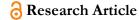
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Investigation on Science Education Chemistry Students' Attitudes towards Online Instruction in Public Universities

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Abstract

Despite the importance of Chemistry online instruction like accessibility, flexibility, and the quality of learning experiences some students seems not to appreciate it due to some attitude factors like lack of skills. Due to this, the study examined science education Chemistry students' attitudes towards online instruction in public universities. Four research questions guided the study. The study adopted a descriptive Survey design. The sample size of the study was 195 undergraduate chemistry education students from the population of 312 comprising of 217 males and 95 females in Anambra State public universities. The study adopted a random sampling technique and data were collected through structured questionnaire administered to the students from Nnamdi Azikiwe University, Awka and Chukwuemeka Odumegwu Ojukwu University, Uli. The questionnaire which was adapted from Azeta and Durowoju (2018) titled Chemistry Education Students' Attitudes Towards Online Instructions (CESATOI) was validated by three experts in the Department of Science Education, faculty of education, Nnamdi Azikiwe University and its reliability coefficient of 0.86 was established using Cronbach alpha. The data collected were analyzed using mean. Findings revealed that students generally have a positive attitude towards online instruction of computer science as a course. While these attitudes exist among students, the findings also indicated some challenges that undermine the quality of online instruction and the strategies to enhance the system. Based on the findings, it was recommended that Undergraduate chemistry education students should avail themselves to participate fully in the different possible strategies as identified by putting more interest in the use of online instruction. This will help to validate the level of challenges that has been dealt with. To enhance the quality of online instruction, and to foster right attitude among students, the institutions and government should provide a conducive online learning environment, free network access and good technological support. From the recommendations it was concluded that chemistry education students display a positive attitudes towards online instruction.

Keywords: Chemistry, Online Instruction, Science Education

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1. INTRODUCTION

Science education plays a pivotal role in equipping students with the knowledge, skills, and critical thinking abilities necessary to navigate the complexities of our increasingly scientific and technological society which is part of Science Technology Engineering and Mathematics (STEM) (National Research Council, 2012). In recent decades, there has been a growing recognition of the importance of STEM education in preparing students for the challenges and opportunities of the 21st century (National Science Foundation, 2007). STEM fields drive innovation, economic growth, and global competitiveness. As such, science education has evolved to emphasize not only the acquisition of scientific facts but also the development of scientific inquiry skills and the cultivation of a scientific mindset in students which Chemistry as a subject is one of it (Hodge et al., 2020; Igba et al., 2018).



Chemistry is the study of matter, analysing its structure, properties and behaviour to see what happens when they change in chemical reactions. It is also a discipline in STEM that studies the properties, composition, and structures of matter together with the associated changes as well as how such changes impact on the welfare of man and his environment. There is scarcely a single area of man's daily life that is not affected by Chemistry. This is the more reason why Chemistry as a subject should be digitally transformed to be an ever ready subject to whomever that wish to learn it any time and any day (Chikendu et al., 2021; Obikezie et al., 2023). The digital transformation of Chemistry education has ushered in a new era of teaching and learning the subject which is called Chemistry online instruction (Obikezie et al., 2023; Abdul-Rahim, 2021; Adeola et al., 2021; Hodges et al., 2020).

