

Effect of Teachers' Instructional Competence on Students' Achievement and Acquisition of Science Process Skills in Basic Science and Technology in Nasarawa State, Nigeria

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Abstract

This study investigated the crucial role of teachers' instructional competence in influencing both students' academic achievement and acquisition of science process skills within basic science and technology education. The study employed a correlational design with 368 participants from five public secondary schools in Nasarawa State, Nigeria. Three instruments were used for data collection: Instructional Competence Scale (ICS), Science Process Skill Observation Scale (SPSOS), and a student Basic Science Achievement Proforma. The results revealed a highly significant positive relationship between teachers' instructional competence and students' achievement in Basic Science and Technology ($r = 0.99, p < 0.05$). Similarly, a strong positive relationship was found between teachers' instructional competence and students' acquisition of science process skills ($r = 0.84, p < 0.05$). Furthermore, a statistically significant positive relationship ($p < 0.05$) was observed among teachers' instructional competence, students' academic achievement, and the acquisition of science process skills. These findings highlight the critical influence of teachers' instructional competence on students learning outcomes in basic science and technology. The study recommends comprehensive training programs, regular professional development opportunities, and mentorship programs to equip teachers with the necessary knowledge, skills, and strategies to effectively facilitate student learning and skill acquisition.

Keywords: Teachers' instructional competence, Student academic achievement, Science process skills, Basic science, and technology education.

Introduction

Basic Science and Technology formerly referred to as Integrated Science, serves as the initial science subject introduced to primary and junior secondary school students. It is considered the cornerstone of all sciences, engineering, and technology at the senior secondary school level, representing an undifferentiated course aimed at demonstrating the unity, wholeness, and interrelationship of scientific disciplines (Eya et al., 2021). In Nigeria, greater emphasis has been placed on science education because it is believed to be the only avenue for national development. However, this can only be achieved if students are actively involved in the academic activities which will enhance their academic achievement. Academic achievement has been defined as students' knowledge, skills and study habits in a training course and the effectiveness of their application to their work. Ince (2023) explained that academic achievement is the progress made towards the goal of acquiring educational skills, materials, and knowledge, usually spanning a variety of disciplines.

Acquiring the educational skills, abilities, and attitudes necessary for conceptual learning depends on mastering science process skills. Science process skills include aptitudes, potentials, and technical expertise that may be developed via practice and applied to mental processes and bodily movements (Nasution, Al-Muhdhar, & Sari, 2023). Science process skills refer to the abilities and technical know-how developed through experience, enabling students to perform mental operations and physical actions on their own. Acquiring science process skills empowers learners to explore their environment and tackle challenging problems encountered in their surroundings. To improve students' academic achievement in Basic Science and Technology and by implication, their acquisition of basic science process skills; the instructional competency of the teacher, needs to be examined.

Instructional competence refers to the abilities, knowledge, skills, and attitudes that enable teachers to effectively plan, deliver and assess teaching to facilitate student learning. It's a multifaceted concept encompassing various aspects of teaching practice, and it's important for ensuring that students reach their full potential. Instructional competence in the teaching profession is about excelling in tasks, not merely completing them. It's a blend of knowledge, skills, attitudes, and experiences, specifically tailored to the educator's profession (Palaming, 2023). Blömeke, et al (2022) highlights how these competencies directly impact learners and emphasizes their crucial role in fostering meaningful science literacy, encompassing understanding, knowledge, and skill development in the subject.

Some key components of teachers' instructional competencies as enumerated by Albarra et al 2022) include:

1. Content Knowledge: Content knowledge, also known as subject matter knowledge, refers to the deep understanding and mastery of the specific subject area a teacher teaches. It's the foundation upon which effective teaching is built. It's a deep comprehension of the subject matter they teach, encompassing:

- i. Factual knowledge - Understanding the key concepts, theories, principles, and data within the subject area.
- ii. Procedural knowledge - Knowing how to apply their knowledge to solve problems, analyze information, and draw conclusions.
- iii. Conceptual understanding - Being able to explain the "why" and "how" behind the facts, connecting different concepts, and seeing the bigger picture.
- iv. Metacognitive knowledge - Understanding how knowledge is constructed and used, reflecting on their own understanding, and guiding students to do the same.

