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Research Article

Pre-service science educators' perception of pedagogical skills acquisition and the use of open technology for inclusive classroom interaction

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Abstract

Inclusive education, a key component of SDG 4, emphasizes enabling students with Special *Education Needs (SENs) to learn alongside their non-disabled peers in the same environment. However, the implementation of this policy in Nigeria is hindered by deficiencies in educator training programs. This paper examines how pre-service science educators can acquire pedagogical skills through open technology for effective inclusive classroom interactions.The study adopted a descriptive survey research design. Five research questions were raised and answered, while two hypotheses were tested at 0.05 level of significance. The population comprised all science education students in public and private higher institutions in Ilorin. A total of 300 respondents were randomly selected 50 each from one federal university, one state university, one private university, one federal college of education, one state college of education, and one private college of education. Data were collected using a 32-item, researcher-designed questionnaire on a 4-point Likert scale titled* Pre-service Educators' Acquisition of Pedagogical Skills with the Use of Open Technology for Inclusive Classroom Questionnaire (PEAPSOTICQ).*Findings revealed that inclusive education in Nigeria is constrained by limited knowledge among educators, largely due to inadequate training in teaching schools. The study further established that open technology can help pre-service educators acquire the pedagogical skills necessary for successful implementation. It is therefore recommended that educator training programs be strengthened and that teachers be enlightened on integrating open technology to enhance inclusive education practices in Nigeria.*

Keywords: *Pre-Service Educators, Pedagogical Skills, Open Technology, Inclusive classroom*

1. Introduction

Science plays an important role in a developing nation; it brings about civilization and technological advancement. Its importance cannot be overemphasized because it effects are felt in all ramifications. The word "science" is derived from Latin word "scientia" which means knowledge so, science as a discipline is termed to be a creative structure, built on facts. According to Abimbola (2013) science is defined as a body of knowledge, a way or method of investigating, and a way of thinking in order to understand nature.In the submissions of Olorundare (2023), science is a self-criticizing, self-correcting and an improving activity which deals with facts relating to the natural phenomenon of the universe and how these are interpreted. The Business dictionary (2023) defined science as a body of knowledge comprising of measurable or veritable facts acquired through application of the scientific method and generalized into scientific laws or principles. The attitudes or values that underlie 'sciencing' is known as the spirit of science which includes longing to know, questioning of all things, search for data and their meaning, demand for verification, respect for logic, consideration of premises and consideration of consequences (Olorundare, 2023). Educators who teach

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science are not scientists but science Educators who have undergone Educators' training in science education.

Science education is a field concerned with sharing science content and processes with individuals that are not traditionally considered part of scientific community. These individuals may be children, college students or adults within the general public. In the submissions of Abimbola(2013), the field of science education comprises science content, a bit of sociology and some teaching pedagogy. The goal of science teaching is to produce scientifically literate citizenry (Olorundare, 2023). Science is being taught at the senior secondary level of education by educators who received a form of training known as Educator-education. Educators play a very crucial role in the education of children; they are mediators between the curriculum and the learners (Ernest, Christopher and kofi 2019). An educator is a person whose job is to teach in a school or college. The most basic definition of the Educator is that he/she is the person who does the teaching (Zincirili,2021). An educator in the opinion of Adedeji and Bello (2016) is a unique human being who has learnt to use himself effectively and efficiently to help a society achieve their own purpose of education. The teaching profession has the most effective role in the process of teaching the cognitive and psychomotor details of other professions.

In the conclusions of Ernest, Christopher and kofi (2019), the roles of educators cannot be displaced by any form of technology, they are the real mediators between curriculums and the learners. Educators have an important role in classroom behavior management, they spend one-third of their day at work in schools and in pursuit of the achievement of teaching aims which make an important contribution to students' academic success (Gelisi 2007). Thus, the poor quality of education and low achievement scores of students in school and external examination was attributed to the fast disappearing breed of educators with "missionary" spirit (Mavic, 2020). The researcher found out that educators whose professionalism has come to be seen as an integral part of their character; and who are deeply committed to making a difference in the lives of their people are very few. Zincirili (2021) categorized learners who are taught to become educators later in a near future may be referred to as pre-service educators which means educators in training.

