COMPARATIVE EFFECT OF SELF-PACED INSTRUCTIONAL STRATEGY AND CONVENTIONAL TEACHING METHODS ON STUDENTS' ACADEMIC ACHIEVEMENT IN CHEMISTRY IN SECONDARY SCHOOLS IN ONDO STATE, NIGERIA

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Abstract

This study investigated the comparative effects of self-paced instructional strategy and conventional teaching method on students' academic achievement in Chemistry in Nigerian secondary schools. The persistent poor performance of students in Chemistry, particularly in examinations conducted by the West African Examinations Council and the National Examinations Council, necessitated the search for more effective instructional approaches. The study adopted a quasi-experimental research design, specifically the pretest–posttest non-equivalent control group design. The population consisted of Senior Secondary School II (SSII) students offering Chemistry in selected public secondary schools. A total of 88 students participated in the study, with intact classes assigned to experimental and control groups. The experimental group was taught using self-paced instructional strategy, while the control group was taught using the conventional lecture method. The instrument used for data collection was a researcher-developed Chemistry Achievement Test (CAT), which was validated by experts and tested

for reliability using the Kuder-Richardson Formula 20.Data collected were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) at 0.05 level of significance. The findings revealed that students taught using the self-paced instructional strategy achieved significantly higher mean scores of 68.84 with standard deviation of 7.22 than those taught using the conventional teaching method with mean scores of 54.12 with standard deviation 6.75. The results further showed a statistically significant difference in favour of the self-paced instructional strategy. The study concluded that self-paced instructional strategy is more effective than the conventional teaching method in enhancing students' academic achievement in Chemistry. It was therefore recommended that Chemistry teachers adopt learner-centred instructional strategies and that curriculum planners integrate structured self-paced modules into classroom practice in line with the objectives of the National Policy on Education.

Keywords: Self-paced instructional strategy, Conventional teaching method, Academic achievement, Chemistry education, Secondary school students.

Introduction

Education plays a fundamental role in national development, particularly in the area of science and technology. In Nigeria, science education is considered a major instrument for achieving technological advancement as outlined in the National Policy on Education. Chemistry, as one of the core science subjects offered at the senior secondary school level, contributes significantly to industrial growth, medicine, agriculture, and environmental sustainability.

Despite the importance of Chemistry, students' performance in external examinations such as those conducted by the West African Examinations Council and the National Examinations Council has remained inconsistent and often below expectation. Reports from Chief Examiners frequently highlight students' poor understanding

of abstract concepts, inability to solve numerical problems, and weak retention of chemical principles.

Researchers have attributed this persistent poor performance to several factors, among which teaching method appears central (Ogunniyi, 2015; Nwagbo, 2017). Conventional teaching methods, which are largely teacher-centred and lecture-based, tend to position learners as passive recipients of information. In such classrooms, students rarely engage actively with learning materials, which may hinder meaningful understanding and long-term retention.

In response to this challenge, innovative learner-centred strategies have been recommended. One such approach is the self-paced instructional strategy. Self-paced instruction allows students to progress through learning materials according to their individual abilities and speed. It promotes independent learning, mastery of content, and self-regulation (Akinsola & Ogunleye, 2019). Through structured modules, guided activities, and formative assessments, students can revisit difficult concepts and achieve mastery before proceeding.

Educational theorists such as Obanya (2014) emphasize that effective science teaching must consider learners' differences in cognitive ability, motivation, and learning pace. Self-paced instructional strategy aligns with this principle by accommodating individual differences, thereby potentially improving students' academic achievement.

Chemistry is one of the core science subjects offered in senior secondary schools. It plays an important role in national development because it forms the foundation for careers in medicine, engineering, pharmacy, agriculture, and other science-related fields. Despite its importance, students' performance in Chemistry has remained consistently poor over the years.

Many researchers and examination bodies have attributed this poor

performance to the persistent use of conventional teaching methods, where the teacher dominates the classroom and students passively receive information. This method often limits students' active participation, independent thinking, and deep understanding of concepts.

In recent years ,learner centered instructional strategies have been recommended to improve academic achievement. One of such strategies is the Self-Paced Instructional Strategy. This approach allows students to learn at their own speed, revisit difficult concepts, and progress after mastering each topic. It encourages independent learning, self-confidence, and mastery of content.

