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Research Article

Mediating Role of Learning Skills in the Relationship between Student Achievements in Basic Science and Teaching Skills in the Twenty-First Century in Government-aided Secondary Schools

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Abstract
This study investigated the mediating role of learning skills in the relationship between student achievements in basic science and teaching skills in government-aided secondary schools in Ebonyi State, Nigeria. The study utilized a cross-sectional correlation research design. The target population encompasses 17 secondary schools of 9,062 students from the 2023/2024 academic session. A sample size of 340 students was selected using a stratified random sampling technique through Cochran's formula. A self-structured questionnaire was developed and rigorously evaluated for coherence, relevance, and clarity, with revisions from science education experts incorporated into the final version. A pilot study involving 45 participants outside the main sample area confirmed the validity and reliability of the instrument, achieving a Cronbach's alpha coefficient of 0.775, surpassing the acceptable threshold of 0.70. The data collected were analyzed using SPSS version 27 and descriptive statistics to address key research questions related to student achievement levels, perceived teaching skills, and learning skills. The findings indicated that students demonstrate a robust understanding of basic science concepts, indicating effective teaching methods. However, a gap existed between students' theoretical knowledge and their confidence in problem-solving, highlighting the need for enhanced problem-based learning strategies. The study also revealed that while students showed high motivation for assignments, traditional assessments may not fully capture their comprehension. Furthermore, there are limited opportunities for collaborative projects and technology integration, and challenges remain in fostering higher-order thinking skills. The study also showed that students expressed the importance of constructive feedback and hands-on learning, but required additional support for self-reflection and active participation. Finally, improving teacher-student relationships and creating a more inclusive learning environment are essential for enhancing educational outcomes. From the results' findings, the researchers recommended that the PBL strategy, technology, and collaboration should be integrated into students' learning.

Keywords: Learning Skills, Student Achievements, Basic Science, Teaching Skills, Twenty-First Century, Government-aided Secondary Schools

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1. INTRODUCTION

Every country recognizes the importance of education in fostering national development, so they work to ensure everyone has access to it, not just those who can afford it (UNESCO, 2024). Any society's progress depends heavily on science and technology, which demand knowledge and expertise. Science has

impacted every facet of existence and significantly contributed to the creation of the contemporary world (Nwafor & Aja, 2017). Subject integration from science and technology has proven an open route for science projects in Nigeria at the primary and junior secondary levels (Nwafor & Aja, 2017). Science was incorporated into Nigerian school curricula because of its significance for the country's development, global awareness, and the creation of new technologies that foster creativity, innovation, and the acquisition of new skills. Science promotes inquiry and analytical thought and transmits academic achievement, especially in subjects like basic science.

It is crucial to comprehend how these skills are formed, and that is why teachers at all levels work hard to prepare students for the demands of the modern world (Darling-Hammond et al., 2017). A few decades ago, basic science was included in Nigeria's junior secondary school curriculum (Omiko, 2016). It is essential to the science education curriculum in Nigeria because it provides students with the fundamental knowledge needed to study core science courses at the post-basic science levels (Nwafor & Aja, 2017). In Nigeria, science education programs must include basic science since it sets the groundwork for students to succeed in senior secondary school. Providing students with the abilities and information required to comprehend the natural world is essential. Basic science covers all of science's many aspects, providing a comprehensive view of science education (Ochu & Haruna, 2015). Students integrate disparate fields to comprehend the basic unity of the sciences (Anaekwe, Nzelum, Olisakwe, & Okpala, 2010).

The Federal Ministry of Education's three-year basic science curriculum is intended to be followed from Junior Secondary School I (JSS 1) to Junior Secondary School III (JSS 3) (Federal Ministry of Education, 2014). Learning science is more about empowering the students to take control of their education than imparting knowledge to them in their numerous subject areas (Darling-Hammond, Schachner, Wojcikiewicz, & Flook, 2023). To attain successful learning and take ownership of their education, students must embrace 21st-century learning skills, and educators must integrate these skills into the classroom (Bellanca and Brandt, 2010). The abilities needed to educate in the twenty-first century are learning and innovation, digital literacy, and life skills (Partnership for 21st Century Skills, 2009). Cox (2019) asserts that using technology and modern teaching tools in instruction is a crucial component of 21st-century teaching skills.