Chemistry online instruction, also known as Chemistry e-learning or Chemistry distance education, has emerged as a transformative force in the field of Chemistry education. It represents a paradigm shift in how teaching and learning are conducted in Chemistry, enabled by advances in digital technology and connectivity in the subject (Igba et al., 2018). The concept of Chemistry online instruction goes beyond the mere digitization of traditional classroom materials in a Chemistry class. It encompasses a diverse array of pedagogical approaches, including synchronous and asynchronous learning, video lectures, discussion forums, and interactive simulations the subject (Hodges et al., 2020). This diversity allows Chemistry lecturers and teachers tailor their instructional methods to suit various learning styles and objectives of the subject (Evgeny et al., 2021). However, Chemistry online instruction also presents challenges. Due to these challenges, the Chemistry online instruction characterized by disparities in technology access, poses an equity issue, as not all students have equal access to the necessary devices and internet connectivity. This the reason why most public universities in the world are embrace online instruction in most field which include Chemistry (Evgeny et al., 2021; Yue Zhu et al., 2020; Seyum et al., 2024; Azeta & Durowoju 2018). Additionally, Chemistry online instruction demands a level of self-discipline and digital literacy that may not be innate to all learners. It requires lecturers to adapt their teaching methods and materials to suit the Chemistry online environment such as digital tools, online resources, and technology-driven pedagogical approaches have expanded educational horizons. Chemistry online instruction, in particular, has emerged as a flexible and accessible mode of learning, enabling students to engage with educational content regardless of geographical constraints not minding students' attitude. No wonder Abdul et. al. (2021) perceived in their study an ease to use positively affected satisfaction and performance. The authors further asserted that satisfaction and performance were positively related to attitude in their finding. More so, Artino and Stephens (2018) confirmed in their report that Chemistry students' perceptions of course design significantly influenced their attitudes not minding their gender.

Subsequently, Obikezie and Ezeliora (2017) found that the male and female participants' in Chemistry online learning attitudes were general positive and increased when completing a course and the participants' continuous intention to learn Chemistry online was significantly predicted by four self-regulatory factors and attitudes, mediated through perceived online social interactions. Similarly, Eke and Achugbu (2020) reported that there is a positive attitude among male and female Chemistry students' in digital literacy which significantly contributed to self-efficacy and in turn, positively affected the engagement dimensions of the students not minding their gender type. In condor, Obikezie et. al. (2020) asserted a generally positive attitude toward e-learning by male and female secondary school Chemistry students appreciating the flexibility and importance like versatility of knowledge, time management accessibility, flexibility, and the quality of learning experiences, the online instructions offers in Chemistry teaching and learning.

Despite the importance of Chemistry online instruction like accessibility, flexibility, and the quality of learning experiences some students do not appreciate it due to some attitude factors like lack of skills as most authors asserted in a secondary school environment (Eke & Ikokwu, 2020; Faradilla et al., 2020; Fatimah, & Son 2020; Fatma, 2021). More so, most universities in the world embrace online instruction in many field which Chemistry as a subject is inclusive, it is imperative to comprehensively examine and address the attitudes of science education Chemistry option students in the university towards this mode of learning. Attitudes held by these students may significantly influence the success and efficacy of Chemistry online instruction initiatives. Attitudes may undermine engagement, retention, and the overall educational experience not minding the students' gender type. On this note the researchers investigated on science education Chemistry students' attitudes towards online instruction in public universities in Anambra state

1.1. Purpose of the Study

The primary purpose of this research is to investigate on science education Chemistry students' attitudes towards online instruction in public universities. By undertaking this investigation, the following purposes are defined specifically to guide this study:

- 1. To investigate the attitudes of Chemistry education students towards online instruction in public universities.
- 2. To determine the differences between male and female Chemistry education students' attitude towards the use of online instruction in public universities.
- 3. To identify the factors that influence Chemistry education students' attitudes towards the use of online instruction in public universities.
- 4. To ascertain the strategies to enhance the quality of online instruction in Chemistry education programs in public universities.

1.2. Research Questions

- 1. What are the mean attitudes of Chemistry education students towards online instruction in public universities?
- 2. What are the differences between male and female Chemistry education students attitude towards the use of online instruction in public universities?
- 3. What factors influence the attitudes of Chemistry education students towards the use of online instruction in public universities?
- 4. What are the strategies for enhancing the quality of online instruction in Chemistry education programs in public universities?

2. METHOD

The design of the study was survey research design. The area of study is Anambra State. The population of the study comprised of all the levels of Chemistry education undergraduate students in the Department of Science Education in all the public universities in Anambra state. The sample size of the study was made up of 195 undergraduate Chemistry science education students; 50 from year 1, 55 from year 2, 45 from year 3 and 45 from final year, all in science education and from the faculty of education. A total of 105 students were sampled from Nnamdi Azikiwe University, Awka and 90 students from Chukwuemeka Odumegwu Ojukwu University, Uli using stratified random sampling technique.