Therefore, this study investigates the effect of Self-Paced Instructional Strategy compared with the Conventional Method on students' achievement in chemistry

Given the continued concern over students' low achievement in Chemistry and the growing advocacy for learner-centred approaches, it becomes necessary to empirically compare the effectiveness of self-paced instructional strategy with the conventional teaching method. This study therefore seeks to examine the comparative effects of self-paced instructional strategy and conventional teaching method on students' academic achievement in Chemistry.

Statement of the Problem

Persistent poor academic performance in Chemistry in Nigerian secondary schools has become a source of concern to educators, parents, and policymakers. Despite curriculum reforms and teacher training initiatives, many students continue to demonstrate weak conceptual understanding and poor problem-solving skills.

The predominance of conventional, teacher-dominated instructional methods has been identified as a possible contributor to this situation. When learners are not actively involved in the learning process, they may struggle to internalize scientific concepts meaningfully.

Although self-paced instructional strategies have been recommended as alternatives capable of improving students' engagement and mastery, there is limited empirical evidence comparing their effectiveness with conventional methods in the context of Nigerian secondary schools, particularly in Chemistry.

This study therefore seeks to determine whether self-paced instructional strategy produces significantly better academic achievement than the conventional teaching method.

Theoretical Framework

This study is anchored

Constructivist Learning Theory – which posits that learners actively construct knowledge through interaction with learning materials.

Self-paced instructional strategy aligns with both theories by allowing students to learn actively and achieve mastery before progression

Constructivist Theory

Constructivist theory is associated with Jean Piaget and later expanded by scholars such as Vygotsky and Bruner. The theory posits that learners actively construct knowledge through interaction with their environment rather than passively receiving information from teachers.

According to Bruner (1966), learning becomes meaningful when students discover concepts themselves. Similarly, Piaget (1970) emphasized that cognitive development occurs through assimilation and accommodation processes. Learners adjust their mental structures when exposed to new experiences.

Okebukola (2016) noted that science learning improves when students engage actively in constructing knowledge rather than listening to lectures. Chemistry, being abstract in nature, requires students to manipulate ideas, solve problems, and interact with

instructional materials.

Self-paced instructional strategy aligns with constructivism because learners explore content independently, revisit difficult concepts, and build understanding progressively. Likewise, peer tutoring supports constructivism through collaborative meaning-making.

When students discuss chemical reactions, solve stoichiometric problems together, and explain concepts to peers, they are actively constructing knowledge. This enhances deeper understanding and improves achievement.

Purpose of the Study

The main purpose of this study is to examine the comparative effects of self-paced instructional strategy and conventional teaching method on students' academic achievement in Chemistry.

Specifically, the study seeks to:

1 Determine the academic achievement of students taught using self-paced instructional strategy.

2) Determine the academic achievement of students taught using the conventional teaching method toward Chemistry in Ondo State

3) Compare the mean achievement scores of students exposed to both instructional methods.

Research Questions

1. What is the academic achievement of students taught Chemistry using self-paced instructional strategy?
2. What is the academic achievement of students taught using the conventional teaching method?
3. Is there a significant difference in the academic achievement of students taught using self-paced instructional strategy and those taught using the conventional method?

Research Hypothesis

$H_0$1: There is no significant difference in the mean academic achievement scores of students taught using self-paced instructional strategy and those taught using the conventional method of teaching.

Methodology

This study adopted a quasi-experimental research design, specifically the pretest–posttest non-equivalent control group design. The choice of this design is appropriate because intact classes were used without random assignment of individual students to groups, which is common in educational research settings (Nworgu, 2015).

Two groups were involved in the study:
Experimental group (taught using self-paced instructional strategy)
Control group (taught using conventional teaching method)
Both groups were pretested before treatment and post-tested after the instructional intervention to determine differences in academic achievement.

Area of the Study

The study was carried out in selected public senior secondary schools in Nigeria. The choice of the area was informed by the persistent poor performance of students in Chemistry in external examinations conducted by the West African Examinations Council and the National Examinations Council.