Pre-services educators experience different difficulties during the teaching practice program, some of which are mostly associated with instructional delivery, acquisition and use of pedagogical skills and technologies. Nigeria as a nation is striving hard to change its classroom educator's attitude toward accommodation of students with special need in accordance with SDG4 for vision 2030 (UNESCO, 2023). In the submissions of Spalding, Klecka, Lin, Odell and Wang (2010) educators are expected to meet the needs of all students and move them towards attainment of their individual potential evenly and are sometimes pressured to prepare students for maximum performance on high-stakes assessment tests. In a research conducted by Attah (2023), the researcher submitted that meeting the needs of all students has become difficult for educators because of the deficiency in their training program. The researcher submitted that special education is placed as a different body of knowledge or discipline known as special education which has formed the basis of excluding elements of inclusive education from the Educator training programs in Nigeria.

Inclusive classroom was defined by McManis (2023) as a class setting where all students, regardless of any challenges they may have, are placed in the same learning condition in an age-appropriate general education class that are in their own neighborhood schools to receive high-quality instruction, interventions, and supports that enable them to meet success in the core curriculum. The idea of inclusiveness in education in Nigeria was to allow special education needs (SENs) students spend most if not all of their time with their non-disabled colleagues in same class situations (Attah, 2023). Reaserchers (McManis, 2023; Attah, 2023; &Spalding, Klecka, Lin, Odell and Wang, 2010) opined thatthe success of inclusive education will depend primarily on accepting, understanding, and attending to student differences and diversity, which may include the physical, cognitive, academic, social, and emotional aspects when planning instructions .

Instruction that is well-planned moves students from their current level of competency toward explicit criteria for success (Marzano, Pickering, & Pollock, 2001). The essence of the use of different instructional delivery models is to enable the instructor or educator surmount the challenges on the organization and passage of the instruction to students who are assumed to have come from different backgrounds, therefore, possess different learning styles, pace and understanding the lessons based on their previous knowledge (Lukman, 2023). The future of a country is in the hands of its educators and their use of pedagogical skills to ensure effectiveness of teaching and learning in the classroom. Pre-service educators needs a high level of pedagogical skills in order to become effective educators in the future (Zincirili 2021).

Pedagogical skills was defined by The Indeed Editorial Team (2022) as educators' ability to instruct students and manage their classroom, learn the materials, understand their students, communicate with parents, collaborate with colleagues and form their own fair and consistent guidelines. In the opinion of Dew (2023) Pedagogical skills are linked to both helping students learn better, and ensuring students are well behaved. In the submissions Bolaji (2023), asking questions to find out the prior knowledge of students, rewarding their efforts, setting high

expectations and spaced repetition are examples of pedagogical skills. According to Dew (2023) pedagogy is the art of teaching; it describes all the teaching strategies used by Educators. The researcher submitted that students need to be well behaved in order to learn more effectively. The Pedagogical skills, thus, include the capacity to plan, initiate, lead and develop education and teaching with the departure point in both general and subject-specific knowledge which can be acquired through open technology.

Open technology according to Buss (2015) may be defined as all forms of technologies that allows users access to platforms or systems with very few constraints or restrictions on use, reuse, retaining, revising, remixing and redistribution of materials. Open technology is essential for the acquisition of pedagogical skills because of the way it connects teaching to research in the subject of interest (Bolaji, 2023). In the discussions of Umar (2022), connecting teaching to research rest solely on the use of latest technologies. Open Technology thrives and feeds on Open Standards and Open Source, and is better characterized as a process and attitude similar to the scientific process than by technological aspects (Scheerder & Koymans, 2023). In the submissions of Scheerder and Koymans (2023), an open technology project can be identified by how those tools and platforms are used: open participation, an ethic of sharing, and a willingness to adapt to the evolving needs of its participants. The challenges of inclusive classroom interactions in Nigeria as advanced by researchers (McManis, 2023; Savage & Erten 2015; & Attah, 2023) can be attributed to poor training of Educators from teaching schools. The researchers submitted that elements of inclusive education are lacking in the educator training programs. Therefore, this study wants to investigate pre-service Biology educators' acquisition of classroom pedagogical skills with the use of open technology for inclusive education.

