



Effects of Multilingual Teaching Strategy on Performance and Retention of Physics Students among Science and Technical Secondary Schools of Sokoto State, Nigeria

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Abstract

This paper investigated the effects of multilingual teaching strategy on performance and retention of physics students in science and technical secondary schools of Sokoto State. The low performance of students in physics examinations attributed to the complexity of some physics concepts among other factors prompted the study. Two objectives, two corresponding research questions and two hypotheses guided the study. Quasi-experimental design involving pre-test, post-test, experimental and control groups was used. Population was nine hundred and fifteen (915) SS1 students from ten (10) public science and technical secondary schools of the state. 267 students were selected using cluster and random sampling, comprising one intact class from each of the six educational zones of the state. The sample was divided into experimental and control groups comprising three schools each. Two instruments were used for collecting data, namely; Physics Performance Test and Retention Test (re-shuffled performance test). The instruments were validated; their reliability was found to be 0.84. It was found that experimental groups taught using CRT performed and retained physics concepts better than control taught using TLI. It was concluded that multilingual teaching strategy has more effect on performance and retention. It was recommended among others that teachers need to integrate learner's native language and culture in teaching physics for better performance and retention in physics.

Keywords: multilingual teaching strategy, traditional language of instruction, performance, retention, students

1 Introduction

The importance of physics in general science education as well as science and technological development of any nation or society cannot be over-emphasized. Nigerian Educational Research and Development Council(2017) reported that science education plays a crucial role in shaping the countries technological and economic development. It includes the teaching of various disciplines such as Biology, physics and chemistry. Physics as a branch of physical science deals with the study of matter in relation to energy. Hossain (2026) reported that physics plays a vital role in driving rapid growth and reshaping global development in science and technology in 21st century, especially in areas of Compton computing, semiconductors, lasers and medical imaging systems. Despite the importance of physics, it is regarded as one of the difficult subjects because of the abstractness of some of its concepts among other reasons. Furthermore, Ajayi et al., (2021) reported that low students' enrolment in physics and low performance is attributed to poor science, mathematics background, scientific language of communication, poor motivation of teachers, inappropriate teaching strategies, poorly equipped laboratories and insufficient number of qualified teachers among others. These factors equally lead to loss of interest and decline in students' performance in physics.

Multilingual teaching strategy refers to the use of more than one language in teaching a body of knowledge. It is also the integration of learner's language to prescribe language of instruction for better understanding of concepts. Multilingualism has been a prevalent issue in our increasingly globalized world. According to Adeniyi et al., (2024) linguistic diversity can present significant challenges for multilingual students. Alhamed et al., (2024) reported that multilingual students often face language barriers that can hinder their understanding of complex scientific concepts. The language of instruction may not be their first language, leading to difficulties in comprehending technical terminologies and academic texts. Gameson and Morales (2024) reported that multilingual students face additional challenges beyond language barriers by experiencing cultural differences that impact their learning experience in STEM subjects. For example, certain cultural norms or educational practices may differ with these in mainstream educational system leading to misunderstanding or difficulties in adopting a new learning environment. There are several multilingual approaches that can be used, among which are;

Content and Language Integrated Learning(which involve teaching language and content at the same time) and Culturally Responsive Teaching (CRT) (which involve teaching concepts in learner's language and culture).

Moreover, other methods of multilingual teaching strategies include; translanguaging (which enable students to use full linguistic toolkit to clarify difficult concepts and boost learner confidence). Multilingual media (which are digital tools and translated materials, that enable learners to revisit complex content and foster independent knowledge acquisition). Some of the benefits of multilingual teaching strategies include; (a) Long-term performance (b) Metalinguistics awareness ; using multiple languages strengthens students capacity to analyses language structures and improve critical thinking and performance. (c) Socio-economic buffer; multilingual group participation can help in reducing negative effects of socio-economic status on academic progress. Other benefits of multilingual teaching strategies include; improvement of cognitive development, boosting academic engagement and fostering social inclusion. Some of the challenges of multilingual teaching strategy includes; (a) Teacher constraints(traditional training often leaves educators reliant on rigid, monolingual methods rather than adaptive multilingual frameworks. (b) Resource gaps (missing of bilingual materials and institutional backing requires effective implementation).

