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Chemistry teachers' utilization of three different constructivist-based teaching strategies in senior secondary schools in Dekina local government area of Kogi state

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Abstract: The study investigated chemistry teachers' utilization of three different constructivist-based teaching strategies in senior secondary schools in the Dekina local government area of Kogi state. The study adopted a descriptive survey research design. Three research questions and two hypotheses guided the study. The population of the study comprised 33 chemistry teachers in all the public secondary schools in the Dekina local government area. Purposive sampling was used for the study. The instrument for data collection was an observational rating scale on chemistry teachers' utilization of constructivist-based teaching strategies developed by the researcher. The reliability of the instrument was obtained. A Cronbach alpha reliability estimate was used to determine the internal consistency of the instrument, which gave a reliability index of 0.71. Kendall's coefficient of concordance was used to determine the inter-raters' reliability, which was obtained as 0.75. Data collected were analyzed using mean and standard deviation to answer the research questions, while the z-test was used in testing the hypothesis formulated at the 0.05 level of significance. The findings of the study revealed the following: it was revealed that chemistry teachers' qualifications and experience influence the utilization of constructivist-based teaching strategies. Based on the findings and conclusions, it was recommended, among others, that the government and Ministry of Education should employ qualified and experienced teachers to handle chemistry courses in senior secondary schools.

Keywords: chemistry; teachers' utilization; constructivist-based teaching; senior secondary schools

1. Introduction

Science holds immense potential for humanity, offering solutions to alleviate life's challenges. Its profound impact on individuals and nations is evident in the systematic acquisition of knowledge through observation and experimentation [1]. Science, as a coordinated body of knowledge derived from accurate observations and the formulation of general principles and laws [2], is a critical enterprise for technological advancement that receives significant emphasis in education due to its relevance to life and society. Recognizing the importance of science, the Federal Government of Nigeria, through the Federal Ministry of Education, introduced science subjects, including chemistry, into the secondary school curriculum.

Chemistry, as a major branch of science, plays a vital role in society by exploring the composition, properties, and uses of matter. Osei [3] emphasizes that chemistry delves into the transformations of matter, while Peter [4] defines it as the scientific

study of the interaction of chemical substances, involving atoms or subatomic particles like protons, electrons, and neutrons [5].

Despite the significance of chemistry, students' achievement in the subject has been consistently poor. This may be attributed to the insufficient adoption of constructivist-based teaching methods, hindering greater interaction in the teaching and learning of chemistry. Nigerian schools have witnessed subpar academic performance in chemistry over the years [6,7], as evidenced by consistent reports of poor achievement from the West African Examination Council (WAEC).

Several factors contribute to students' poor achievement in chemistry, including teaching strategies, teacher qualifications, teaching experiences, teachers' location, and gender. Ajaja [8] emphasized that the teaching and learning method in science is a significant factor contributing to low achievement, advocating for alternative instructional strategies to stimulate student interest and enhance their performance. The inadequacy of effective teaching strategies, as highlighted by Osokoya [9], may be a key contributor to low achievement in chemistry, emphasizing that science concepts cannot be well understood without the implementation of efficient teaching strategies.

While various teaching strategies have the potential to enhance learning, their poor utilization has resulted in subpar achievement. Ayemi [10] emphasized that teaching is a continuous process requiring desirable changes in learners through appropriate methods. Adunola [11] stressed the importance of aligning teaching strategies with the subject matter to bring about positive changes in students. To facilitate knowledge transmission, Tebabal and Kahssay [12] highlighted the need for teachers to apply suitable methods that align with specific objectives and level exit outcomes. Therefore, it is imperative to assess the utilization of constructivist-based teaching strategies by chemistry teachers.

Constructivism, defined as a teaching style prioritizing the student as an active agent in knowledge acquisition and understanding, stands out as an effective approach. Bada and Olusegun [13] noted that constructivism deliberately centers on the learner, encouraging active contributions to education rather than passive absorption of information. Essien and Uden [14] emphasized constructivist pedagogical practices involving critical thought and reflective learning, fostering ideas and innovative solutions to real-world societal issues. Constructivist teaching strategies encourage the active participation of learners, allowing them to construct their knowledge from experiences. As noted, these strategies serve as effective means of improving learning and enhancing students' achievement.

