

8

Application of Technological Pedagogical Content Knowledge (TPACK) Skills in Physics Teachers for Quality and Sustainable Development in Rivers- State

NDUKA NKECHI NTAKA Ph. D

Ignatius Ajuru University of Education

*Department of Curriculum Studies and Instructional Technology
(Physics Education) Port- Harcourt- Nigeria*

Abstract

The study, Technological pedagogical content knowledge (TPACK) for quality assurance in sustainable development among Physics teachers. Three objectives and three research questions were used for the study which was carried out in secondary schools in Obio- Akpor local government area of Rivers-State, Nigeria. The population size constituted of a hundred and fifty (150) teachers selected from six schools within the district. The study was made up of 75 male teachers and 75 female teachers, selected through the stratified sampling technique. The instrument for the study was titled, 'application of technological pedagogical content knowledge skills in teaching Physics questionnaire (ATPAKTP) was used to collect information. The instrument used was the face and content, validated by three experts from IgnatiusAjuruUniversity of education in Physics education and measurement /evaluation respectively. to ensure the reliability of the instrument, 20 copies of the questionnaires were administered to 20 teachers outside the sample used for trial testing while the internal consistency was estimated from the instrument which was at 0.83while the data collected was analyzed using the mean and standard deviation to answer the research questions. Results revealed that,there was an overpowering agreement among Physics teachers and the encounters experienced in applying TPACK skills in the teaching of Physics concepts .It was recommended amidst others, that Physics teachers should be given the prospect to attend trainings and workshops to improve on their skills for utilizing TPACK components.

Keywords: Technological Pedagogical Content Knowledge, Quality, Sustainable Development, Physics Teachers

Introduction

Physics is an authentic science subject targeted towards advancement, ingenuity and novelty, desirable towards sustainable development. Physics is a framework that explains the ultimate laws that oversee the universe from the subatomic to the cosmological scale. It is a vital subject among other science and referred to as, 'the salt of sciences'. Ntaka, (2020) mentioned that , poor instructional strategies may have impeded the academic performance of students in the teaching and learning of Physics and pinioned that, technology, being the 'master man' in the teaching and learning of Physics could activate the interest of students. Professionalism in innovative teachers could also adjust the millennial goals through the use of the internet, as having Physics teachers should be equipped to facilitate the use of digital tools in spurring learning processes. Azunwo et al, (2022) penned that technology is transit in ensuring quality assurance in the teaching and learning of Physics.

Quality assurance is the process by which an institution pledges one with poise and certainty in educational provisions, maintenance and enactment. It is the assertion of self-evaluation, external valuation (including inspection), teaching practices and skills to facilitate learning processes in secondary schools. (Drew, 2023). This is made possible by strict adherence to (ISTE standards for teachers (2008) international standard developed by the international organization to encapsulate quality reassurance among Physics teachers.

Conventionally, Physics teachers have been faced with enormous challenges ranging from wrong teaching drill in theoretical, practical and mathematical Physics. The researcher is obsessed with the fact that, most Nigerian schools are not moving alongside with international standard based on poor code of conduct in employment processes based on technological disposition in the 21st century. (Ntaka, 2020) mentioned that, some newly recruited teachers have no understanding of the use of Information and Communication Technology, not to talk about innovative methods in the teaching and learning of Physics. (Avwiri, 2022). The researcher orchestrated that, globally, most schools have long explored modern strategies in enhancing creativity and development among Physics students. Physics teachers and students must continue to work harmoniously to further mental development in learning while quality assurance must be imposed to ensure that, the best is given to Physics students to achieve the best.