Performance is defined by Mustapha and Ahmad (2024) as the ability of students to apply acquired knowledge, complete tasks and demonstrate understanding effectively. They also reported that instructional strategies improve achievement in science. Retention is the ability of learners to remember and reproduce previously learned materials after a period of time. It showed the lasting effect of instruction beyond immediate learning outcomes. The problem that prompted the study is the poor performance of some secondary school students in physics and inability of some students to apply or recall the learned facts after a period of time. This is evident from preliminary investigations conducted through interviews with teachers and students at some secondary schools. Also, few research conducted in the area of language related effects in physics despite complaints of complexity of some scientific language prompted the study. This study is different from reviewed studies in relating two dependent variables i.e performance and retention at the same time and geographical locations of where the reviewed studies and present one are conducted. This study therefore intends to fill the existing gap of low number of language related research conducted in physics and investigate the effects of Culturally Responsive Teaching approach of multilingual strategy on students' performance and retention in physics among science and technical secondary schools of Sokoto state. The objectives and research questions that guided the study include; determination of difference between performance of students taught using Culturally Responsive Teaching and those taught using Traditional Language of Instruction and determination of difference between the retention ability of students taught using Culturally Responsive Teaching and those taught using Traditional Language of Instruction among science and technical secondary schools of Sokoto state. The two objectives were also the basis on which two hypotheses were formulated for testing at 0.05 level of significance. The findings of the study will be of benefit to government and education stakeholders in seeing the effect or otherwise of the strategy and decide whether to integrate it in curriculum or not. It will also benefit teachers and students in improving performance and retention as well as teaching objectives.

2 Literature Review

Some of the theories guiding this study is Linguistics interdependence theory by Jim Cummins, Socio-cultural theory by Lev Vygotsky constructivist theory and translanguaging pedagogy. These frameworks showed that students' home language builds a strong base for learning new languages and complex ideas.

Linguistics Interdependence Theory: Jim Cummins uses an iceberg analogy to show that a common underlying proficiency links all languages, meaning skills learned in native language transfer to a second language. The theory states that a person's first language and second language are connected. Skills, concepts and literacy learned in the first language transfer to the second language, because both languages share a central cognitive foundation. The theory is relevant to this study, as students' native language was used in teaching experimental group to assess its effects in understanding physics in second language of instruction.

Sociocultural Theory: Developed by Soviet psychologist, Lev Vygotsky states that learning is a social process where language acts as a primary tool for thought, making the zone of proximal development vital for guided peer and teacher interactions. The theory states that cognitive development is a social process. Learning happens first through social interaction with others and is then internalized by the individual, culture, language and guidance from mentors to shape how persons think and learn. According to the theory people learn through social interaction and cultural influence. The theory is also relevant to this study, as culturally responsive teaching is used in teaching experimental groups, to assess the effect of integrating learner's native language and culture on retention and performance.

Translanguaging Theory: This framework views a students' entire linguistic system as one integrated repertoire, allowing flexible movement between languages to deepen comprehension and ease expression. The theory is also relevant to present study, as learner's native language was used in clarifying physics concepts presented in language of instruction, to assess its effects on performance and retention of experimental students.

Constructivist theory: This views learners as active participants in the construction and evaluation of learning process (Shepard, 2000). This can only be achieved if learner clearly understands the knowledge, possibly by using his native language and culture. The theory is also relevant, as students's native language and culture were used to make experimental groups actively involved in learning process.

Asset-Based pedagogy: This approach values the cultural and linguistic knowledge students bring to school, treating diverse backgrounds as strengths rather than barriers to academic success. The pedagogy is also relevant to present study as learner's language and culture was integrated in school's learning.