Constructivist teaching strategies play a crucial role in education by fostering the development of essential skills such as problem-solving, creativity, and critical thinking. These strategies also enable the active participation of students during teaching and learning. Various approaches, including personalization, small learning communities, student advisories, multidisciplinary curricula, peer tutoring, peer instruction, and team teaching, are employed by educators at different higher education levels. The rapid advancements in technology have further expanded the possibilities for adopting constructivist-based teaching in the classroom.

In response to this educational trend, numerous constructivist approaches to science teaching have been introduced in secondary schools, involving curriculum

revisions to provide meaningful science education to students. Salf and Kinyo [15] highlighted instructional approaches based on constructivism, such as computer-assisted instruction, peer tutoring, and project-based learning. The peer tutoring technique aligns with social constructivism, emphasizing peer interaction and collaboration. It underscores the importance of learning from more knowledgeable peers. Computer-assisted instruction, grounded in constructivist theory, presents real scenarios and typical cases, creating a conducive learning environment that promotes learners' knowledge, cognition, and construction. Kareem [16] noted that the application of computer-assisted instruction in science empowers learners by enhancing skills, understanding, learning, and accessibility to information in a technological world, contributing to the country's social and mechanical significance, and sustainable development. The researcher has chosen these various constructivist-based teaching strategies against this backdrop.

Project-based learning, another constructivist approach, contributes to the development of reasoning skills through collaborative activities, allowing students to compare different approaches and draw logical conclusions [17]. Vasiliou et al. [18] observed that the project-based learning setting involves simple physical elements such as markers, whiteboards, and post-it notes, facilitating student teams' collaboration and enhancing their cooperative learning skills in the process. This underscores the importance of hands-on, collaborative learning experiences in the constructivist framework.

Peer tutoring is a teaching strategy that uses students as tutors. The student pairs might work on academic, social, behavioral, functional, or even social skills. There are so many different ways to pair students, such as ability level, skills mastered, or age [19].

Computer-assisted instruction (CAI) is a form of instructional method supported by a computer-controlled display and a response entry device. It employs a combination of text, graphics, sound, and video to enhance the learning process through interactive engagement, aiming to achieve specific instructional goals and improve educational outcomes. According to Audu and Agbo [20], CAI is an instructional technique where the computer instructs students, containing a stored program designed to inform, guide, control, and test students until a prescribed level of proficiency is attained. In a constructivist learning approach, teachers provide diverse learning situations for students. Experiencing various learning scenarios leads to transformative changes in their roles.

The role of teachers is crucial for effective teaching and learning. While poor teaching strategies may contribute to students' poor achievement, there is also a need to investigate teachers' qualifications as a potential factor. The educational qualification of teachers significantly impacts the delivery of lessons in the classroom. Professional development is an ongoing process integral to educators' daily work, moving beyond being viewed as a one-time event. Qualified teachers play a pivotal role in promoting effective teaching and learning and enhancing students' achievement in school. A qualified teacher possesses a teaching qualification, is licensed by the state, holds at least a bachelor's degree from a degree-awarding university, and is well-qualified in their area of specialization [21]. In addition to teachers' qualifications, Achor et al. [22] also revealed that the utilization of

constructivist-based teaching strategies may vary across teachers' experiences, emphasizing the influence of experiential factors in the effective application of such strategies.

Teachers' experiences are integral to the teaching and learning process, encompassing the knowledge, attitudes, and skills acquired through participation in educational programs. These experiences play a crucial role in helping teachers cope with and adapt to changes in educational programs. The years of experience a teacher accumulates serve as a measure of their quality and become imperative in influencing students' achievement [23]. As a result, this study focuses on investigating the impact of both teachers' qualifications and experiences on Chemistry teachers' utilization of five constructivist-based teaching strategies for senior secondary school students. By exploring the interplay between qualifications, experience, and instructional strategies, the study aims to provide insights into the factors influencing effective chemistry education.