Physics teachers must operate with a standard, equipped with the ability to operate in optimum performance towards altering the formula of low productivity to achieve sustainable development in a modus operandi (distinct pattern) to maximize changes in the ways of teaching and passing information through sound teaching skills, strategies and resources in quality teachers that could be digitally transformed in line with quality assurance. (Ibeogu, 2019)

Application of Technological Pedagogical Content Knowledge (TPACK) Skills in Physics Teachers for Quality and Sustainable Development in Rivers- State - **Nduka Nkechi Ntaka Ph. D.**

Teachers are therefore, agents of change, pivotal in alleviating the fears of Physics students catalyse sustainable development, through the use of innovative techniques and formulas in the teaching and learning of Physics. (Ntaka, 2022). This move is orchestrated, by ensuring that a paradigm shift is maintained among Physics teachers through the superposition of Information, communication and Technology (ICT) to make ways in making visible changes in educational goals. (Agbarakwe &Ntaka, 2021).Quality assurance in teachers must be maximized through systematic review of educational policies to maintain and improve the quality, equity and efficiency of the teaching and learning of Physics among other science subjects. (Adolphus, 2019)

Currently, the pressing need of the Government in the present millennium is hinged towards improving the quality of Physics teacher, by maintaining quality assurance on lesson delivery, code of conduct and professionalism in classroom management. The researcher is worried that teachers are not really giving enough to sustain national development while Johnson et al (2016)maintained that, TPACK could be employed to actualize the teaching and learning of Physics by equipping more professional hands in teaching practices , by displaying expertise in Technology Knowledge, Content area and Pedagogical knowledge infused in(TPACK). Drew (2023).

Physics teachers are still finding it problematic to adjust towards splitting down abstract and difficult concepts to the understanding of their students. (Aderotiti&Obafemi 2022), This move has been relatively chaotic and has to be modelled up, to ease up the pain of Physics students by making teaching much easier for students to assimilate and empower them to solve mathematical problems with simplicity from quality teachers through modern practices(Agbarakwe &Ntaka, 2021) while Amadi (2021) mentioned that, to get the teaching and learning of Physics right, there should be an upward amalgamation of ICT into schools and teachers tasked to play the role of counsellors, rather than expert in concepts, mathematical problems and experiments in Physics through the use of TPACK.

TPACK is the framework for measuring teaching knowledge in a potential and impactful model through training and professional development exercises, designed for both pre-service and in-service teachers. The TPCK framework acronym was renamed TPACK (pronounced “tee-pack”) for the purpose of making it easier to recollect and to form a more integrated whole for the three kinds of knowledge addressed: technology, pedagogy, and content will be used in this research. TPACK is a framework of Technological Pedagogical Content Knowledge (TPACK), commonly used for thoughtful learning, and used in describing different knowledge types obligated by dons or teachers (Mishra & Koehler, 2006). It is a tool, principally implemented on students toenable them induce technology passably, to the educational research field by restructuring

and assisting teacher's model out facts ,needed for effective technological tutelage .(Mishra & Koehler, 2006).

The TPACK framework is also built on Shulman's construct of Pedagogical Content Knowledge (PCK) that illuminate sets of expertise that teachers need, to teach their students effectively through the application of technological know-how. This analogy could be incorporated, based on the wide demand on the use of proficiency of ICT in the Physics classroom, on the point of content, method, content and strategy on the teaching and learning of Physics. (Ibeogu, 2019). Physics teachers must be entailed with knowledge and technological, 'know-how', to add value to the classroom environment (Yenen, 2021), especially in a developing country like Nigeria, as emerging giants in world countries which have long deployed technology in the teaching and learning of Physics. Since, the world is in dire-need of expertise, particularly in smart education that stimulates a high tenacity in strategies among Physics teachers.

This wide spread of the use of technologies, tools and platforms have also necessitated its use especially in Physics , to increase student's biased mind-set in the teaching and learning of Physics. Adoniou (2015) mentioned that, teacher's knowledge must be persistently updated to enable students compete favourably with their counterparts in the diaspora while Amadi (2022) made mention of the poor learning strategies among Physics students by saboteur teachers who has little or no knowledge of technology. He regretted the abysmal on teacher's technological and stereotyped nature in technological practices and so much bond to the conventional method of teaching. (Xin, 2021) mentioned that, the high and increasing amount of data may be a causative agent , which might not determine student's ranking and examination input in Physics teachers, which if not properly acquainted with technology applications, might not fit into digital reformations in secondary schools.