2.1. Instrument

The instrument used for data collection was a structured questionnaire adapted from Azeta and Durowoju (2018). The is titled Chemistry Education Students' Attitudes Towards Online Instructions (CESATOI). CESATOI was divided into two section A and B. Section A sought information on personal variables of the respondent such as name of universities. Section B made was made up of clusters (B1-B3) with 38 items which addressed the research questions. The questionnaire aims to capture both qualitative and quantitative data. A four (4) point scale as shown below was used to enable the researcher judge the respondents' level of confidence on each items. Responses for research question 1-4: Strongly agree (SA) =4, Agree (A) =3, Disagree (D) = 2and strongly disagree (SD) =1. To test the consistency and reliability of the instrument adapted CESATOI where administered to 30 undergraduate Chemistry Education in the Department of Science Education Delta State University Abraka, Delta state which is outside the area of study and reliability of .71was yielded using Cronbach alpha. Decision rule was that questionnaire items that attracted a mean score of 2.50 and above is regarded as Agreed and accepted by the respondent and any questionnaire item that attracted a mean score rating less than 2.50 is regarded as disagreed and rejected by the respondent.

3. RESULTS

The result of this study was presented in line with the research questions as follows.

3.1. Research Question 1

What are the mean attitudes of Chemistry education students towards online instruction in public universities?

Table 1. Respondents Mean Rating on the Attitudes of Chemistry Education Students in Public Universities in Anambra State towards Online Instruction. N=195

S/N	Items	Mean X	Decision
1	I like the flexibility of my online communication with my peer and instructors	3.4	Agreed
2	I can reach out to my instructor online and receive sufficient feedback and response	3.2	Agreed
3	Students and teacher interaction is weak through online instruction	2.6	Agreed
4	I have a positive feelings towards the utilization of online instructions for teaching and learning of a course in my department	3.4	Agreed
5	Chemistry online instruction motivates me to learn	2.7	Agreed
6	Chemistry online instruction gives me opportunity to express my organizational and communication skills	3.3	Agreed
7	I encounter significant challenges with online instruction	2.6	Agreed
8	I am comfortable using online instruction platforms.	3.3	Agreed
9	I prefer online instruction to tradition classroom learning.	2.5	Agreed
10	Chemistry online instruction fosters a sense of community among student	2.6	Agreed
11	Chemistry online instruction prepares me for real-world application of the course content.	2.6	Agreed
12	I am always under a terrible strain in online classes	2.3	Disagree
13	Chemistry online instruction allows me to learn more in the time I have for studies	3.2	Agreed
14	My learning improve with online instruction because it integrates various types of media	3.0	Agreed
15	Chemistry online instruction grants me access to current learning material	3.3	Agreed
	Grand Mean	3.0	Agreed

In Table 1, it shows the respondent agreed to 14 items (1,2,3,4,5,6,7,8,9,10,11,13,14 and 15) with mean score of 3.4, 3.2, 2.6, 3.4, 2.7, 3.3, 2.6, 3.3, 2.5, 2.6, 2.6, 3.2, 3.0 and 3.3 respectively which had mean score above the cutoff point of 2.50. This implies that the interaction between students and teacher, flexibility of online instruction, utilization of online instruction for teaching and learning determines the attitude of students towards chemistry online instruction in public universities in Anambra State. On the other hand, respondent disagree with item 12 with mean score 2.3 which stated that they are always under a terrible strain in online class. This research question has a grand mean score of 3.0 which implies that the attitudes of students toward Chemistry online instruction is positive.

3.2. Research Question 2

What are the differences between male and female Chemistry education students attitude towards the use of online instruction in public universities?

In Table 2, its how's the male respondent agreed to 14 items (1,2,3,4,5,6,7,8,9,10,11,13,14and15) with means core of 3.31, 2.91, 2.50, 3.00, 2.70, 3.12, 2.50, 3.13, 2.50, 2.64, 2.71,3.13,3.10 and3.21 respectively which had mean score above the cutoff point of 2.50. This implies that the interaction between students and lecturers, flexibility of online instruction, utilization of online instruction for teaching and learning determines the attitude of male students towards Chemistry online instruction in public universities in Anambra State. On the other hand, male respondents disagreed with item 12 with mean score 2.40 which stated that they are always under a terrible strain in online class. This research question has a grand mean score of 2.86 which implies that the attitude of male students toward Chemistry online instruction is positive.