1.1. Research questions

The following research questions guided the study:

- 1) To what extent do Chemistry teachers utilize computer-assisted instruction (CAI), peer tutoring (PT), and project-based learning (PBL) teaching strategies in teaching and learning?
- 2) What is the influence of chemistry teachers' qualifications on the utilization of constructivist-based teaching strategies?
- 3) What is the influence of chemistry teachers' experiences on the utilization of constructivist-based teaching strategies?

1.2. Research hypotheses

The following research hypotheses were formulated to guide the study. The hypotheses were tested at a 0.05 level of significance.

- 1) There is no significant difference between the mean rating scores of highly qualified teachers and less qualified teachers in their utilization of constructivist-based teaching strategies.
- 2) There is no significant difference between the mean rating scores of highly experienced teachers and less experienced teachers in their utilization of constructivist-based teaching strategies.

2. Methodology

The study adopted a descriptive survey research design and was conducted in the Dekina Local Government Area of Kogi State, Nigeria. The population comprised 33 Chemistry teachers from 26 senior secondary schools in the Dekina Education Zone, including teachers from both urban and rural areas. Purposive sampling was employed due to the limited number of chemistry teachers in the schools. The data collection instrument was an observational rating scale developed by the researcher, consisting of two sections (A and B). Section A gathered demographic data on teachers' qualifications and experience, while Section B included 15 items related to the utilization of five constructivist-based teaching strategies.

The mean score interpretation for research question one was based on real limit numbers, categorizing mean scores of 3.50–4.00 as Very Often (VO), 2.50–3.49 as Often Used (OU), 1.50–2.49 as Rarely Used (RU), and 0.50–1.49 as Not at All (NA). Teachers with 0–9 years of experience were considered less experienced, while those with 10 years and above were classified as highly experienced. Similarly, teachers without educational qualifications were labeled as less qualified, and those with educational qualifications were classified as highly qualified. The instrument underwent validation by four specialists, including three from the chemistry education unit and one from the measurement and evaluation unit at the University of Nigeria, Nsukka. Trial testing involved six chemistry teachers from Ankpa local government, and a reliability value of 0.71 was obtained. The inter-rater reliability score of 0.79 indicated a high degree of agreement among the raters. Kendell’s Coefficient of Concordance was utilized for correlation among multiple raters.

The analysis of research questions utilized mean and standard deviation, while a t-test was employed to address the research hypotheses. This comprehensive research design aimed to explore the influence of chemistry teachers’ qualifications and experiences on their utilization of constructivist-based teaching strategies for senior secondary school students in the Dekina Local Government Area.

3. Results

3.1. Research question one

To what extent do Chemistry teachers utilize computer-assisted instruction (CAI), peer tutoring (PT), and project-based learning (PBL) teaching strategies in teaching and learning?

The result in **Table 1** shows that peer tutoring and project-based learning have a mean score of 1.85 and 1.72, respectively, which means that chemistry teachers rarely utilize peer tutoring and project-based teaching strategies. Computer-assisted instruction has a mean score of 1.46, which indicates that chemistry teachers do not utilize computer-assisted instruction in teaching and learning.

Table 1. Mean Score and Standard Deviation of Chemistry teacher’s utilization of Computer-assisted instruction (CAI), Peer tutoring (PT), and Project-based learning (PBL), teaching strategies in teaching and learning.

Constructivist-based teaching strategies	Mean	Standard deviation	Decision
CAI	1.46	0.08	Not at all
Peer tutoring	1.85	0.06	Rarely used
Project based learning	1.72	0.07	Rarely used

3.2. Research question two

What is the influence of a chemistry teacher’s qualification on the utilization of constructivist-based teaching strategies?