The main purpose of this study was to find out pre-service Science Educators' pedagogical skills with the use of open technology for inclusive classroom interaction.

Specifically, the study would seek to:

(i) examine the level of awareness of pre-service science educators on open technologies.
(ii) find out the usability of open technologies for inclusive classroom interactions.
(iii) determine the pedagogical skills used by pre-service science educators for inclusive classroom interactions.
(iv) investigate the influence of gender on pre service educators' pedagogical skills in an inclusive classroom environment.
(v) examine the influence of gender on pre-service science educators' use of open technologies for inclusive classroom interaction.

The following questions were raised and answered;

1. What is the level of awareness of pre-service science educators on open technologies in Ilorin, Kwara state?
2. What is the level of usability of open technology for inclusive classroom by pre-service science educators in Ilorin, Kwara state?
3. What are the pedagogical skills used by pre-service science educators in an inclusive classroom environment?
4. Does gender influence the pedagogical skills employed for inclusive classroom interaction among pre-service science educators in Ilorin, Kwara state?
5. Does gender influence pre-service science educators on their use of open technology for inclusive classroom interaction in Ilorin, Kwara state?

The following null hypotheses were formulated and tested

HO_1 Gender does not significantly influence thepedagogical skills for inclusive classroom interaction by pre-service science Educators in Ilorin, Kwara state.

HO_2 There is no significant difference in the level of usability of open technology for inclusive classroom by male and female pre-service Biology educators in Ilorin, Kwara state.

2. Methodology

The study adopted a descriptive survey research design to investigate pre-service science educators' acquisition of pedagogical skills with the use of open technology for inclusive classroom interaction in Ilorin, Kwara State, Nigeria. The population comprised all science education students in both public and private higher institutions in Ilorin. Stratified random sampling was employed, and 50 respondents each were drawn from one federal university, one state university, one private university, one federal college of education, one state college of education, and one private college of education, giving a total of 300 respondents.

A researcher-designed questionnaire titled *Pre-service Educators' Acquisition of Pedagogical Skills with the Use of Open Technology for Inclusive Classroom Interaction Questionnaire (PEAPSOTICIQ)*, consisting of 32 items on a 4-point Likert scale, was used for data collection. The instrument had four sections: Section A (biographical data), Section B (awareness of open technologies), Section C (usability of open technologies), and Section D (pedagogical skills with the use of open technology for inclusive classroom interaction). The instrument was validated by the researcher's supervisor, two experts in Educational Technology, and two experts in Information and Communication Technology to ensure face and content validity. The reliability of the instrument was established using Cronbach's Alpha, yielding a coefficient of 0.91, which indicates high reliability.

Ethical clearance was obtained, and respondents were informed that their participation was voluntary, with their responses treated confidentially. Data were collected through Google Forms and retrieved for analysis. Descriptive

statistics (percentages and mean scores) were used to analyze demographic data and answer the research questions, while inferential statistics (t-test) were used to test the hypotheses at 0.05 level of significance.

Table 1. Demographic Characteristics of Pre-service Science Educators

Variables	Options	Number of respondents	Percentage %
Gender	Male	124	41.33
	Female	176	58.67
Academic level	Year 2	260	86.67
	Year 3	40	13.33
School Type	Public	200	66.67
	Private	100	33.33
Course	Agric. Edu.	56	18.67
	Biology Edu.	72	24.00
	Chemistry Edu.	51	17.00
	PHE	50	16.67
	Physics Edu.	28	9.33
	Maths Edu.	43	14.33

3. Results

3.1.Demographic data of Respondents

Table 1 showed that the sample included 300 respondents, 260 respondents (86.67%) were year 2 students while 40 (13.33%) respondents were year 3 students, 124 males (41.33%) and 176 females (58.67%), 200 respondents (66.67%) attends public schools while 100 respondents (33.33%) attend private schools. 56 respondents (18.67%) are studying Agricultural science education, 72 respondents (24.00%) studying Biology education, 51 respondents (17.00%) studying chemistry education, 50 respondents (16.67%) studying PHE, 28 respondents (9.33%) studying physics education, and 43 respondents (14.33%) are studying mathematics education