Some of the research conducted in multilingualism, includes Farayola et al. (2024) who reported that, one of the earliest efforts to addressing linguistic diversity in science education can be traced back to 1960s and 1970s with emergence of bilingual education program in united states. The program aims to provide instruction in students native language when gradually transitioning them to English, allowing them to develop proficiency while learning STEM subjects. However, those programs face challenges such as funding and lack of support, leading to their decline in 1980s and 1990s. The effort is similar to present research in using multilingual approach, but geographical locations, i.e., United state and Nigeria as well as periods of study i.e 1960 and 2026, also non-inclusion of investigating interest and retention are the difference. Moreover, Joduth and Faola (2024) investigated the benefit of multilingualism to the personal and professional developments of the residents of United state. The result revealed that multilingualism change understanding of the consequences of learning and use of two or more language for the cognition, for the brain and wellbeing across the life span far from stereotype, they also reported that, exposure to multilingualism at infancy stage complicate language and cognitive development, the finding also revealed that individual benefit from that exposure with openness to other language and to new learning itself. The study is relevant to present one in investigating effects of multilingualism, but the study paid more attention to personal life and health than educational performance, interest and retention, which make the difference. Muzalina and Tangire (2025) investigated the impact of multilingualism on cognitive development and academic performance among secondary schools in south Kivu, Democratic republic of Congo, employing quantitative research design, the study used 102 sample of students for both monolingual and bilingual groups. The finding revealed that bilingual students outperform monolingual students in academic performance, however bilingual students reported high level of cognitive failures, including forgetfulness. The study is relevant to present one in investigating effects of language barrier, but no investigation of interest makes the difference.

Robert, Anderia, Rolsi and Micheal (2024) examine the impact of multilingualism and socio-economic status in United Kingdom. Utilizing data from 3,213 pupils from National pupil's database. They employed multilevel modeling to analyse the relation between language experience, key stage 1(11years) and key stage 4(16years) performance in English, Math and Science. Findings revealed that multilingual learners initially face challenge particularly in English and Science but achieve comparable result and excel beyond their monolingual counterparts and achieve long-term benefits. The study is relevant to present one in investigating effects of language, but non investigating interest and geographical locations of the two research are different. Similarly, Francis, Gabriel and Aneidi (2023) conducted a study assessing the impact of ICT-Based teaching methodology(vedio-taped instruction and PowerPoint presentations) on academic performance and retention of secondary school students in physics. The study was conducted in Cross Rivers state, Nigeria. Quasi-experimental design using non-randomised pre-test and post-test control group. The sample of the study was 176 SS2 students drawn from four intact classes of four secondary schools in the study area. Physics Achievement Test (PAT) with a reliability coefficient of 0.85 was used for data collection. Means and Analysis of Covariance (ANCOVA) was used in the treatment of the data obtained. The result of the study showed that there was a significant difference in the academic performance and retention of students taught using video-taped instruction and those taught using power-point presentations. Findings of the study showed that students taught using video-taped instruction had higher academic performance and retention than those taught using power-point presentations. The study concluded that the use of blended ICT-Based subject methods can improve learner's performance and retention. The study is relevant to present one in investigating effects on performance and retention as dependent variables, but the independent variables of reviewed study (ICT-Based teaching methodology and that of present study(multilingualism) make the difference.

Daniel and Universidad (2022) conducted research on relationship between school retention and performance, academic self-concept and goal orientation of secondary school students of Canary Island, Spain. Longitudinal design was used, a