Results in **Table 2** show that highly qualified teachers have a mean score of 2.59 and a standard deviation of 0.12, while the less qualified teachers have a mean score of 2.40 and a standard deviation of 0.11. This means that the highly qualified teachers

utilize constructivist-based teaching strategies more than the less qualified teachers.

Table 2. Mean score and Standard deviation on the influence of chemistry teacher’s qualification on utilization of constructivist-based teaching strategies.

Qualification	N	Mean	SD
Highly qualified	18	2.59	0.12
Less qualified	15	2.40	0.11

3.3. Research question three

What is the influence of chemistry teachers’ experience on the utilization of constructivist-based teaching strategies?

The result in **Table 3** reveals that the highly experienced teachers had a mean score of 2.26 and a standard deviation of 0.68, while the less experienced teachers had a mean score of 2.16 and a standard deviation of 0.88. This shows that the high-experience teachers had a higher mean score on the utilization of constructivist-based teaching strategies than the less experienced teachers.

Table 3. Mean score and Standard deviation on the influence of chemistry teacher’s experience on utilization of constructivist-based teaching strategies.

Experience	N	Mean	SD
Highly experienced	13	2.26	0.68
Less experience	20	2.16	0.88

3.4. Hypothesis one

There is no significant difference between the mean rating scores of highly qualified teachers and less qualified teachers in their utilization of constructivist-based teaching.

The result presented in **Table 4** shows that the z-cal of 4.255 with an associated probability value of 0.000 at 31 degrees of freedom was obtained. The z-cal of 4.255 is greater than the z-crit of 1.96. The associated value of 0.000 when compared with 0.05 was set as the level of significance for testing the hypothesis and was found to be significant. Thus, the null hypothesis of no significant difference is rejected. This implies that teachers’ qualifications have a significant influence on their utilization of constructivist-based teaching strategies.

Table 4. Test analysis of the significant difference between the mean rating scores of highly qualified teachers and less qualified teachers on their utilization of constructivist-based teaching strategies.

Variable	N	X	SD	z-crit	z-cal	Df	p-value
Highly qualified	18	2.59	0.12	1.9	4.255	31	0.000
Less qualified	15	2.40	0.11				

3.5. Hypothesis two

There is no significant difference between the mean rating scores of highly qualified teachers and less qualified teachers in their utilization of constructivist-based teaching.

The result in **Table 5** showed that the z-cal of 3.435 with an associated probability value of 0.002 at 31 degrees of freedom was obtained. The z-cal of 3.435 is greater than the z-crit of 1.96. Therefore, the null hypothesis of no significant difference is rejected since the *p*-value (0.002) is less than 0.05 level of significance. This implies that teachers' experience has a significant influence on their utilization of constructivist-based teaching strategies.

Table 5. Test analysis of the significant difference between the mean rating scores of highly experienced teachers and less experienced teachers on their utilization of constructivist-based teaching strategies.

Variable	N	X	SD	z-crit	z-cal	Df	<i>p</i> -value
Highly experienced	13	2.26	0.68	1.96	3.435	31	0.002
Less experienced	20	2.16	0.88				

5. Discussions of the findings

The study conducted in the Dekina local government area of Kogi State offers an insightful exploration into the adoption of constructivist-based teaching strategies by chemistry teachers in senior secondary schools. Constructivism, a learning theory positing that learners construct their understanding and knowledge of the world through experiences and reflecting on those experiences, has significant implications for teaching methodologies.

The study's first objective assesses how extensively Chemistry teachers employ CAI, PT, and PBL in their instructional practices. CAI involves using computers and software applications to deliver instructional material or support learning activities. It offers interactive, engaging content that can significantly enhance students' understanding of complex chemistry concepts. Peer tutoring involves students helping each other understand a subject or concept; it fosters collaborative learning and reinforces the tutor's knowledge. Project-Based Learning, on the other hand, is an instructional approach that enables students to engage in extended inquiry on real-world challenges, thereby developing problem-solving skills and deeper subject matter understanding. The study's findings indicate that chemistry teachers in the surveyed area do not frequently utilize computer-assisted instruction, and both peer tutoring and project-based teaching strategies are rarely employed. This observation aligns with the results reported by Osorong [24], who found that computer-assisted instruction, mastery learning, peer tutoring, and project-based learning strategies are seldom used and are adopted by only a few teachers in the teaching and learning of chemistry. The reluctance to embrace these strategies may be attributed to teachers' adherence to traditional teaching methods, indicating a potential lack of awareness or familiarity with the benefits of constructivist-based teaching strategies.