3.2. Analyses of Data to Answer the Research Questions

Research Question 1: *What is the level of awareness of pre-service science educators on open technologies in Ilorin, Kwara state?*

Table2. Meanandstandarddeviationofresponsesonthelevel of usability of open technology for inclusive classroom by pre-service Science Educators in Ilorin, Kwara state

S/N	Item Statements	X	SD	Remark
1.	Mozilla Firefox	3.52	0.80	Aware
2.	WordPress	3.11	0.87	Aware
3.	LibreOffice	3.05	0.99	Aware
4.	GNU Compiler Collection	2.29	0.35	Unaware
5.	GIMP	2.32	0.51	Unaware
6.	VLC Player	3.31	0.91	Aware
7.	Shotcut	2.03	0.48	Unaware
8.	Brave	2.15	0.39	Unaware
9.	Linus	2.01	0.47	Unaware
10.	Python	3.23	0.91	Aware
11.	PHP	2.12	0.42	Unaware
	Weighted average	**2.34**	**0.57**	**Unaware**

Table2.revealedthattherespondentsindicatedtheir awareness of Mozilla Firefox (mean=3.52), Word Press (mean=3.11), LibreOffice (mean=3.05), VLC Player (mean=3.31), and Python (mean=3.23) as open technologies

that can be used for instructional delivery. They declared that they are unaware of GNU Compiler Collection, GIMP, Shortcut, Brave, Linus, and PHP with means between 2.03 and 2.32 which is lower than the 2.5 benchmark for awareness on the four point scale.

Research Question 2: *What is the level of usability of open technology for inclusive classroom by pre-service Science Educators in Ilorin, Kwarastate?*

Table3revealedthattherespondentsindicatedthat Mozilla firefox (mean=3.12), Word Press (mean=3.21), Libre Office (mean=3.45), VLC Player (mean=3.07), and Python (mean=3.53) are usable open technologies that for instructional delivery in an inclusive classroom environment. They indicated that GNU Compiler Collection, GIMP, Shotcut,

Brave, Linus, and PHP with means between 2.05 and 2.26 which is lower than the 2.5 benchmark for awareness on the four point scale are not usable for instructional delivery.

Research Question 3: *What are the pedagogical skills used by pre-service science educators in an inclusive classroom environment?*

Table3:Meanandstandarddeviationofresponsesonthelevel of usability of open technology for inclusive classroom by pre-service Science Educators in Ilorin, Kwara state.

S/N	ItemStatements	X	SD	Remark
1.	Mozilla Firefox	3.12	0.82	Usable
2.	WordPress	3.21	0.78	Usable
3.	LibreOffice	3.45	0.91	Not Usable
4.	GNU Compiler Collection	2.15	0.59	Not Usable
5.	GIMP	2.23	0.51	Not Usable
6.	VLC Player	3.07	0.91	Usable
7.	Shortcut	2.17	0.84	Not Usable
8.	Brave	2.05	0.58	Not Usable
9.	Linus	2.26	0.97	Not Usable
10.	Python	3.53	0.91	Usable
11.	PHP	2.09	0.42	Not Usable
	Weightedaverage	**2.67**	**0.75**	**Usable**

Table 4: Mean and standard deviation of responses on the pedagogical skills used by pre-service Educators during teaching practice