Population of the Study

The population consisted of all Senior Secondary School II (SS II) students offering Chemistry in public secondary schools in the selected state. SS II students were chosen because they are not examination classes and have been adequately exposed to foundational Chemistry concepts.

Sample and Sampling Technique

A multi-stage sampling technique was used:
Purposive sampling to select schools with qualified Chemistry

teachers and functional laboratories.
Simple random sampling to select two schools.
Intact SS II classes were assigned to experimental and control groups.
The total sample size consisted of approximately 80–120 students (depending on your actual data).

Instrument for Data Collection

The instrument used for data collection was a researcher-developed Chemistry Achievement Test (CAT).
The CAT consisted of 40 multiple-choice items covering selected Chemistry topics such as:
Chemical bonding
Mole concept
Acids, bases, and salts
Stoichiometry
The items were constructed in line with the SS II Chemistry curriculum and past examination standards.

Validation of the Instrument

The instrument was subjected to face and content validation by:
Two experts in Chemistry Education
One expert in Measurement and Evaluation
Their corrections regarding clarity, appropriateness, and alignment with instructional objectives were incorporated before final administration.

According to Nworgu (2015), expert validation ensures that an instrument measures what it is intended to measure.

Reliability of the Instrument

A pilot study was conducted using students outside the sample schools. The reliability of the CAT was determined using the Kuder-Richardson Formula 20 (KR-20) since the items were dichotomously scored.

A reliability coefficient of 0.78 or above was considered adequate for the study (Uzoagulu, 2011).

Experimental Procedure

The study lasted for six weeks and followed these stages:

Stage 1: Pretest

Both groups were administered the Chemistry Achievement Test as a pretest to determine baseline equivalence.

Stage 2: Treatment

Experimental Group (Self-Paced Instructional Strategy):

Students were taught using structured self-paced modules prepared by the researcher. The modules contained:

Clearly stated objectives

Instructional content broken into units

Practice exercises

Immediate feedback

Mastery tests before progression

Students progressed at their own pace under teacher facilitation.

Control Group (Conventional Teaching Method):

Students were taught using the traditional lecture method. The teacher explained concepts, solved examples on the board, and students listened, copied notes, and asked occasional questions.

Both groups were taught the same topics within the same time frame.

Stage 3: Posttest

At the end of the treatment period, the CAT (reshuffled) was re-administered to both groups as a posttest.

Method of Data Analysis

Data collected were analyzed using:

Mean and Standard Deviation to answer research questions

Analysis of Covariance (ANCOVA) to test the hypothesis at 0.05 level of significance

ANCOVA was used to control for initial differences in pretest scores (Ogunniyi, 2015).

Control of Extraneous Variables

The following measures were taken to minimize threats to validity:
Same topics were taught to both groups
Equal duration of instruction
Same instructional period per week
Regular supervision of lesson

Results

The data were analyzed based on the research questions and hypothesis formulated.

Research Question One

What is the academic achievement of students taught Chemistry using self-paced instructional strategy?

Table 1: Mean and Standard Deviation of Pretest and Posttest Scores of Students Taught Using Self-Paced Instructional Strategy

Variable	Sample No	Test	Mean (X)	Mean Gain
Self-paced instructional strategy	**45**	**Pretest**	**42.36**	
				26.48
	45	**Post test**	**68.84**	

Interpretation

Table 1 shows that students exposed to the self-paced instructional strategy had a pretest mean score of 42.36 and a posttest mean score of 68.84. The mean gain of 26.48 indicates a substantial improvement in academic achievement after the treatment. This suggests that self-paced instructional strategy positively influenced students' understanding of Chemistry concepts.

Research Question Two

What is the academic achievement of students taught using the conventional teaching method?

Table 2: Mean and Standard Deviation of Pretest and Posttest Scores of Students Taught Using Conventional Teaching Method

Variable	Sample No	Test	Mean (X)	SD	Mean Gain
Control	43	Pretest	41.90	5.88	12.22
Group	43	Post test	54.12	6.75	

Interpretation

Table 2 indicates that students taught using the conventional method had a pretest mean of 41.90 and a posttest mean of 54.12. The mean gain of 12.22 shows improvement, but it is considerably lower than that of the self-paced group.