The 21st-century skill, according to Shouman, Itani, & Kawtharani (2023), refers to the life and work skills and habits crucial to students' success as they transition from college to working life and adulthood. Teaching students scientific principles and facts is no longer enough; they must learn to critically analyze scientific problems and challenges, collaborate with others on scientific initiatives, and effectively communicate their research. Flexibility, initiative, leadership, productivity, and social skills are the attributes that emphasize life skills, which can be applied in both personal and professional contexts (Loannou, Miliou, Adamou, et.al, 2024). These abilities enable individuals to make decisions and find solutions to problems, which are regarded as essential skills needed to thrive in life. Similar to digital skills, literacy skills are another essential 21st-century teaching ability. Literacy encompasses reading and writing skills, utilizing media and technology as teaching aids to enhance learning (Partnership for 21st Century Skills, 2007).

Investigating the relationship between students' achievement in basic science and 21st-century abilities, as well as the possible mediating roles of the 4Cs learning skills in this relationship, is necessary for the meaningful and effective teaching and learning of basic science (Pongsakorn, Supaprawat, Bordin, & Sutithep, 2022). Both teachers and students must incorporate 21st-century teaching techniques into the classroom if they are to successfully take ownership of their education and study in the twenty-first century. According to Ira, Ninfa, Braziel & Gerlinda. (2024) describes 21st-century teaching skills as incorporating modern tools and technology into instruction, which affects people from all walks of life and brings about significant changes. The four Cs of 21st-century learning skills are communication, collaboration, creativity, and critical thinking, which are essential for fostering an effective educational environment (Saavedra, Ana, & Opfer, 2012). These 4Cs must be integrated into fundamental scientific instruction for it to be meaningful and successful (Partnership for 21st Century Skills, 2009). The education ministries and the nation as a whole are greatly concerned about the low achievement of students in the Junior Secondary School Certificate Examination and the ensuing low enrollment of students in core sciences at the senior secondary level. Also, there have been reports of students performing poorly in basic science (Afuwape & Olugbuyi, 2019).

The current emphasis on science, technology, engineering, and mathematics (STEM) as the primary tools for ensuring national survival and progress makes the 4Cs, communication, collaboration, creativity, and critical thinking extremely crucial (Saavedra & Opfer, 2012). Students are regularly exhibiting low levels of achievement in basic science, despite the subject's relevance. Scores on standardized tests, classroom behavior, and general comprehension of basic scientific ideas all demonstrate this. The main reasons for this low achievement could include insufficient teaching strategies, a lack of resources, disinterest on the part of the students, or other issues that prevent fundamental science instruction from being conducted effectively (Karalı, 2022).

The goal of this study is to determine the degree to which the 4Cs learning skills (Critical thinking, Communication, Collaboration, and Creativity (Partnership for 21st Century Skills, 2019) moderate the association between students' proficiency in basic science and the development of these 21st-century competencies. Curriculum designers must take into account the mediating functions that learning skills play in the relationship between education in the twenty-first century and students' achievement in basic science (Dilekçi and Karatay, 2023). Teachers can modify their lesson plans to strengthen students' academic achievement in basic science by recognizing the particular learning abilities that are necessary for success. Bandura's Social Cognitive Theory is one theoretical framework that can be used to comprehend the mediating functions of learning skills in the relationship between education in the twenty-first century and students' achievement in basic science. This theory holds that people learn by imitation, modeling, and observation and that their motivation, cognitive processes, and self-efficacy beliefs all have an impact on how well they learn (Bandura, 1986). In the twenty-first-century educational setting, students' acquisition of critical thinking, problem-solving, and information literacy skills is essential to their success in fundamental scientific courses. Collaborative learning environments, real-world knowledge applications, and technological interactions all contribute to the development of these learning skills.