Mandinach et al 2015b maintained the need on professionalism to explore educational development towards integrating Physics teachers especially on the need to have connections with the use of technology especially on the use of TPACK in the teaching and learning of Physics (Azunwo et al). Education stands for, proficiency, innovation and human development and in magnanimous way, should be uphold to guarantee basic principles in spurring academic performance among students. (Ntaka, 2020). Thus, learners, parents, governmental bodies, proprietors, school administrators, policy makers' and examination bodies are all stake holders to this exertion of teacher's development. Since, one of the greatest key point of an innovative teacher is through the application of technology, an unquantified component of learning using Technogical pedagogical content knowledge must be understood in this voyage.

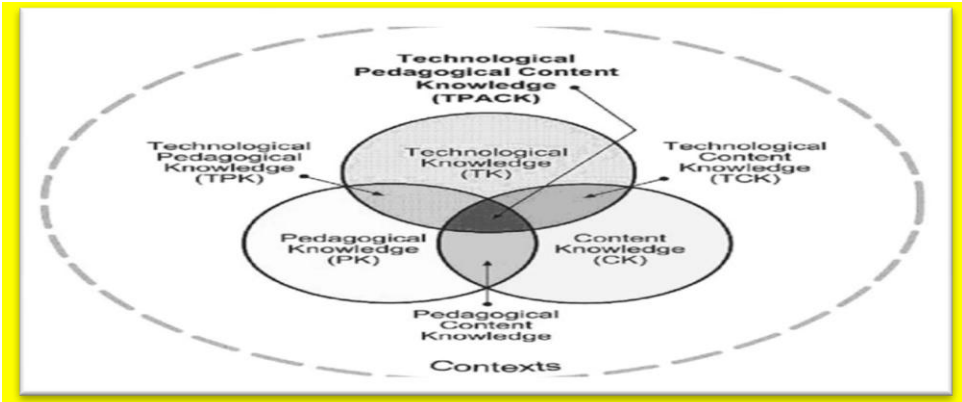


Fig 1: (TPACK) in the teaching and learning of Physics.

Source: Goggle scholar, 2023

TPACK is a framework that introduces the relationships and complexities between all three basic components of knowledge (technology, pedagogy, and the seven components (see Figure 1) as included in the TPACK framework, defined:

1. **Technology knowledge (TK):**Technology knowledge refers to the knowledge on countless technologies, ranging from low technologies (pencil and paper) to digital technologies (Internet, digital video, interactive whiteboards, and software programme).
2. **Content knowledge (CK):**Content knowledge indicates expertise on the subject matter, learned or be taught, were Physics teachers are cautioned to be knowledgeable in diverse content areas.
3. **Pedagogical knowledge (PK):** Pedagogical knowledge is the method and process of teaching. This includes knowledge in classroom organization, assessment, lesson plan development, and student erudition.
4. **Pedagogical content knowledge (PCK):** this is the content knowledge that deals with the teaching progression. In some cases, pedagogical content knowledge differs from various content areas, since it mergers both content and pedagogics with expected goals meant to develop and interpret better teaching method and practices in the content areas.
5. **Technological content knowledge (TCK):** refers to the knowledge of technology through creation of new exemplifications in specific contents. It suggests the need for Physics teachers to interpret their lesson plan through specific technology, that can change the ways their learners, practice and understand concepts in specific content area.
6. **Technological pedagogical knowledge (TPK):** refers to the knowledge in diverse technologies demonstrated in teaching practices.
7. **Technological pedagogical content knowledge (TPACK):** refers to knowledge expected of teachers to integrate technology into teaching in their

content area. Teachers must have asponaneous understanding of complex interplays between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies. Therefore, the framework focus on designs and evaluation of teacher knowledge, concentrated on effective student learning in various content packages (AACTE Committee on Innovation and Technology, 2008). Next time, one thinks of the TPACK, it means education of Physics teachers towards knowledge, by integrating technology into the teaching and learning of Physics.