Imagine a teacher standing before a classroom, brimming with enthusiasm but unable to answer their students' questions with confidence. Frustration brews on both sides, the spark of learning flickering out. This, unfortunately, can be the consequence of weak content knowledge – the bedrock of effective teaching. But why is it so crucial?

Firstly, consider the teacher who has mastered their subject. They explain concepts with clarity and depth, weaving stories and insights that resonate with students. No more fumbling for answers - they confidently address misconceptions, leaving knowledge gaps filled with understanding. This builds trust and fosters a classroom where questions are encouraged, not feared. But effective teaching transcends mere facts. A teacher with strong content knowledge possesses the magic

wand of engaging lessons. They effortlessly draw connections between seemingly disparate topics, revealing the fascinating tapestry of their subject. They bridge the gap between abstract ideas and real-world application, sparking curiosity and igniting a desire to learn more.

Furthermore, content knowledge empowers teachers to guide students beyond rote memorization. They become architects of critical thinking, crafting challenges that encourage problem-solving and analysis. Students dissect information, weigh evidence, and draw their own conclusions, actively participating in the construction of knowledge rather than passively receiving it. And finally, a teacher's content knowledge becomes their superpower for adaptability. They understand the nuances of their subject, allowing them to tailor their teaching to diverse learning styles and needs. This differentiated instruction ensures that each student, regardless of background or preference, could thrive.

In essence, strong content knowledge equips teachers to be more than just dispensers of facts; they become guides, mentors, and co-explorers on the journey of learning. They ignite curiosity, cultivate critical thinking, and empower students to become life-long learners. So, the next time you see a teacher confidently navigating their subject, remember, they hold the key to unlocking a world of knowledge and potential for their students.

2. Pedagogical Knowledge: Simply put, is the understanding and skillset required to effectively design, deliver, and assess instruction. It's the art of knowing how to teach, going beyond subject matter expertise, and delving into the intricate world of student engagement, learning styles, and classroom management. Here are some key aspects of pedagogical knowledge as enumerate by Mohammed, Ibitoye, & Haruna (2024):

- i. **Knowledge of Students** - Understanding child development and learning theories: Teachers who grasp how children learn at different stages can tailor their teaching accordingly. Recognizing diverse learning styles and needs: Effective educators cater to individual differences, ensuring all students have access to meaningful learning experiences. Creating a positive and inclusive classroom environment: Fostering a supportive and respectful atmosphere is crucial for optimal learning.
- ii. **Instructional Design and Delivery** - Developing engaging and well-structured lesson plans: Planning ensures clear learning objectives, effective use of time, and integration of diverse teaching methods. Employing a variety of teaching strategies: From lectures and discussions to simulations and collaborative activities, effective teachers adapt their methods to suit the content and students. Mastering questioning techniques: Asking open-ended and thought-provoking questions prompts critical thinking and deepens understanding.
- iii. **Assessment and Feedback** - Designing assessments that correspond with learning objectives, providing effective and timely feedback; Constructive feedback guides students towards improvement and reinforces understanding. Using assessment data to inform instruction: Analyzing data allows teachers to identify areas where students need additional support and adjust their teaching methods accordingly.
- iv. **Classroom Management** - Establishing clear expectations and routines: Consistent routines create a predictable and structured learning environment. Managing disruptive behavior: Effective teachers can address distractions

constructively while maintaining a positive classroom climate. Promoting positive student interactions: Encouraging collaboration and respect among students fosters a strong learning community.

Pedagogical knowledge evolves through continuous learning, reflection, and experimentation. By building their knowledge in these areas, teachers can unlock the magic of effective instruction and empower their students to reach their full potential.