The findings reveal varying degrees of adoption among these strategies, with

each having unique challenges and benefits in the chemistry classroom. The limited use of CAI points towards potential resource limitations or a lack of familiarity with integrating technology into teaching. Meanwhile, the somewhat higher but still limited engagement with PT and PBL suggests recognition of their value but perhaps challenges in implementation, possibly due to curriculum constraints or the need for more substantial teacher preparation. The study suggests that there is a need for increased awareness among chemistry teachers regarding the advantages and effectiveness of constructivist-based teaching strategies in enhancing student learning. Eze [25] also identified a tendency among science teachers to frequently use some recommended teaching methods while neglecting others. The utilization of a limited set of strategies may not adequately promote students' academic achievement in chemistry. Therefore, the study emphasizes the importance of chemistry teachers adopting a variety of teaching strategies to enhance overall academic achievement.

Additionally, the research reveals a significant difference in the utilization of constructivist-based teaching strategies based on teachers' qualifications. This finding aligns with Bamidele and Adekola's [26] results, indicating a substantial difference in the achievement of students taught by highly qualified teachers compared to those taught by less qualified teachers. However, it contradicts the findings of Onyelekan et al. [27], who reported no significant difference in science teachers' use of innovative teaching strategies based on qualification. The study underscores the importance of increasing awareness and promoting the adoption of constructivist-based teaching strategies, especially in the areas of computer-assisted instruction, peer tutoring, and project-based learning.

The second objective explores how Chemistry teachers' qualifications influence their use of constructivist-based teaching strategies. Qualifications, in this context, refer to the teachers' academic and professional credentials, including degrees in chemistry or education and pedagogical training. The study hypothesizes that teachers with higher qualifications are more likely to integrate CAI, PT, and PBL into their teaching, given their presumably greater exposure to and understanding of constructivist principles during their training. The results support this hypothesis, indicating a positive correlation between the level of qualification and the use of these innovative teaching strategies. This suggests that enhancing teacher qualifications through further education and professional development could encourage the broader adoption of constructivist approaches. Furthermore, it emphasizes the potential impact of teachers' qualifications on the effective implementation of these strategies, highlighting the need for continuous professional development and training to enhance teaching practices and ultimately improve students' academic achievement in chemistry. The findings of this study align with those of Khursid and Zahur [28], indicating that teachers with professional qualifications are more aware of and tend to utilize innovative teaching methods compared to those without professional qualifications. The exposure to professional training is highlighted as a potential reason for this difference, suggesting that teachers with higher qualifications may have undergone specific training that enhances their classroom practices.

Lastly, the study examines the impact of teachers' experience on the utilization of constructivist-based teaching strategies. Experience is considered in terms of years spent teaching Chemistry, with the assumption that more experienced teachers might

be more adept at incorporating complex instructional strategies such as CAI, PT, and PBL. Interestingly, the findings suggest that while experience does contribute to a greater use of these strategies, the correlation is not as strong as might be expected. This implies that experience alone, without ongoing professional development and exposure to current teaching methodologies, may not suffice to significantly enhance the use of constructivist approaches. Furthermore, the study reveals that chemistry teachers' experience significantly influences the utilization of constructivist-based teaching strategies. Experienced teachers are more likely to incorporate these strategies into their teaching compared to less experienced teachers. This finding is consistent with Odoh [29], who emphasized the impact of teachers' experience on the choice of teaching methods. Additionally, Ebiringa [30] reported similar results, stating that teachers' experience influences the selection of instructional methodologies in secondary schools.