Statement of the Problem

Teachers are role models and human tools used to impact knowledge to the understanding of their students. This function ought to be catalysed, through modern practices in the Physics classroom. However, over the years Physics teachers have been beclouded with conventional methods of learning which may possibly have stagnated their genuine efforts. The researcher is optimistic anevolution in theset of innovative method applied may have an upturn in productivity among Physics teachers to yield optimum performance among Physics students by paying attention to use of TPACK, in a captivating and fascinating way. Therefore, an urgentneed in teaching skills as considered tosalvage the inadequacies among Physics teachers in teaching Physics. The study therefore investigated three essential components of TPACK, which include technology, content, and pedagogy in the teaching and learning of Physics.

Scope of the Study

The study was carried out among senior secondary one Physics teachers in Obio/ Akpor local Government Area of Rivers-State. Physics teachers engaged students on the ball and ring experiment in heat energy using TPACK in their lesson plans. The teaching method used was the Technological pedagogical content knowledge (TPACK) and the discussion method. The following research questions were constructed to investigate Physics teachers' knowledge, in line with three components of TPACK and their combination. The questions have been developed on the foundation of seven domains, which include technology, pedagogy, content, technological content, technological pedagogy, and pedagogical content, along with the combination of all these components (TPACK) skills among Physics teachers for quality and sustainable development in Rivers- State.

Purpose of the Study

The general purpose of the study was to apply Technological Pedagogical Content Knowledge (TPACK) skills in Physics Teachers for Quality and Sustainable Development in Rivers- State Specifically, the student sought to:

Application of Technological Pedagogical Content Knowledge (TPACK) Skills in Physics Teachers for Quality and Sustainable Development in Rivers- State. - **Nduka Nkechi Ntaka Ph. D.**

- 1 Assess the ways of applying TPACK Skills in teaching Physics, for quality and sustainable development in Rivers-State
- 2 Ascertain the benefits of TPACK skills for Physics teachers for quality and sustainable development in Rivers-State.
- 3 Examine the challenges of applying TPACK among Physics teachers for quality and sustainable development. in Rivers-State

Research Questions

In light of the above, the study sought the following research questions:

1. What are the ways of applying TPACK among Physics teachers, for quality and sustainable development in Rivers-State?
2. What are the benefits of applying TPACK Skills in Physics teachers for quality and sustainable development in Rivers-State?
3. What are the challenges of applying TPACK skills in Physics teachers for quality and sustainable development in Rivers-State?

Methodology

The descriptive survey was the design of the study, as the study was carried out in secondary schools in Obio- Akpor local Government Area of Rivers-State. The population size consisted of a hundred and fifty (150) teachers selected from six schools that was made up of 75 male teachers and 75 female teachers, selected through the stratified sampling technique. The instrument for the study titled, 'Application of Technological Pedagogical Content Knowledge Skills in Teaching Physics Questionnaire (ATPAKTP), was used to collect the required information that contained thirty-two items. The instrument was structured on a four-point- Likert type of scale, ranging from strongly agree = 4, Agree=3, Disagree=2, strongly agree=1, used to analyse the research questions for positive statements, while the reverse was the case for negative statements. In taking decisions, a mean value of (2.56-4.00) was accepted (2.49-0.49) was rejected. The instrument used was the face and content, validated by three experts from Ignatius Ajuru University of Education in Physics Education and measurement /evaluation respectively. To ensure the reliability of the instrument, 20 copies of the questionnaires were administered to 20 teachers outside the sample used for trial testing while the internal consistency was estimated from the instrument which was at 0.83 while the data collected was analyzed using the mean and standard deviation to answer the research questions.

Results

Research Question 1: What are the ways of applying TPACK among Physics teachers, for quality and sustainable development in Rivers-State?