3. Planning and Assessment: Planning and assessment are two intricately linked aspects of teachers' instructional competence. They represent the foundation and the feedback loop in a cycle of effective teaching and learning. Süral (2019) enumerate and explain the two concepts into their roles as: Planning - Building the Road to Learning and Assessment - Measuring and Guiding Progress

A competent teacher starts by establishing what students should know, understand, and be able to do by the end of a lesson, unit, or course. Establishing these objectives provide a roadmap for the entire learning journey of a competent teacher. Based on the objectives, teachers choose appropriate instructional strategies, considering diverse learning styles and needs. This may involve lectures, discussions, simulations, group activities, or technology-integrated approaches. These plans outline the sequence of activities, resources, and assessments used to achieve the objectives. They ensure efficient use of time, clear transitions, and a logical flow of learning. Competent teachers foresee potential difficulties and plan for them. This could involve having alternative activities prepared, differentiating instruction for struggling learners, or incorporating scaffolding techniques.

Teachers choose assessments that align with the learning objectives, measuring not just memorization but also deeper understanding and application of knowledge. This might involve quizzes, essays, projects, presentations, or performance-based tasks. Effective feedback is specific, actionable, and focused on improvement. It helps students understand their strengths and weaknesses, guiding them towards progress. Assessment data provides valuable insights into student learning. Competent teachers use this data to identify areas of strength and weakness, adjust their teaching strategies, and personalize learning experiences for individual students. Encouraging students to reflect on their own learning and set personal goals empowers them to take ownership of their learning journey.

4. Classroom Management: Effective instructional competence necessitates that teachers possess classroom management skills. Classroom management is an ongoing process requiring teachers to make decisions about variable situations such as where and with whom the students should sit down; which teaching methods should be followed; how to ensure motivation and student participation; which materials to use; how to deal with misbehaviors, etc. (Anyigor-Ogah, 2023).

5. Communication Skill: Communication skills involve listening and speaking as well as reading and writing. For effective teaching, a teacher needs to be highly skilled in all these areas. Teachers with good communication skills always make the learning easier and understandable. Proficient communication skills are of great significance for educators, as they are crucial for conveying knowledge, managing the classroom, and engaging with students with diverse thought processes. Teachers must instruct students with varying cognitive approaches. To teach in accordance with the ability and

capability of the learners, an educator needs to adopt such skills of communication which motivate the students toward their learning process (Asilevi, Kärkkäinen, Sormunen & Havu-Nuutinen, 2024).

The fundamental requirement for students' academic achievement and lifelong professional success is the teacher's exceptional communication skills. Teacher communicates more instructions orally in the classroom to students. A teacher with poor communication skills may hinder students' learning and academic progress. Students need to understand what is right, and what is wrong, while it totally depends upon the communication skills of teachers which he adopts in classroom (Dragnić-Cindrić, et al, 2024). Good communication minimizes the potential negative feelings during the teaching process. For learning, the learner must be attentive toward their teacher during the lesson. Adeosun, and Shanu, (2024) recommended that the teacher communicate in a clear and understandable manner. Communication is the method used for expressing one's opinions when interacting with others. Teachers require strong communication skills to assist students and to attain significant professional objectives. The success of teaching doesn't rely on technicalities but rather on the approach the teacher employs when instructing students. To ensure students, have a solid grasp of their lectures and to prevent learning difficulties, teachers require clear communication skill. Additionally, teachers must prioritize comprehension before delivering lessons to students (Okolie, Igwe, Nwosu, Eneje, & Mlanga, 2020).

This study investigates the critical role of teachers' instructional competence in influencing both student academic achievement and acquisition of science process skills within basic science and technology education.

Research Questions

The following research questions guided the study.

1. What is the relationship between teachers' instructional competence and students' academic achievement in Basic Science and Technology?
2. What is the relationship between teachers' instructional competence and the students' acquisition of science process skills?
3. What is the relationship between teachers' instructional Competence, Students' academic achievement and acquisition of science process skills in Basic Science and Technology?

Hypotheses

The following null hypotheses were formulated for the study and tested at a 0.05 level of significance.

- H₀₁: There is no significant relationship between the instructional competencies of the teachers and academic achievement of students in Basic Science and Technology.
- H₀₂: There is no significant relationship between the teachers' instructional competence and acquisition of science process skills in Basic science and Technology.
- H₀₃: There is no significant relationship between teachers' instructional competence, student academic achievement and acquisition of science process skills in Basic Science and Technology.