However, the current study's results contradict those of Tella [31], who found in a study on teachers' variables as predictors of academic achievement in primary school pupils that teachers' experience had no significant influence on pupils' achievement in mathematics. Similarly, Ewetan and Ewetan [32] reported conflicting results, stating that teachers' teaching experience had a significant influence on students' academic performance in mathematics and the English language. In agreement with the findings of this study, Adeinyi et al. [33] observed that the teaching experience possessed by a teacher plays a role in determining students' achievement. The rationale behind this association is that the more years a teacher spends in a particular field, such as teaching, the more experienced and knowledgeable they become. Teachers' experience ensures adequate pedagogical exposure, allowing them to discover new teaching strategies and explore various approaches in teaching.

The study reinforces the notion that professional qualifications and teaching experience are influential factors in determining the utilization of constructivist-based teaching strategies among chemistry teachers. It highlights the importance of continuous professional development and the accumulated experiences of teachers in enhancing their pedagogical practices and ultimately improving students' academic achievement.

6. Broader implications of the findings of the study

The findings of the study have significant implications for educational policy and practice in Nigeria. The implications extend to various aspects of teacher training, professional development, resource allocation, and curriculum design, emphasizing the need for targeted interventions to enhance the quality of chemistry education in the country.

Professional Development Initiatives: The study highlights the importance of continuous professional development for chemistry teachers. Educational policies should prioritize the provision of workshops, seminars, and training programs focusing on constructivist-based teaching strategies. This can empower teachers with the necessary skills and knowledge to effectively integrate CAI, PT, and PBL into their classrooms.

Teacher Qualifications and Recruitment: Policymakers should consider the

findings on the positive correlation between teacher qualifications and the utilization of constructivist-based strategies. Efforts should be made to recruit and retain highly qualified chemistry teachers. Incentives for further education and training could be introduced to attract qualified educators to the field.

Integration of Technology in Education: Given the limited utilization of Computer-Assisted Instruction (CAI), there is a need for policies that promote the integration of technology in education. This involves providing schools with necessary infrastructure, such as computer labs and internet connectivity, and ensuring that teachers receive training in using technology effectively for instructional purposes.

Curriculum Revision: The study's findings suggest that the current curriculum may pose challenges for the effective implementation of constructivist-based strategies. Educational policymakers should consider revising the curriculum to allow for more flexibility and integration of innovative teaching methods. This could involve incorporating elements of project-based learning and peer tutoring into the prescribed curriculum.

Resource Allocation: Policymakers should recognize the resource constraints that may hinder the adoption of constructivist-based teaching strategies. Adequate funding and resource allocation are essential to provide schools with the necessary materials and tools for implementing PT and PBL effectively. This may include funding for collaborative projects, access to relevant textbooks, and the availability of technological resources.

National Guidelines for Constructivist Approaches: Considering the importance of constructivist-based teaching strategies, national educational bodies could develop guidelines and recommendations for the integration of these approaches across subjects, including chemistry. This could serve as a framework for teacher training institutions and ongoing professional development programs.

7. Conclusion

Based on the findings of the study, the following conclusions can be drawn. The study revealed a significant influence of qualification on chemistry teachers' utilization of constructivist-based teaching strategies in senior secondary schools. This implies that teachers' qualifications play a crucial role in influencing the adoption and implementation of constructivist-based teaching strategies. Educators with higher qualifications may be more likely to incorporate innovative teaching methods into their instructional practices.

The research also established a significant influence of teachers' teaching experience on the utilization of innovative teaching strategies in senior secondary schools. This suggests that the number of years a teacher has spent in the field significantly affects their adoption of constructivist-based teaching strategies. More experienced teachers may be more inclined to integrate these strategies into their teaching methods. The study underscores the importance of both qualification and teaching experience in shaping the utilization of constructivist-based teaching strategies among chemistry teachers in senior secondary schools. These findings emphasize the need for ongoing professional development and the accumulation of teaching experiences to enhance the integration of innovative and effective

instructional methods in the classroom.

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