sample of 1326 students were randomly selected and evaluated for 18 months. The result of the study showed negative effect of grade retention on academic performance and motivational variables. The capacity of previous performance, academic self-concept and goal orientation predict grade retention. The study is relevant to present study in investigating relationship between retention and performance, but the type of retention investigated in reviewed study is school retention while the present study investigated concepts retention. Also, the reviewed study was conducted in Spain which has different educational system with Nigeria. Moreover, Maimuna, Aminu and Ibrahim (2024) investigated the effect of Brain-Based learning strategy on academic performance and retention among secondary school Geography students in Katsina State, Nigeria. Four research objectives and four null hypotheses guided the study. Quasi-experimental research design was used. The population comprised of 6,623 Geography students from 21 public secondary schools in Katsina Zonal Education Quality Assurance. 122 students from 2 intact classes of SS2 were sampled for the study using cluster sampling technique. A validated Geography Performance Test was used for data collection with reliability coefficient of 0.82. The mean performance and retention level between those taught using Brain-Based learning strategy and those taught using lecture method, the study concluded that, students taught Geography using Brain-Based learning performed significantly better than those taught using lecture method and that brain-based learning is gender-friendly. The study recommended among others that Geography teachers should adopt the use of brain-based learning to improve students' academic performance and retention. The study is similar to present one in investigating effects on performance and retention as dependent variables with Brain-Based learning as teaching strategy and independent variable. While the present study multilingual teaching strategy as dependent variable. Among all the reviewed research, only one investigated effect on physics performance, while none of them investigated effects of multilingualism on performance, interest and retention together, which are the key steps of achieving objectives and assumptions of every lesson as well as constructivism theory. Also, among all the reviewed research, none is conducted in Sokoto state, which indicated the need for the study and this study fills the gap.

3 Material and Method

3.1 Research Design

The design adopted for the study is quasi experimental involving pre-test, post-test, experimental and control group design.

3.2 Population/sample

The population of the study is 915 SS1 students from 10 science and technical secondary schools of sokoto state. 267 students were selected using cluster sampling, comprising one intact class from each of the six educational zones of the state, comprising 47 from OOTC Bafarawa, 43 from G.S.S.S Yabo, 41 from G.S.S.S Gwadabawa, 47 from GTC Runjin sambo, 48 from G.G.C Sokoto, and 41 from GTC farfaru. The sample was divided into three experimental (namely OOTC Bafarawa, GSSS Yabo and GSSS Gwadabawa) totaling 131, while GGC Sokoto, GTC R/sambo and GTC Farfaru are the control groups, totalling 136. The experimental group were treated using Culturally Responsive Teaching after pretest on performance, while control group were treated using Traditional Language of Instruction after pretest on performance.

3.3 Instruments

Two instruments were used for collecting data, namely; Physics Performance Test and Physics Retention Test(which is re-shuffled Performance test). Performance test was administered to both groups to determine their performance before treatment, after which experimental group were treated using Culturally Responsive Teaching, while control group were taught using Traditional Language of Instruction, for six weeks each. Both groups were administered with post-performance test, to ascertain their effects on performance. The instruments were validated by a team of experts comprising University senior lecturer from physics department and experienced secondary school physics teacher . The reliability of the instrument was determine using pilot test result of intact class of SS1 secondary school students. The students were re-tested after one week, the result was analysed using Pearson Product Moment Correlation and measure of equivalence, a reliability of 0.84 was obtained for PPT and PRT respectively.

3.4 Data Collection Procedure and Analysis

The students' performance in Post-performance were recorded, mean scores of experimental and control groups were computed and presented using mean and standard deviation as answer to research question one, which was also analysed using independent sample t-test to answer null hypothesis one. Mean scores of each group in Retention test were also presented using mean and standard deviation to answer research question two, which was analysed using independent-sample t-test to answer null hypothesis two. Independent sample test was chosen because of its suitability in testing significant difference between the group means of two completely unrelated independent groups, using continuous dependent variables. The core justifications of research design, include; when using two distinct groups i.e your independent variables split participants into two separate, mutually exclusive categories e.g. control and experimental or males and females. Or when independent observations were made, i.e. subjects in one group are entirely unrelated to and unaffected by subjects in the other group. Or continuous outcome, i.e. the dependent variable is measured on continuous scale, meaning interval or ratio data, e.g. test-scores, wait or reaction time. The present study satisfied all the listed justifications for using independent sample t-test. Moreover, some of the statistical assumptions and flexibility of independent sample t-test includes; Normality, i.e. the dependent variable, should be roughly and normally distributed within each group. However, the test is robust against moderate departures from normality if sample size is reasonable. Secondly, homogeneity of variance, which assumes equal variances between groups. If this assumption fails, you can justify using Welch's t-test instead, which safely handles unequal variance and sample size without pooling variance. The present study has normally distributed data within each group and assumed equal variance between groups, which satisfied the usage of independent sample t-test for analyzing the data collected between experimental and control groups.