Methodology

The study adopted the correlational research design to establish the relationship between Teachers' instructional competence on students' achievement and acquisition of Science Process Skills in Basic Science and Technology in Lafia Education Zone of Nasarawa State. A correlational design is a research design that involves collecting data through self-report surveys or questionnaires to examine the relationship between two or more variables. Seeram (2019) explain that a correlational research design is a non-experimental approach used to investigate the relationships between two or more variables, without actively manipulating or controlling these variables. The total population for the study is 4642 JSS two students in the 138 Government public secondary schools in Lafia Education Zone of Nasarawa State (Planning, Research and Statistics Units, Ministry of Education, Lafia, 2022). The sample size for the study was made up of 368 JSS two students, drawn from 5 public secondary schools. The selection of Junior Secondary School two (JSS 2) of 2022/2023 session was based on the aim to secure a group of participants readily accessible and available for the study. The multi-stage sampling procedure was employed to draw the sample for the study. The first step employed simple random (Balloting) sampling without replacement or lucky dip method to select two AEQEOs out of three in Lafia Metropolis. The second step involved the use of purposive sampling, which was used to select the five (5) schools required for this study because of the number of students involved. The third stage involved using a proportionate stratified random sampling technique in composing the number of students in the five schools. The choice of this technique was to give an equal opportunity in proportion to the total number of students selected. Finally, simple random sampling through balloting without replacement was used to sample the students from each school sampled in the Education Zone.

Three instruments were used for data collection in this study, namely: Instructional Competence Scale (ICS), Science Process Skill Observation Scale (SPSOS) and a student Basic science achievement Proforma. The contents of ICS are 20 structured items with four (4) options ranging from 4 (always), 3 (often), 2 (sometimes) to 1 (Rarely) using Likert scales type from which the students are expected to pick their response to rate their teachers. The items were structured around the teachers' knowledge of the subject, classroom management, pedagogy skills, evaluation skills and communication skills, as shown in the instrument. The second instrument is the Science Process Skill Observation Scale (SPSOS), it is an observation-based assessment that measures students' ability to identify the basic science process skills during laboratory experiments. It consists of items for two or three teachers (inter-rater) to rates the students' ability to identify and use the six (6) (observation, communication, measurement, classification, questioning, & inference) basic science process skills in the classroom or laboratory. This assessment scales were modeled on four (4) point scale ranging from excellent, good, fair, and poor. Kendall's coefficient of concordance was used to establish the inter-rater reliability index of 0.77.

Data Analysis:

Descriptive statistics was used to collect data, Pearson Product-Moment Correlation Coefficient, and Regression analysis were employed for data analysis: Pearson Product-Moment Correlation Coefficient was applied to assess the relationships between variables and answer research questions. Regression ANOVA was utilized to test research hypotheses.

Results

Table 1: *Pearson's Product-Moment Correlation Analysis of teachers' instructional competence and students' academic achievement in Basic Science and Technology*

Model	N	R	R ²
Achievement scores	368		
teachers' competence		0.9	0.98

$\alpha = 0.05$, R^2 = coefficient of determination

To answer this research question, the scores from the responses of the respondents on instructional competence were correlated with the responses on students' achievement in Basic Science and Technology. The result in Table 1 showed that the correlation coefficient obtained was 0.99. This means that, there exists a very high direct positive relationship between teachers' instructional competence and students' achievement in Basic Science and Technology. Table 1 also shows that, the coefficient of determination (R^2) associated with the correlation coefficient of 0.99 was 0.98. 98% of students' academic achievement is accounted for by teachers' instructional competence accounted in Basic Science and Technology. This is an indication that just 2% of the variation in teachers' instructional competence is attributed to other factors not studied.

Table 2: *Regression Analysis of the teachers' instructional competencies and academic achievement of students in Basic Science and Technology.*

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	28613.40	1	28613.40	16203.55	.000 ^b
Residual	646.33	367	1.77		
Total	29259.73	368			

$\alpha = 0.05$

To test hypothesis 1 (H_{01}), regression analysis was used. The result in Table 2 shows that an F-ratio of 16203.40 with associated exact probability value of 0.00 was obtained. This probability value of 0.00 was compared with 0.05 significance level for hypothesis testing. Since 0.00 is less than 0.05, therefore, the null hypothesis was rejected. The null hypothesis, which stated that, there is no significant relationship between the instructional competencies of the teachers and academic achievement of students in Basic Science and Technology was therefore rejected and inference drawn was that instructional competencies of the teachers significantly determine academic achievement of students in Basic Science and Technology. In other words, there is a significant relationship between instructional competencies of the teachers and academic achievement of students in Basic Science and Technology.