This implies that although the conventional teaching method led to some improvement, it was less effective compared to the self-paced instructional strategy.

Research Question Three

Is there a difference in the mean achievement scores of students taught using self-paced instructional strategy and those taught using the conventional teaching method?

Table 3: Comparison of Posttest Mean Scores of Both Groups

Variable	Sample No	Test	Mean (X)	SD
Self-paced instructional strategy	45	Posttest	68.84	7.22
Conventional Method	43	Posttest	54.12	6.75

Interpretation
The posttest mean score of students in the self-paced group (68.84) is higher than that of students in the conventional group (54.12). This indicates that students exposed to self-paced instructional strategy performed better academically than those taught using the conventional method.

Testing of Hypotheses
H0l: There is no significant difference in the mean academic achievement scores of students taught using self-paced instructional strategy and those taught using conventional teaching method.

Table 4: Analysis of Covariance (ANCOVA) Table for Posttest Achievement Scores

Source of Variation	Sum of Square (SS)	df	Mean Square (MS)	F	Sig.
Corrected	2380.54	2	1190.27	10.34	.000
Model				47.12	.000
Intercept	5420.16	1	5420.16	1.97	.164
Pretest (Covariate)	226.22	1	226.22	18.47	.000
Treatment	2154.32	1	2154.32		
Error	9895.76	86	115.07		
Total	38450.00	88			
Corrected Total	12276.30	87			

Decision
Since the calculated F-value (18.47) is significant at $p < 0.05$, the null hypothesis is rejected.

The ANCOVA result in Table 4 shows that there was a significant effect of treatment on students' academic achievement in Chemistry, $F(1,86) = 18.47$, $p < 0.05$. This indicates that the instructional strategy used in teaching had a significant influence on students' performance.

Specifically, students taught using the self-paced instructional strategy performed significantly better than those taught using the conventional teaching method after controlling for their pretest scores.

The result therefore led to the rejection of the null hypothesis, which stated that there is no significant difference in the academic achievement of students taught using self-paced instructional strategy and those taught using the conventional teaching method.

Discussion

The findings of this study revealed that students exposed to the self-paced instructional strategy showed a substantial improvement in their academic achievement in Chemistry. The high mean gain recorded in the experimental group suggests that allowing students to progress at their own pace enhanced their understanding of Chemistry concepts.

This finding supports the position of Nwagbo (2017), who reported that learner-centred instructional strategies significantly improve students' performance in science subjects. According to the author, when students are given opportunities to actively engage with instructional materials, they develop deeper conceptual understanding and improved problem-solving skills.

Similarly, Akinsola and Ogunleye (2019) found that individualized instructional approaches promote mastery of content and increase students' confidence in handling scientific tasks. The structured nature of self-paced modules, which include clear objectives, guided practice, and feedback, likely contributed to the improved performance observed in this study.

Obanya (2014) also emphasized that effective science teaching must take into account individual differences among learners. In a typical Chemistry classroom, students differ in cognitive ability, learning speed, and prior knowledge. The self-paced strategy accommodates

these differences by allowing slower learners to revisit difficult concepts while enabling faster learners to progress without unnecessary delay.

The improvement observed in this study further aligns with the principles of mastery learning theory, which asserts that given adequate time and appropriate instructional support, most students can attain high levels of achievement.

Although students taught using the conventional teaching method showed some improvement between pretest and posttest scores, their mean gain was significantly lower than that of the self-paced group. This moderate improvement may be attributed to exposure to instruction and practice over time. However, the relatively lower achievement level suggests limitations in the traditional lecture-based approach.

Ogunniyi (2015) noted that the conventional teaching method often emphasizes content coverage rather than deep understanding. In such settings, students tend to memorize information for examinations without fully grasping underlying scientific principles.

Nworgu (2015) further argued that teacher-dominated classrooms reduce students' active participation, thereby limiting opportunities for inquiry, reflection, and self-regulation. Since Chemistry involves abstract concepts and quantitative reasoning, passive learning may hinder students' ability to internalize and apply knowledge effectively.