4 Results

The results are presented on the basis of Answering Research question and null hypotheses.

Research Question 1. What is the difference between the mean performance scores of experimental and control groups in physics among science and technical secondary schools of Sokoto state.

The mean performance scores in post-test are presented in Table 1.

Table 1

Mean performance scores of Experimental and Control groups

Groups	Treatment	N	Mean	S.D	Mean difference
Experimental	CRT	131	31.80	18.91	8.15.
Control Group	TLI	136	23.65	15.27	
Total		267			

Source; Field work, 2026

Table 1 showed that experimental group taught using CRT had a higher post-test mean performance score of 31.80 and standard deviation of 18.91 than the control group which has a mean score of 23.65 and standard deviation of 15.27. The mean difference of 8.15 indicates that students in experimental group perform better than those in control group by 8.15 points at posttest. This suggests that, the instructional strategy used with experimental group, i.e Culturally Responsive Teaching is more effective in improving academic performance than Traditional Language of Instruction used for control group. However, the statistical significance of this difference was determined by using independent sample t-test results.

Research Question 2; What is the difference in mean retention scores between experimental and control groups in physics among science and technical secondary schools in Sokoto state?

The mean retention scores of experimental and control groups in physics are presented in Table 2.

Table 2

Mean retention scores of experimental and control groups

Groups	Treatment	N	Mean	S.D	Mean diff
Experimental	CRT	131	27.32	21.32	11.41
Control	TLI	136	38.73	17.00	

Source; FIELD WORK, 2026

Table 2 showed that students in the experimental group obtained higher mean retention scores of 38.73 and standard deviation of 21.32. While control group has a mean of 27.32 and standard deviation of 17.00. The mean difference of 11.41 indicates that experimental group had higher retention score after one week of posttest. The descriptive result indicates that the instructional strategy used for experimental groups, i.e. Culturally Responsive Teaching was more effective in enhancing retention of physics concepts than students taught using Traditional Language of Instruction. However, the statistical significance of this observed difference was determined using independent sample t-test.

Testing Null Hypothesis 1

There is no significant difference between the mean performance scores of experimental and control groups.

The mean performance scores of experimental and control groups were subjected to independent t-test for testing difference and is presented in Table 3.

Table 3

Summary of Independent T-test result on difference between performance of experimental and control groups

Group	N	Mean	Std dev.	Std Error mean	T-Value	Df	P-Value	Decision
Experimental	131	31.80	18.91	1.659	-3.873	265	0.001	Reject Ho
Control	136	23.65	15.27	1.310				
Total	267							

Source; Field work, 2026.

Table 3 shows that the experimental group had a higher posttest performance mean score of 31.80 and standard deviation of 18.91, while control group had a mean of 23.65 and standard deviation of 15.27 with a mean difference of 8.15 points. The independent sample t-test revealed a statistically significant difference of between the two groups, $t(265) = -3.873$, $p = 0.001$. Since the p-value is less than 0.05, the difference is statistically significant. Therefore, the null hypothesis stating: There is no significant difference between the posttest mean performance scores of experimental and control group is rejected. This indicated that, students in the experimental group performed significantly better than those in control group after intervention.

Null hypothesis 2: There is no significant difference between the mean retention scores of experimental and control groups.

The mean retention scores are subjected to independent sample t-test for testing difference, and is presented in Table 4.