Table 3: *Pearson's Product Moment Correlation Analysis of teachers' instructional competence and the students' acquisition of science process skills*

Variables	$\bar{x}$	SD	N	R	R ²
science process skills	56.38	7.12	368	0.84	0.71
teachers' competence	56.88	8.85			

$\alpha = 0.05$, R^2 = coefficient of determination

To answer research question two, the teachers' instructional competence scores were correlated with the students' responses on acquisition of science process skills in Basic science and Technology. The result in Table 3 shows that the correlation coefficient obtained between teachers' instructional competence and acquisition of science process skills in Basic science and Technology was 0.84. This means that, there exist a very high direct positive relationship between teachers' the instructional competence and acquisition of science process skills in Basic science and Technology. Table 3 also shows that, the coefficient of determination (R^2) associated with the correlation coefficient of 0.84 is 0.71. This coefficient of determination (R^2) indicates that, 71% of teachers' instructional competence accounted for the students' acquisition of science process skills in Basic science and Technology.

Table 4: *Regression Analysis of the teachers' instructional competence and students' acquisition of science process skills in Basic science and Technology*

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	131.68	1	131.68	2.61	.000 ^b
	Residual	18477.06	366	50.48		
	Total	18608.74	367			

$\alpha = 0.05$

To test hypothesis 2 (H_{02}), regression analysis was used. The result in Table 4 shows that an F-ratio of 2.61 with associated exact probability value of 0.00 was obtained. This probability value of 0.00 was compared with 0.05 set as level of significance for testing the hypothesis and it was found to be significant because 0.00 is less than 0.05. The null hypothesis which stated that; there is no significant relationship between the instructional competence and acquisition of science process skills in Basic science and Technology was therefore rejected and inference drawn was that instructional competence of teachers significantly determines students' acquisition of science process skills in Basic science and Technology. In other words, there is a significant relationship between teachers' instructional competence and students' acquisition of science process skills in Basic science and Technology.

Table 5: *Regression Analysis of Instructional Competence and Students' academic achievement and acquisition of science process skills in Basic Science and Technology*

Model	R	R-Squared	Adj. R-Squared	S. E
1	0. 90	0. 81	0. 81	2.78

$\alpha = 0.05$, R^2 = coefficient of determination

Table 5 above shows the regression analysis of teachers' instructional competence, students' academic achievement, and acquisition of science process skills in Basic science and technology. The result shows that the correlation between the two (2) independent variables (Teachers' Instructional Competence and Students' academic achievement) and the dependent variable (the acquisition of science process skills in Basic Science and Technology) was 0.90. This means that there exists a very high direct positive relationship among teachers' instructional competence, students' academic achievement, and the acquisition of science process skills in Basic Science and Technology. It also shows that the coefficient of determination (R^2) associated with the correlation coefficient of 0.90 was 0.81. This coefficient of determination (R^2) indicates

that, 81% of teachers' instructional competence, students' academic achievement accounted for students' acquisition of science process skills in Basic Science and Technology. The result in Table 5 reveals a remarkably strong positive correlation between the variables.

Table 6: Regression Analysis Variance (ANOVA) of the teachers' instructional competence and student academic achievement and acquisition of science process skills in Basic Science and Technology.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	12163.78	2	6081.90	784.28	.000 ^b
	Residual	2830.50	365	7.76		
	Total	14994.30	367			

$\alpha = 0.05$

To test hypothesis 3 (H_{03}), regression analysis was used. The result in Table 18 shows that an F-ratio of 784.28 with associated exact probability value of 0.00 was obtained. This probability value of 0.00 was compared with 0.05 set as level of significance for testing the hypothesis and it was found to be significant because 0.00 is less than 0.05. The null hypothesis which stated that; there is no significant relationship among teachers' instructional competence and student academic achievement and acquisition of science process skills in Basic Science and Technology was therefore rejected and inference drawn was that teachers' instructional competence and student academic achievement significantly determine students' acquisition of science process skills in Basic Science and Technology. In other words, there is a significant relationship among teachers' instructional competence and student academic achievement and acquisition of science process skills in Basic Science and Technology.