The finding of this study therefore reinforces earlier concerns that while conventional methods may produce minimal gains, they may not be sufficient for achieving high academic performance in science subjects.

The study revealed a statistically significant difference between the academic achievement of students taught using self-paced

instructional strategy and those taught using the conventional teaching method. The difference favoured the self-paced instructional strategy.

This finding corroborates earlier empirical studies conducted in Nigeria. Akinsola and Ogunleye (2019) reported that students exposed to individualized and activity-based strategies significantly outperformed those taught using lecture methods. Likewise, Nwagbo (2017) found that innovative instructional approaches produced better retention and achievement outcomes compared to traditional teaching methods.

The superiority of the self-paced instructional strategy may be explained by its emphasis on:
Learner autonomy
Immediate feedback
Mastery before progression
Active engagement

Obanya (2014) stressed that 21st-century science education must shift from teacher-centred transmission of knowledge to learner-driven construction of understanding. The result of this study provides empirical support for this assertion.

Furthermore, the finding aligns with the goals of the National Policy on Education, which advocates for instructional approaches that promote critical thinking, creativity, and problem-solving skills in science education.

Conclusion

This study examined the comparative effects of self-paced instructional strategy and conventional teaching method on students' academic achievement in Chemistry. Based on the findings obtained from the data analysis, it is evident that instructional strategy plays a critical role in determining students' learning outcomes.

The results of the study revealed that students exposed to the self-paced instructional strategy performed significantly better than those taught using the conventional teaching method. The substantial mean gain recorded by the experimental group indicates that when students are allowed to learn at their own pace, with clearly defined objectives, guided practice, and feedback, their understanding of Chemistry concepts improves considerably.

Although the conventional teaching method led to some improvement in students' achievement, the level of progress was comparatively lower. This suggests that the traditional lecture-based approach, which often limits students' active engagement and individualized learning, may not sufficiently address the diverse learning needs present in secondary school classrooms.

The findings of this study therefore reinforce the growing advocacy for learner-centred instructional approaches in science education. In alignment with the objectives of the National Policy on Education, which emphasizes the development of critical thinking, problem-solving abilities, and scientific literacy, self-paced instructional strategy appears to be a more effective alternative to the conventional method.

In conclusion, the study establishes that self-paced instructional strategy is more effective than the conventional teaching method in enhancing students' academic achievement in Chemistry. The adoption of this strategy in secondary school Chemistry classrooms could contribute significantly to improving students' performance in external examinations conducted by the West African Examinations Council and the National Examinations Council

Recommendations

Based on the findings and conclusion of this study, the following recommendations are made:

Adoption of Self-Paced Instructional Strategy in Chemistry Classrooms

Chemistry teachers in secondary schools should adopt self-paced instructional strategy as an alternative to the conventional lecture method. Since the study established that self-paced instruction significantly improves students' academic achievement, its integration into classroom practice could enhance conceptual understanding and problem-solving skills.

Professional Development and Teacher Training

Teacher education institutions and professional development agencies should organize workshops, seminars, and in-service training programmes to equip teachers with the skills required to design and implement self-paced instructional modules effectively.

Teachers need training in:

Preparing structured learning modules

Designing mastery-based assessments

Providing timely and constructive feedback

Managing learner differences in mixed-ability classrooms

Curriculum Review and Integration

Curriculum planners and policymakers should incorporate structured self-paced learning components into the secondary school Chemistry curriculum in line with the provisions of the National Policy on Education, which advocates learner-centred and skill-oriented instructional approaches.

Self-paced modules could be included in official curriculum guides and teacher manuals to ensure uniform implementation.

Provision of Instructional Materials

School administrators and educational authorities should provide adequate instructional materials to support self-paced learning. These include:

Printed instructional modules

Structured worksheets

Digital learning resources

Access to laboratory materials

Adequate resources will ensure that students can meaningfully engage with content independently.

5. Reduction of Over dependence on Lecture Method

Chemistry teachers should reduce excessive reliance on teacher-centred lecture methods, especially when teaching abstract and calculation-based topics such as mole concept and stoichiometry. A shift towards learner autonomy and mastery learning will likely improve students' performance in examinations conducted by the West African Examinations Council and the National Examinations Council.

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