspective. Anales de Psicología. 2016;**32**(3):793-802

[48] Gbemu LA, Sarfo FK, Adentwi KI, Aklassu-Ganan EKK. Teacher educators' self-efficacy beliefs and actual use of ICTS in teaching in the Kumasi metropolis. TOJET: The Turkish Online Journal of Educational Technology. 2020;**19**(2):13-23

[49] Omar MN, Ismail SN. Empowering teacher self-efficacy on I.C.T: How does technology leadership play a role? Malaysian Online. Journal of Educational Management (MOJEM). 2021;**9**(3):1-22

[50] Islam S. Exploring Teachers' self-efficacy towards I.C.T. integration in government primary schools of Bangladesh. International Journal of Advance Research and Innovative Ideas in Education. 2020;**6**(2):1703-1714

[51] Adeyemi TO. Teacher shortages and surpluses in senior secondary schools in Ondo State, Nigeria: A critical review. American Journal of Social and Management Sciences. 2011;**2**(3):304-315

[52] Babatunde ML, Braimoh DS. The Nigerian teacher education industry: Gaps, challenges and prospects. International Journal of Arts Humanities and Social Sciences Studies. 2018;**3**(1):47-56

[53] Aina JK, Abdulrahman OA. Mitigating the impact of COVID-19 on the teaching and learning of science in the Nigerian higher education. International Journal of Research and Innovation in Social Science (IJRISS). 2020;**4**(6):334-337

[54] Sani A. Nigerian curriculum and national integration: Issues and challenges. British Journal of Education, Society & Behavioural Science. 2014;**4**(3):309-317

[55] Akolokwu GO. Pedagogical challenges in the educational system: Towards an effective assessment of students in Nigerian universities. The Journal of Jurisprudence and Contemporary. 2017;**9**(1):163-173

[56] Obielodan OO, Omojola EA, Tijani OK. Assessment of teachers' pedagogical knowledge on the utilisation of information and communication technology in Kwara state, Nigeria. International Journal of Education and Development using Information and Communication Technology (IJEDICT). 2020;**16**(1):62-71

[57] Aderemi HO, Hassan MO, Siyanbola WO, Taiwo K. Trends in enrollment, graduation and staffing of science and technology education in Nigeria tertiary institutions: A gender participation perspective. Educational Research and Reviews. 2013;**8**(21):2011-2020

[58] Subair ST, Talabi RB. Teacher shortage in Nigerian schools: Causes, effects and administrators coping strategies. Asia Pacific Journal of Education, Arts and Sciences. 2015;**2**(4):31-37

[59] Akpan CP, Ntukidem PJ, Ekpiken W, Etor R. 2016. The challenges of teacher education in Nigeria: Case study Retrieved from https://www.researchgate.net/publication/306137585

[60] Wu SC, Pearce E, Price JC. Creating virtual engagement for pre-service

teachers in a science methods course in response to the covid-19 pandemic. Electronic Journal for Research in Science & Mathematics Education. 2020;**24**(3):38-44

[61] Kumar R. Assessing higher education in the COVID-19 era. Brock Education Journal. 2020;**29**(2):37-41

[62] Owolabi TO, Oyewole BK, Oke JO. Teacher education, information and communication technology: Prospects and challenges of e-teaching profession in Nigeria. American Journal of Humanities and Social Sciences. 2013;**1**(2):87-91

[63] Vasquez S. Developing an online learning environment for community college students enrolled in human anatomy & physiology and microbiology courses amid the COVID-19 pandemic. Electronic Journal for Research in Science & Mathematics Education. 2020;**24**(3):53-59

[64] Gilles B, Britton S. Moving online: Creating a relevant learning experience for pre-service teachers in the time of COVID-19. Electronic Journal for Research in Science & Mathematics Education. 2020;**24**(3):19-28

[65] Karakose T. Emergency remote teaching due to COVID-19 pandemic and potential risks for socioeconomically disadvantaged students in higher education. Educational Process: International Journal. 2021;**10**(3):53-61

[66] Mindzak M. COVID-19 and the ongoing problem of educational efficiency. Brock Education Journal. 2020;**29**(2):18-23

[67] Senel S, Senel HC. Remote assessment in higher education during covid-19 pandemic. International Journal of Assessment Tools in Education. 2021;**8**(2):181-199

[68] Wijaya TT. How Chinese students learn mathematics during the coronavirus pandemic. International Journal of Educational Research and Innovation (IJERI). 2020;**15**:1-16

[69] Allen J, Rowan L, Singh P. Teaching and teacher education in the time of COVID-19. Asia-Pacific Journal of Teacher Education. 2020;**48**(3):233-236

[70] Brown S. Teaching science methods online during COVID-19: Instructor's Segue into online learning. Electronic Journal for Research in Science & Mathematics Education. 2020;**24**(3):14-18

[71] Fackler AK, Sexton CM. Science teacher education in the time of COVID-19: A document analysis. Electronic Journal for Research in Science & Mathematics Education. 2020;**24**(3):5-13

[72] Graham SR, Tolar A, Hokayem Y. Teaching Preservice Teachers about COVID-19 through Distance Learning. Electronic Journal for Research in Science & Mathematics Education. 2020;**24**(3):29-37

[73] Sahu P. Closure of universities due to coronavirus disease 2019 (COVID-19): Impact on education and mental health of students and academic staff. Cureus. 2020;**12**(4):1-6. DOI: 10.7759/cureus.7541