Table 1: Physics Teachers’ Response on the application of TPACK

S/N	Variables	\bar{x}	S.D	Remark	Remark
1	Alternating the tone voice of the teacher	3.25	0.75	Agree	Agree
2.	Asking Physics students to ascertain their prior knowledge	3.24	0.76	Agree	Agree
3.	Rewarding students for their effort	3.48	0.52	Agree	Agree
4.	Changing the classroom layout	3.33	0.67	Agree	Agree
5	Setting up, high expectations	3.02	0.98	Agree	Agree
6.	Employing effect instructional strategies	3.26	0.74	Agree	Agree
7.	Understanding student needs, interest And learning styles	3.24	0.76	Agree	
8.	Providing timely and constructive feedback	3.73	0.27	Agree	
9	Reflecting on teaching practices and building Positive relationships	3.52	0.48	Agree	
10.	Selecting relevant and authentic materials	3.50	0.50	Agree	
11.	Scanning the classroom	3.26	0.74	Agree	
12.	Spacing Repetition	3.27	0.85	Agree	

Sum of Cluster Mean 3.708.0

Mean of items Mean 3.08 0.19

The result in Table 1, showed ways of applying TPACK skills in secondary schools for quality and sustainable development in Rivers-State. The result obtained, indicated that all the items were rated as, ‘agreed’ based on the criteria mean of 2.50 while the cluster mean was 37.0 and the mean of items was 3.08, indicating that, there was an awe-inspiring agreement by Physics teachers in applying the use of TPACK skills in secondary schools.

Research Question 2

What are the benefits of applying TPACK Skills in Physics teachers for quality and sustainable development in Rivers-State?

Table 2

S/N	Variables	\bar{x}	Std	Remark	Remark
11	It encourages Physics teachers to develop creative and interactive classroom sessions	3.52	0.48	Agreed	Agree
12.	It creates access to innovative resources	3.27	0.85	Agreed	Agree
13.	It helps teachers to teach effectively	3.76	0.30	Agreed	Agree
14.	It ensures enjoyable experiences and interesting lesson materials for students to assimilate	3.73	0.27	Agreed	Agree
15.	It encourages teachers to improve on their computerized knowledge and skills	3.48	0.52	Agreed	Agree
16.	It improves learning activities, due to the provision of guidance for teachers to develop academic innovations.	3.26	0.74	Agreed	Agree
17.	It enable Physics teachers to use Technology appropriately in Physics experiments	3.52		0.48	Agreed
18.	It aims to provide learning opportunities and experiences for students	2.26		1.39	Agreed
19.	It helps to determine appropriate teaching methods to enhance students learning opportunity	2.76		1.24	Agreed
20	It ensures quick and easy access to diverse sourceof knowledge	3.33		0.67	Agreed

Sum of cluster mean	33.0	7.0	Agreed
Mean of item Mean	3.30	0.46	

The result in Table 2 showed that, the benefit of TPACK skills on Physics teachers for quality and sustainable development in Rivers-State. The results specified that items: 11, 12, 13, 14, 15, 16, 17, and 20 were rated as agreed based on the criteria mean of 2.50 while items 18 and 19 were rated as disagreed, since the mean scores were below the criterion mean of 2.50. The cluster mean was 33.0 while the mean of items were 3.30. An indication that there was an astonishing input by Physics teachers since all the items were beneficial to the Physics teachers except items 18 and 19. Therefore, observations showed that, Physics teachers derive massive benefits from participating in the use of TPACK, in teaching Physics.

Research Question 3: What are the challenges of applying TPACK skills in Physics teachers for quality and sustainable development in Rivers-State?

Table 1: Physics Teachers’ Response on the Challenges of Applying TPACK

S/N	Variables	\bar{x}	Std	Remark
1.	Inadequate Professional development and training	3.28	0.72	Agreed
2.	Limited availability of facilities and infrastructure	3.27	0.73	Agreed
3.	Unfamiliarity with apps that will be useful	4.00	0.01	Agreed
4.	Lack of skills on the part of some teachers	2.77	1.12	Agreed
5.	Inadequate technological training	2.80	1.20	Agreed
6.	Denial of computer and fast internet connection	4.06	0.01	
7.	Inadequate technical support and administrative peer support.	Inconsistent	1.12	
8.	Poor Implementation of educational Technology			
9.	Crowd funding			
10.	Inconsistent Computer Access , making it difficult for teachers to teach Physics effectively			
	Sum of cluster, mean	30.0	7.00	
	Mean of item mean	3.00	0.55	

Result in table 3 showed that, the challenges in applying TPACK skills among Physics teachers, for qualitative and sustainable development in Rivers-State. The result revealed that, all the items were above the cut-off point of 2.5

Application of Technological Pedagogical Content Knowledge (TPACK) Skills in Physics Teachers for Quality and Sustainable Development in Rivers- State - **Nduka Nkechi Ntaka Ph. D.**

while the cluster mean was 30.0 and the mean of items was 3.00, an indication that there was an overpowering agreement on Physics teachers and the encounter experienced in applying TPACK skills in teaching Physics.