Table 2. Respondents Mean Rating on the Attitude of Male and Female Chemistry Education Students in Public Universities in Anambra State towards Online Instruction

S/N	Items	Male Mean X	Male Decision	Female Mean X	Female Decision
1	I like the flexibility of my online communication with my peer and instructors	3.31	Agreed	3.60	Agreed
2	I can reach out to my instructor online and receive sufficient feedback and response	2.91	Agreed	3.51	Agreed
3	Students and teacher interaction is weak through online instruction	2.50	Agreed	2.81	Agreed
4	I have a positive feelings towards the utilization of online instructions for teaching and learning of a course in my department	3.00	Agreed	3.50	Agreed
5	Chemistry online instruction motivates me to learn	2.70	Agreed	2.74	Agreed
6	Chemistry online instruction gives me opportunity to express my organizational and communication skills	3.12	Agreed	3.60	Agreed
7	I encounter significant challenges with online instruction	2.50	Agreed	2.73	Agreed
8	I am comfortable using online instruction platforms.	3.13	Agreed	3.51	Agreed
9	I prefer online instruction to tradition classroom learning.	2.50	Agreed	2.50	Agreed
10	Chemistry online instruction fosters a sense of community among student	2.64	Agreed	2.50	Agreed
11	Chemistry online instruction prepares me for real-world application of the course content.	2.71	Agreed	2.42	Disagreed
12	I am always under a terrible strain in online classes	2.40	Disagree	2.30	Disagreed
13	Chemistry online instruction allows me to learn more in the time I have for studies	3.13	Agreed	3.31	Agreed
14	My learning improve with online instruction because it integrates various types of media	3.10	Agreed	3.00	Agreed
15	Chemistry online instruction grants me access to current learning material	3.21	Agreed	3.41	Agreed
	Grand Mean	2.86	Agreed	3.02	Agreed

Male = 111; Female = 84

More so Table 2 shows that female respondents agreed to 13 items (1,2,3,4,5,6,7,8,9,10,13,14and15) with mean score of 3.60,3.51, 2.81, 3.50, 2.74, 3.60, 2.73, 3.51, 2.50, 2.50, 3.31, 3.00 and 3.41 respectively which had means core above the cutoff point of 2.50. This implies that the interaction between students and teacher, flexibility of online instruction, utilization of online instruction for teaching and learning determines the attitude of female Chemistry education students towards online instruction in public universities in Anambra State. On the other hand, respondents disagreed with item 11 and 12 with mean score 2.42 and 2.30 which stated that Chemistry online instruction prepares them for real world application of the course content and that they are always under a terrible strain in online class. This research question has a grand mean score of 3.02 which implies that the attitudes of female Chemistry education students toward online instruction is positive.

3.3. Research Question 3

What factors influence the attitudes of Chemistry education students towards the use of online instruction in public universities?

Table 3. Respondents Mean Rating on the Factors that Influence Chemistry Education Students' Attitude Towards the Use of Online Instruction. N=195

S/N	Items	Mean X	Decision
16	My proficiency in using technology contributes to my attitude towards chemistry online instruction	2.9	Agreed
17	Limited access to resources influences my attitude towards online instruction	2.7	Agreed
18	Effective communication positively influence my attitude towards online instruction	3.1	Agreed
19	Positive interaction with instructors and peers contribute to my attitude to online instruction positively	2.9	Agreed
20	Poor course design and material quality influence my attitude towards online instruction	3.0	Agreed
21	Lack of adaptability to learning styles negatively affect my attitude towards online instruction	2.5	Agreed
22	Challenges in time management influence my attitude toward online instruction	2.5	Agreed
23	I am much satisfied with the technical support and assistance provided by my university for online instruction	2.2	Disagree
24	The emergence of COVID-19 pandemic influenced my attitude of online instruction in a special manner.	2.8	Agreed
	Grand Mean	3.0	Agreed