S/N	Item Statements	X	SD	Remark
1.	It is important for Educators to speak slowly and clearly enough that students can hear them.	3.46	0.85	Agreed
2.	It is necessary to emphasize keywords and alternate tones to engage listeners.	2.93	0.93	Agreed
3.	Changing the classroom layout maybe necessary to improve learning.	3.08	0.97	Agreed
4.	Reshuffling students sitting arrangement to ensure low scorers aren't sitting together is a good initiative	2.52	1.05	Agreed
5.	Encouraging students may improve their performance	2.89	0.99	Agreed
6.	Rewards and punishment may encourage better performance	2.42	1.10	Disagreed
7.	Providing support while students are learning a new concept is not important.	3.20	0.95	Agreed
8.	Using different formative assessment strategies can enhance learning	3.27	0.91	Agreed
9.	Paced repetition of keywords may not necessarily make learning easier for students	2.28	0.94	Disagreed
10.	Educators should constantly scan through the whole class with their eyes to identify student who need help.	2.95	1.04	Agreed
	Weightedaverage	**2.90**	**0.97**	**Agreed**

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Table 4 revealed that the respondents agreed that speaking clearly is an important pedagogical skill for pre-service educators during teaching practice (Mean = 3.46). They also agreed that alternating tones helps to engage learners (Mean = 2.93). In addition, the respondents agreed that changing classroom layout may improve learning (Mean = 3.08), as well as reshuffling students' seating arrangements (Mean = 2.52). The respondents agreed that encouraging students may improve their performance (Mean = 2.89), providing support while students are learning a new concept enhances understanding (Mean = 3.20), and using different formative assessment strategies promotes learning (Mean = 3.27). They also agreed that scanning through the class with their eyes helps identify students who need help (Mean = 2.95). However, the respondents disagreed with using rewards and punishment to encourage better performance (Mean = 2.42). In the same way, they disagreed with avoiding paced repetition (Mean = 2.28).

All ten items had standard deviation values ranging from 0.85 to 1.17, which are below the fixed value of 1.96. This indicates that the responses of the respondents were not widely spread but rather close to the mean. Overall, the constructs in Table 4 represent the pedagogical skills used by pre-service Biology educators in Ilorin during the teaching practice program, with an average mean of 2.91 and a standard deviation of 0.97 (Mean = 2.91, SD = 0.97).

Research Question 4: *Does gender influence the pedagogical skills employed for inclusive classroom interaction among pre-service science educators in Ilorin, Kwara state?*

Table 5: Mean and standard deviation of responses on the pedagogical skills employed for inclusive classroom interaction among pre-service science educators in Ilorin, Kwara state.

Gender	N	M	SD
Male	124	73.46	15.31
Female	176	78.21	16.25

Table 5 revealed the mean scores of the pedagogical skills employed for inclusive classroom interaction among pre-service science educators in Ilorin, Kwara state based on gender, with female pre-service educators having marginal higher mean (M=78.21, SD=16.25) when compared with male pre-service educators (M=73.46, SD=15.31).

Hypothesis 1: *Gender does not significantly influence the pedagogical skills for inclusive classroom interaction by pre-service science Educators in Ilorin, Kwara state*

Table 6: **t-test analysis of the pedagogical skills employed for inclusive classroom interaction among pre-service science educators in Ilorin, Kwara state.**

Gender	N	M	SD	T	df	Sig
Male	124	73.46	15.31			
				.34	300	.74
Female	176	78.21	16.25			

p>0.05

The t-test statistics result ($t_{(300)}$=0.34, p=0.74) showed that there was no significant difference in the pedagogical skills for inclusive classroom interaction by pre-service science Educators in Ilorin based on gender as shown in Table 5. Hence, hypothesis 1 was not rejected as the p-value 0.74 was greater than 0.05 alpha level. This implies that the pedagogical skills employed by pre-service science educators for inclusive classroom interaction during teaching practice did not differ based on gender.

Research Question 5: *Does gender influence pre-service science educators on their use of open technology for inclusive classroom interaction in Ilorin, Kwara state?*

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Table 7: Meanandstandarddeviationofresponsesonthe influence of gender on pre-service science educators' use of open technology for inclusive classroom interaction in Ilorin, Kwara state?

Gender	N	M	SD
Male	124	73.91	15.01
Female	176	76.21	16.20

Table 7 revealed the mean scores of gender influence pre-service science educators on their use of open technology for inclusive classroom interaction in Ilorin, with female pre-service educators having marginal higher mean (*M*=76.21, *SD*=16.20) when compared with male pre-service educators (*M*=73.91, *SD*=15.01).