Discussion of the Findings

Generally, the finding revealed that there was a vast agreement by Physics teachers on all the items that they were in accordance with the ways of applying TPACK skills in secondary schools among Physics teachers. In line with this development, Drew (2023) mentioned that, an effective way of applying TPACK skills, include: pausing for effect, scaffolding tasks, providing rewards and punishments, chunking, classroom layout and assessment. Scanning the classroom, was differentiating instruction and spacing repetition in the teaching of Physics. The findings of the study was in agreement with Sewell (2023) , who posited that assessing students, prior knowledge gives room for understanding and the unique needs in interest and learning styles.

Results of the finding in Research Question 2 revealed the benefits of TPACK Skills among Physics teachers, in line with Naziri et al (2019), Shulman in Nurwahidah et al (2023) who mentioned that, encouraging teachers towards developing creative and interactive classrooms sessions by providing Physics students, access to innovative resources, assistance to teachers; to teach effectively and improve computerized knowledge and skills which are benefits from the use of TPACK skills.

Results of Research question 3 disclosed the challenges of applying TPACK skills in teaching Physics, as the findings was in line with Johnson et al (2016) that posited that, challenges such as: novice in application, lesson delivery and skills, in some Physics teachers could act as constraints towards access to technological support, crowd funding and implementation of educational technology in the teaching and learning of Physics.

Conclusion

Currently, Physics teachers are willing to accept technological tools in the teaching and learning of Physics and must be equipped towards technological competence in exploring technological resources in classroom teaching and assessment. However, some Physics teachers are not doing adequately well in the integration of TPACK and its associated components in the learning paradigm of the 21st Physics classroom learners. As this might be attributed to the inadequate disposal of the use of technological equipment and trainings available to the teachers effectively for Physics classroom instruction.

Recommendation

1. Physics teachers should be given the prospect to attend trainings and workshops to improve on their skills for utilizing TPACK components especially

when there is a shortfall in the capacity to deliver instructional content effectively.

2. Physics teachers should be given the chance to make inputs on their preferred learning styles and process as this may likely increase teacher's willingness to accept and integrate technological tools and resources in their instructional delivery especially when it is related to Information Communication Technological components.

3. School administrators should endeavour to provide technological tools and resources for teachers to use in their instructional delivery and ensure that Physics teachers have access to technological tools and resources towards utilization of such resources that could improve student's competencies in realizing global goals.

References

- Agbarakwe, H.A & Ntaka, N.N. (2021). Integration of Cloud Computing in the Teaching-Learning of Physics in Nigerian Universities. *Journal of Education and Training Technology (JETT)*. Vol 10, Issue 2, June 2021. ISSN: 1595-2657 (Pg., 26-33)
- Ademoroti, B & O, D. (2021). Influence of Mathematics Ability and Gender on Students; Performance in Calculations of Empirical and Molecular Formulae of Compounds. *Journal of Education and Training Technology (JETT)*. Vol 10, Issue 3, Sept, 2021, (Pg87- 97)
- Adolphus, T. (2019). Why Students in Secondary Schools choose not to do Physics? Implications for Policy and Practice in Developing Countries. *European Scientific Journal* December 2019 edition Vol.15, No.34 ISSN: 1857 – 7881 (Print) e - ISSN 18577431 Doi:10.19044/esj.2019.v15n34p103 URL: <http://dx.doi.org/10.19044/esj.2019.v15n34p103>
- Adoniou. M. (2015). Teacher Knowledge: a complex tapestry. *Asia pac.J. Teacher Educ.* 43, 99-116. 10.101080/359866X.204.932330 [CrossRef] [Goggle Scholar]
- Amadi, R.O. (2021). Social Pathology and the Challenges of Pedagogy: The Digital Option. Inaugural Lecture Series. Ignatius Ajuru University of Education Rumuolumeni, Port Harcourt, Rivers-State. *Inaugural Lecture Series. No 33 7th October, 2021. ISSN: 2579-0714?Doi=10.1.1.523.3855&rep=rep1&type=pdf*. Accessed 24 May 2018