Data in Table 3 shows that respondents agreed to eight items (16, 17, 18, 19, 20, 21, 22 and 24) with mean core of 2.9, 2.7, 3.1, 2.9, 3.0, 2.5, 2.5 and 2.8 respectively which had the mean score above the cutoff point of 2.50. This shows that several factors such as proficiency in the use of technology, limited access to resources, effective communication, positive interaction with instructors and peers influence the attitude of students towards the use of online instruction positively and negatively. On the other hand respondents disagree with item 23 with a mean score of 2.2 that says they are not satisfied with the technical support and assistance provided by their university for online instruction. This research question has a grand mean score of 3.0 which implies that there are several positive and negative attitudes exhibited by Chemistry students towards the use of online instruction.

3.4. Research Question 4

What are the strategies for enhancing the quality of online instruction in Chemistry education programs in public universities?

Table 4. Respondents Mean Rating on Strategies for Enhancing the Quality of Chemistry Online Instruction in Computer Education Program. N=195

S/N	Items	Mean X	Decision
25	My institution should provide detailed information about the course structure, expectations, and technology requirements for online instruction.	3.4	Agreed
26	My institution should utilize discussion forums, group projects, virtual simulations, multimedia contents and other interactive elements to enhance student participation and collaboration.	3.3	Agreed
27	My institution should Provide resources and tutorials that will enhance students' technological familiarity and help them navigate online platforms, tools, and resources.	3.6	Strongly Agreed
28	My institution should allow for asynchronous learning, provide recorded lectures, and accommodate varying learning styles to maximize students' interest in online instruction.	3.3	Agreed
29	My university lecturers should host virtual office hours, participate in discussion forums, and provide personalized feedback to students.	3.4	Agreed

S/N	Items	Mean X	Decision
30	My institution should Include content that reflects various cultural perspectives and	3.5	Strongly
	values will enhance relevance and engagement.		Agreed
31	My institution should be able to encourage a sense of community among students can positively impact attitudes.	3.1	Agreed
32	My institution should provide options for assessments that accommodate different learning preferences and skills	3.5	Strongly Agreed
33	My institution should enable the provision of resources for assistive technology, offering closed captioning for videos, and addressing any barriers to accessibility promptly can positively impact students attitude.	3.3	Agreed
34	Acknowledging their efforts and accomplishments can contribute to a positive learning environment.	3.4	Agreed
35	My institution should establish a mechanisms for students to provide feedback on their online learning experience and regularly seeking input through surveys, focus groups, or feedback forms can regulate continuous improvements.	3.6	Strongly Agreed
36	My institution should Create opportunities for students to connect with each other, utilizing discussion forums, virtual social events, or collaborative projects can foster a sense of community and shared learning experiences.	3.2	Agreed
37	My institution should equip lecturers with the skills needed to create engaging and	3.6	Strongly
	effective online learning experiences can foster improvements.		Agreed
38	My institution should regularly review and update course content, incorporating new	3.7	Strongly
	technologies, and seeking innovative ways to enhance the online learning		Agreed
	environment can foster a positive attitude by students.		
	Grand Mean	3.0	Agreed

Data in Table 4 shows that the respondent agreed to fourteen items (25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37 and 38) with mean score of 3.4, 3.3, 3.6, 3.3, 3.4, 3.5, 3.1, 3.5, 3.3, 3.4, 3.6, 3.2, 3.6 and 3.7 respectively which were above the cut off mean 2.50. This research question has a grand mean score of 3.4 which implies that all the items in table 3 are possible strategies to enhance the quality of online instruction in chemistry education programs in public universities in Anambra State.