Table 4

Summary of Independent T-test Result on difference between retention scores of experimental and control groups

Group	N	Mean	Std Dev	Std Error mean	T-Value	df	P-value	Decision
Experimental	131	38.73	21.32	1.86	-5.06	265	.001	Reject Ho
Control	136	27.32	17.00	1.46				
Total	267							

Source: Field work, 2026

Table 4 shows that students in the experimental group had a higher retention mean score of 38.73 and standard deviation of 21.32 than control group students with mean score of 27.32 and standard deviation of 17.00. The mean difference of 11.2 indicates that students exposed to experimental treatment retained more of the learned contents than control group

taught using traditional language of instruction. The independent sample t-test revealed a statistically significant difference between the retention scores of the two groups, $t(265) = -5.06$, $p = 0.001$. Since the p-value is less than 0.05 significant level, the null hypothesis is rejected. Therefore, there is statistically significant difference between the retention scores of students in experimental and control group, with experimental group demonstrating better retention.

5 Summary of Findings

There is significant difference between the performance scores of experimental and control groups in physics in favour of experimental groups. There is significant difference between the retention scores of experimental and control groups in physics, in favour of experimental group.

6 Discussion

The findings of research question one and null hypothesis one presented in Tables 1 and 3, indicated significant difference in performance of experimental and control groups in favour of experimental groups conform with the finding of Muzalina and Tangire (2025) who found that bilingual students outperform their monolingual peers in academic performance. The findings of research question two and null hypothesis two, presented in Tables two and four indicated that, there is significant difference between the retention scores of experimental and control groups in favour of experimental group, conform with the finding of Robert, Anderia, Rolsi and Micheal (2024) who found that, multilingual students excel more than their monolingual counterparts and achieve significant long term academic benefits (retention). The finding contradicts the report of Muzalina and Tangire(2025) who found that bilingual students reported high level of cognitive failures including forgetfulness. Some of the limitations of this study are; Non coverage of performance in practical aspect of physics, which may affect generalization of the findings on performance, interest and retention in physics. It is suggested that future researchers should investigate the effect of multilingualism on practical physics, for better generalization of finding.

7 Conclusions

It has been concluded that Culturally Responsive Teaching of multilingual teaching strategy improves the performance and retention of physics students in science and technical secondary schools of Sokoto state, compared to Traditional Language of Instruction. This answered the research questions and null hypotheses tested at 0.05 level of significance, that significant difference exists between the performance and retention of experimental and control students in favour of experimental group. This will contribute to knowledge by providing information on need to integrate learner's native language and culture in teaching physics, to achieve better performance and retention.

8 Recommendations

- I. It is recommended that government and policy makers should enforce learner's related language and culture in teaching physics, for better performance and retention.
- II. Physics textbooks should be published and provided in learner's related languages and cultures.
- III. Teachers should comply and integrate learners' related languages in teaching physics topics.

9 Declarations

Acknowledgement/Funding: I wish to acknowledge and appreciate the funding of this research by Tertiary Education Trust Fund (TETFUND) through the management of Shehu Shagari University of Education, Sokoto. I also acknowledge the support of managements and students of all my sample schools to the successful completion of this research. I also wish to use the opportunity to thank Prof S.S Bichi (Who External Examine my M.ED and Ph.D dissertations at U.D.U Sokoto in 2011 and 2021 respectively) Wishing him success in his future endeavors.

Ethical Statements: The permissions of the managements of the sample schools was solicited through notification and introduction letters signed by the Head of Department of the first author. The letters were presented to all principals of the

sample schools, who permitted the data collections and interactions with their students, through heads of physics departments of their schools. The co- author wishes to notify that, data was authoritatively collected in the presence of physics teachers of the sample schools, visitors books of the schools were also signed by the co-author on the day of the visit.

Conflict of Interest: The authors declare neither financial no non-financial conflict of interest.

Author's Contribution: The authors participated in all stages of the study, to ensure accurate and reliable data for the development of academic community.

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