Application of Technological Pedagogical Content Knowledge (TPACK) Skills in Physics Teachers for Quality and Sustainable Development in Rivers- State - **Nduka Nkechi Ntaka Ph. D.**

Avwiri, E. (2021). Effect of Microsoft Excel Spread Sheet on Secondary School Students' Performance in Physics in Obio Akpor Local Government Area, Rivers-State. *Nigerian journal of Curriculum Theories and Educational Technologist (NJOCTET)*. Vol 6, Issue3 Sept, 2021

Azunwo, J. I, Avbenagha, E.A & Ntaka, N.N (2022). Implementation of Technology in the Curriculum: A Global Reformation in meeting the contemporary needs of the 21st Century Physics Learner *Journal of Education and Society*. Vol 12(2). 2676-2690. ISSN: 1596-1462

Drew, C. (2023). What are Pedagogical Skills? 15 examples .*www.helpful professor.com*

Ibeogu, J.I (2019). Post Graduate Students Assessment of Lecturers 'technological and Pedagogical Knowledge in Faculties of Education in Rivers- State. *Unpublished Thesis University of Port Harcourt, Department of Curriculum Studies and Educational Technology*

ISTE standards (2008). T. (C) international society for technology in education. A registered trademarks of international society for technology in education ISTE. *Org/standards*

Johnson, A.M, Jacorina, M.E, Russell, D.C & Soto, C.M. (2016).Challenges, when using Technologies in a Classroom in S.A Crossley and D.S M. Namara (Ed). *Adaptive Educational Technologies for Literacy Instruction (Pg.13-29) Taylor & Francis*

Mandinach E.B., & Grummer, E.S (2016b) .What does it mean or teachers to be data literate: Laying out the skills, knowledge and dispositions. *Teach. Teach. Educ.*60, 366-376. 10.1016/j.tate.2016.07.011[Cross Ref] [Goggle Scholar]

Mishra P & Koehler MJ 2006. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6):1017–1054. Available at <http://citeseerx.ist.psu.edu/viewdoc/download>

Naziri, F.M.S&Affand, H (2019). Importance of Technological Pedagogical and Content Knowledge (TPACK) in design and Technology Subject. *International Academic Resources BUSES, Social Studies*

Ntaka , N.N. (2020)Social Media, As a Global Tool for Supplementing the Teaching and Learning of Physics in Rivers- State during the Covid-19

Nurwahudah, Sulfasyah&Rukli (2023). Analyzing Teachers Technological Pedagogical Content Knowledge (TPACK) in Teaching, Reading Comprehension isfifth –Grade Elementary Schools. Www. *research gate.net*

Sewell, A. C.(2023). Pedagogical Content Knowledge .www. *Structural learning. Com*

Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Pre-service Teachers. *Winter 2009–10: Volume 42 Number 2* Copyright © 2009, *ISTE (International Society for Technology in Education)*, 800.336.5191(U.S. & Canada) or 541.302.3777 (Int'l), iste@iste.org, www.iste.org.

Xin, Z. (2021). From ‘Data’ to ‘Evidence’: how data uses influences teacher’s professional learning. *Glob. Educ.* 400, 75-90[Goggle Scholar]

Yenen, E.T (2021). Prospective teachers’ professional skill need s: a Q method analysis. *Teacher Dev* 25, 196-214. [10.1080/13664530.2021.1877188](https://doi.org/10.1080/13664530.2021.1877188)[CrossRef][Goggle Scholar]