4. DISCUSSION

Students have a positive attitude towards online instruction, valuing its flexibility, accessibility, and the comfort provided by the asynchronous learning format, particularly in chemistry courses. The findings of the study pointed out the prevailing attitudes of Chemistry education students towards the use of online instruction in public universities in Anambra State. The findings indicated that students generally have a positive attitude towards online instruction. Chemistry students appreciate the flexibility that online instruction offers and how accessible the materials are. The asynchronous method of learning which online instruction offers to the students is of their best interest and they tend to be more comfortable with the system. The finding of the study is in line with Obikezie and Ezeliora (2017) reported that Chemistry students' perceptions of course design significantly influenced their attitudes. From this finding this study has joined the school of thought that investigated on science education Chemistry students' attitudes towards online instruction in public universities

Students in public universities exhibit similar attitudes towards online instruction, demonstrating shared perspectives on its effectiveness and usefulness in their education. The findings from the study revealed male and female Chemistry students attitude towards the use of online instruction of in public universities in Anambra State. Both male and female students' greed base on the items of attitude towards the use of online instruction in public universities in Anambra State. This means that both gender had positive attitude towards Chemistry online instruction. The finding is in consonance with Eke and Achugbu (2020) reported that there is a positive attitude among male and female Chemistry students' in digital literacy which significantly contributed to self-efficacy and in turn, positively affected the engagement dimensions of the students not minding their gender type.

More so, Obikezie et. al. (2020) asserted a generally positive attitude toward e-learning by male and female secondary school Chemistry students appreciating the flexibility and importance like versatility of

knowledge, time management accessibility, flexibility, and the quality of learning experiences, the online instructions offers in Chemistry teaching and learning. The positive attitude of both genders towards use of Chemistry online instruction could be because of the quest of undergraduate students to align with trends in technology.

Consequently, factors influencing chemistry students' attitudes towards online instruction include technology ease of use, resource access, communication effectiveness, course design, adaptability to learning styles, technical support, and the impact of COVID-19. The findings from the study revealed that the technology ease of use, access to resources, effectiveness of communication, interaction with instructors and peers, course design and material quality, adaptability to learning styles, management of the system's technical support and assistance, and the emergence of covid-19 are factors that influence the attitudes of Chemistry students towards the use of online instruction in public universities in Anambra State. From the findings, it was indicated that positive attitudes of students were characterized by their proficiency in technology use, effective communication, positive interaction with the instructors and peers, and also the emergence of covid-19 pandemic. It was also indicated that students pose a negative attitude towards online instruction due to some factors which include; limited access to technology, poor course design and material quality, lack of adaptability to learning styles, bad management and the lack of good technical support. This is not in line with most researchers assertion that state that despite the importance of online instruction to education like accessibility, flexibility, and the quality of learning experiences some students do not appreciate it due to some attitude factors like lack of skills (Faradilla et al., 2020; Fatimah, & Son 2020; Fatma, 2021). Also, the finding is in contrast with Evgeny et. al. (2021) who revealed that the online instruction characterized by disparities in technology access, poses an equity issue, as not all students have equal access to the necessary devices and internet connectivity. From the finding, this study has joined the school of thought that identified factors that influence Chemistry students' attitudes towards the use of online instruction.

Finally it is observed that providing clear course information, resources, and positive reinforcement enhances Chemistry students' interests and technological familiarity, will improve the overall quality of online instruction. So the finding shows that when the institutions provide detailed information about the course structure, technology requirements and also provide resources and tutorials that will enhance Chemistry students' technological familiarity, the students interests will maximize and thereby indicating an enhancement of the online instruction system. The quality of online instruction will also be enhanced when positive reinforcement is included to acknowledge Chemistry students efforts, if contents that reflect various cultural values are included and resources for assistive technology is provided, the quality of online instruction will be enhanced. This finding is in consonance with some group of authors averred that ICT facilities help science education students in different fields in science education (Hodges et al., 2020; Igba et al., 2018). The study is in line with Hodges et.al. (2020) who averred that Chemistry online instruction goes beyond the mere digitization of traditional classroom materials in a Chemistry class. It encompasses a diverse array of pedagogical approaches, including synchronous and asynchronous learning, video lectures, discussion forums, and interactive simulations the subject. From this finding, this study has joined the school of thought that ascertained the strategies to enhance the quality of online instruction in chemistry education programs.