Discussion

The results in Table 1 reveal a remarkably high correlation coefficient of 0.99 between teachers' instructional competence and students' achievement in Basic Science and Technology. This signifies an exceptionally strong and direct positive relationship between these two variables, suggesting that as teachers' instructional competence increases, students' academic achievement in Basic Science and Technology also significantly improves. Furthermore, the coefficient of determination (R^2) associated with the correlation coefficient of 0.99 is 0.98. This implies that an impressive 98% of the variability in students' academic achievement can be explained by teachers' instructional competence. This finding confirms the theoretical review and previous study findings in which teachers' instructional competence as independent variable on students' achievement (König, et al, 2021). It shows that teacher instructional competence plays an important role in improving students' achievement and that teachers should take active participation in the instructional process.

The result in Table 3 show that the correlation coefficient obtained between teachers' instructional competence and acquisition of science process skills in Basic science and Technology was 0.84. This means that, there exist a very high direct positive relationship between teachers' instructional competence and acquisition of science process skills in Basic science and Technology. Table 3 also shows that, the coefficient of determination (R^2) associated with the correlation coefficient of 0.84 was

0.71. The findings are consistent with the findings of Çelik (2022), who revealed that primary school teachers are unaware of the basic science process skills and do not render effective instructions for pupils' acquisition of the science process skills. Therefore, the research findings underscore the critical role of teachers' instructional competence in shaping students' ability to acquire science process skills in Basic Science and Technology.

The result in Table 5 shows that the correlation between the independent variable (Teachers' instructional competence) and the two (2) dependent variables (Students' academic achievement and acquisition of science process skills in Basic Science and Technology) was 0.90. This means that, there exist a very high direct positive relationship among teachers' instructional competence, students' academic achievement, and the acquisition of science process skills in Basic Science and Technology. It also shows that, the coefficient of determination (R^2) associated with the correlation coefficient of 0.90 was 0.81. The findings are further supported by the results of hypothesis 3 in Table 6, which asserts a significant relationship among instructional competence, student academic achievement, and the acquisition of science process skills in Basic Science and Technology.

The study's outcomes align with previous research by Bogo, and Aperocho (2023), reinforcing the idea that teachers' instructional competence plays a crucial role in influencing both academic achievement and the acquisition of science process skills in Basic Science and Technology. The high correlation and coefficient of determination emphasize the importance of effective teaching practices in facilitating students' success and proficiency in science process skills.

Conclusion:

The study reveals a highly significant positive relationship between teachers' instructional competence and students' achievement in Basic Science and Technology. This means that as teachers' instructional competence increases, so does students' achievement in the subject. As evidenced by a very high correlation and a significant relationship at a confidence level of $p < 0.05$, which indicates that the observed relationship is unlikely to be due to chance.

This study found that there is a high direct positive relationship between teachers' instructional competence and students' acquisition of science process skills in Basic Science and Technology. This means that teachers who are more effective in their instruction are more likely to have students who can successfully acquire science process skills. The study also found that there is a statistically significant positive relationship ($p < 0.05$) between teachers' instructional competence and students' acquisition of science process skills.

There was a statistically significant positive relationship ($p < 0.05$) among teachers' instructional competence, students' academic achievement, and the acquisition of science process skills in Basic Science and Technology. This suggests that teachers' instructional competence plays a significant role in both students' academic achievement and their acquisition of science process skills.

Recommendations

In view of these findings, the following recommendation were made that, comprehensive training programs for teachers to equip them with the necessary knowledge, skills, and strategies to effectively teach Basic Science and Technology. Regular professional development workshops and seminars can help teachers stay up to date with the latest advancements in the field and continuously refine their teaching methods. Create and implement mentorship programs to pair experienced teachers with new or struggling teachers. There should be opportunities for collaboration, knowledge sharing, and peer feedback to support teachers' professional growth.

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