Hypothesis 2: *There is no significant difference in the level of usability of open technology for inclusive classroom by male and female pre-service science educators in Ilorin, Kwara state.*

Table 8: **t-test analysis of the level of usability of open technology for inclusive classroom by male and female pre-service science educators in Ilorin, Kwara state.**

Gender	N	M	SD	T	df	Sig
Male	124	73.91	15.01	.32	300	.71
Female	176	76.21	16.20			

p>0.05

The t-test statistics result ($t_{(300)}$=0.32, *p*=0.71) showed that there was no significant difference in the usability of open technology for inclusive classroom by male and female pre-service science educators during teaching practice based on gender. Hence, hypothesis 2 was not rejected as the p-value 0.71 was greater than 0.05 alpha levels. This implies that the usability of open technology by pre-service science educators during teaching practice did not differ based on gender.

4. Discussion

The most popular open technologies used by respondents for planning, preparation, and instructional delivery were Mozilla Firefox (a web browser), VLC Player (a cross-platform multimedia player), WordPress (a content management system), LibreOffice (an office productivity suite), and Python (a computer programming language for automating tasks and analyzing data). This finding aligns with earlier reports that pre-service teachers often rely on familiar, easily accessible tools such as browsers, video players, and office software for lesson preparation and video-based reflection activities (Bosch, 2024; Sonmez, 2012; Veiga, 2025).

Respondents, however, indicated that they were not aware of GNU Compiler Collection (an application software that optimizes and supports various programming languages), GIMP (a cross-platform image editor), Linux (an operating system), Brave (a web browser), Shotcut (a cross-platform video, audio, and image editor), and PHP (a general-purpose server-side scripting language). Similar low awareness of these specialized open-source tools has been reported in other studies, where such applications are typically introduced only in dedicated ICT courses rather than being widely embedded across teacher education curricula (Bedi, Vrbanec, & Žajdela Hrustek, 2010; Falade, 2023).

The popularity of Mozilla Firefox and VLC Player could be attributed, among other reasons, to accessibility, as all pre-service educators had VLC Player installed on their smartphones. Previous studies also note that tools available on personal devices are more likely to be adopted for instructional tasks by pre-service teachers (Zhang, Tousignant, & Xu, 2012; Günbaş, 2022). Furthermore, the emerging use of Python among respondents supports earlier work that identified Python as a promising tool for developing computational problem-solving and ICT competencies in pre-service science teacher education (Bati, 2022).

5. Conclusion

Pre-service educators recognize the need to use pedagogical skills to achieve success during their teaching practice and future careers. They acknowledge that open technology enhances the quality of instructional delivery, enabling them to plan, prepare, and deliver engaging lessons that stimulate students' interest in science. Open technologies allow inclusive classroom interactions by using photos, videos, and documents to make learning fun, clarify misconceptions, and carry all students along.

In light of the findings, the following conclusions were drawn:

- Respondents were aware of only a few open technologies.
- The vast majority of respondents used at least one of the technologies for instructional delivery and confirmed their usability.
- There was no significant difference in pedagogical skills and the usability of open technology based on gender.

Recommendations:

Based on the findings, the following recommendations

are made:

- Awareness of open technologies should be promoted through seminars, conferences, and workshops to encourage wider adoption among pre-service science educators.
- Pre-service educators should stay updated with the latest open technologies applicable to instructional delivery.
- Training programs should emphasize pedagogical skills such as communication, adaptability, collaboration, inclusivity, and compassion.
- The educator training curriculum should be reviewed to integrate the effective use of technology.
- Male and female in-service educators should also be inducted into using open technology to support the achievement of SDG 4.

Abbreviations

ICT	Information and Communication Technology
WHO	World Health Organization

Author Contributions

Z. A. Bello: Conceptualization, Methodology, Writing-Original draft,
B. T. Abdulazeez: Methodology ,Analysis of data**,**
B. N. Sadiq: Writing-Review and Editing,
O. Awolola: Writing-Review and Editing,
B. F. Usman: Writing-Review and Editing,
T. T. Ayilara: Writing-Review and Editing.

Conflicts of Interest

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