5. RECOMMENDATIONS

Based on the findings of the study it is recommended that:

- 1. Improvement of the course flexibility and accessibility should be implemented: School administrators should keep providing asynchronous online course options so that students can learn at their own speed. To encourage flexibility, think about building a library of lectures and other resources that are available at any time.
- 2. Encourage inclusivity in communication: To guarantee that male and female students feel equally included and supported, authorities should provide regular, regulated channels of communication between teachers and students (such as discussion boards and weekly Q&A sessions).
- 3. Enhance technology resources and support: Creation of an extensive manual that stresses usability while outlining how to access and use online learning environments. To help students with technological

problems, offer continuous technical support (such as a specialized IT helpdesk or online resource center.

- 4. Make an investment in high-quality materials and an efficient course design: To improve the caliber of online course materials, work with instructional designers to make sure they are engaging, aesthetically pleasing, and take into account different cultural settings. To accommodate various learning styles, use a variety of instructional strategies.
- 5. Promote Community Development and contact: To promote student contact, establish peer mentoring programs or online study groups. To encourage group projects or conversations, make use of features like breakout rooms in video conferencing software.
- 6. University instructors should give Comprehensive Information Right Away: Provide a concise syllabus outlining the expectations, technological needs, course format, and resources at the start of each course. Provide new students with orientation sessions to acquaint them with the online platform.
- 7. Integrate feedback and positive reinforcement should be necessary: Include consistent feedback systems that recognize students' efforts and achievements. To encourage pupils, think about introducing a system of rewards or badges for involvement, teamwork, or progress.
- 8. Modify educational resources to reflect diverse cultural values: Engage students in the process of creating curricula by asking them for input on resources that represent various viewpoints or cultural values. Make sure the course material promotes representation and diversity.
- 9. Track and Assess the Effectiveness of Online Instruction: Get student opinions about their online learning experiences by holding frequent focus groups and surveys. Make incremental changes to student support services and course delivery using this data.

6. LIMITATIONS OF THE STUDY

Potential biases in students' self-reports, a lack of diversity in the sample, and the study's concentration on Chemistry students at public universities which could not accurately reflect other educational contexts are some of the shortcomings in this study. Furthermore, it's possible that external factors that affect attitudes like individual circumstances or institutional differences haven't been well investigated.

The study's constraints include a small sample size, possible participant response biases, students', differing degrees of technological access, and regional variations that impact online learning. Furthermore, the findings' application may be impacted by outside variables such as individual circumstances and the availability of institutional resources.

7. CONCLUSION

This study embarked on the science education Chemistry students' attitudes towards online instruction in public universities. Through a systematic exploration employing both quantitative and qualitative methods, the study has meticulously addressed these objectives, unraveling layers of insights that contribute to the understanding of online education in this specific context.

Based on the findings of the study, it was deduced that Chemistry education students display a positive attitudes towards online instruction. The study's findings underscore the significance of user-friendly interfaces, instructor engagement, and context-specific challenges in shaping Chemistry education students' attitudes towards online instruction. These findings contribute not only to the academic discourse on technology acceptance and online education but also offer practical insights for educators, institutions, and policymakers navigating the evolving landscape of higher education in Nigeria. The study also suggests the strategies that could enhance the quality of online instruction and future research can explore gender differences in online learning experiences, long-term engagement strategies, and the impact of cultural content on learning outcomes in subsequent research. This could prove that knowledge in Chemistry supports online instruction by ensuring content accuracy, fostering collaborative learning, guiding curriculum development, and enhancing students' comprehension, thereby positively influencing attitudes towards online learning platforms in public universities.

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Data Availability Statement. The data supporting the findings of this study are available upon request from the corresponding author. The dataset includes the responses from 195 undergraduate chemistry education students collected through a structured questionnaire, and it is intended to be used for further pat analysis research on attitudes towards online instruction in chemistry education for five years.

Conflicts of Interest. The authors declare that there are no conflicts of interest regarding the publication of this article. There were no financial or personal relationships that could influence the research outcomes, and all authors have disclosed any potential conflicts to ensure transparency and integrity in the study's findings.

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