Education reforms in the twenty-first century have a positive impact on students' ability to learn basic science. This is because cutting-edge teaching strategies, tailored learning strategies that address the needs of each student, and technological integration have all been combined (Eden & Idowu, 2024). A greater array of tools and resources is made available to students as education changes to meet the demands of a rapidly changing world, and these tools and resources help students better understand and apply fundamental scientific principles (Dancsa, Štempeľová, Ondrej, & Annuš, 2023). Students can interact with the content more effectively and gain a deeper understanding of basic science topics by including active learning tactics like group work, problem-solving exercises, and hands-on experiments. Students can learn more dynamically and interestingly in the classroom when digital tools and resources are used. Learning may be more accessible and help students visualize abstract topics through the use of virtual labs, simulations, internet resources, and multimedia presentations (Asare, Amoako, Duut & Apraku, 2023).

Designing education to fit students' unique needs and learning preferences can improve their comprehension and retention of basic science material. They can thrive if they have access to opportunities for self-paced learning, individualized instruction, and personalized feedback (Nurasma & Jasber, 2020; Lyle, Young, Heyden, and McDaniel, 2023). Improvements in education have a positive impact on students' basic science learning abilities in the twenty-first century (National Research Council, 2012). Students' achievement in basic science can be greatly impacted by the teaching techniques of the twenty-first century. As education changes to meet the demands of a rapidly evolving world, students are exposed to a greater range of resources and technologies that improve their comprehension and application of fundamental scientific principles (Haleem, Javaid, Qadri, and Suman, 2022). Inquiry-based learning and a focus on critical thinking abilities can aid students in gaining a deeper comprehension of basic science ideas (Kotsis, 2024). Students can develop their problem-solving abilities and scientific reasoning by being encouraged to pose questions, examine information, and reach conclusions based on solid evidence (Christine & Jonathan, 2008).

Fostering a collaborative learning environment where students work together on projects, discuss ideas, and share perspectives can enhance their understanding of basic science concepts (Ujjwal and Nidhir, 2024). Collaboration can help students develop communication skills, teamwork abilities, and a sense of community within the classroom. Students benefit from this by enhancing their critical thinking skills, problem-solving techniques, and understanding of the scientific method on a deeper level. Ultimately, combining contemporary teaching methods with an emphasis on basic science education improves student learning outcomes and equips them for success in an increasingly complex and interconnected global world

(Saavedra & Opfer, 2012). Through the mediating influence of students' learning skills, education plays a vital role in influencing students' achievement in basic science in the twenty-first century (Biyun, Jong, Ronnel, Ching, & Jiang, 2022; Zorlu & Zorlu, 2021). Modern educational strategies, such as the use of technology, personalized learning approaches, and creative teaching techniques, improve students' learning abilities in basic science. These competencies include the capacity for critical thought, problem-solving techniques, scientific reasoning, and information processing (Irwanto, Elma, & Tiara, 2024).

Success in basic science requires the capacity to evaluate evidence, analyze information, and reach well-reasoned conclusions. Students can learn to think critically about scientific concepts by being taught tools that support critical thinking, such as inquiry-based learning and problem-solving exercises. In the scientific domain, questioning, sharing ideas, and presenting discoveries all depend on effective communication, and students can enhance their capacity to convey scientific concepts clearly and effectively by participating in group projects, presentations, and scientific writing assignments, which are instructional strategies that focus on communication skills (Ornit, Bat-Sheva, & Zahava. (2009). Collaborative abilities are essential for working effectively with others on scientific projects and research. Teaching strategies that promote cooperation—including group projects, peer evaluations, and teamwork exercises—can help students learn how to collaborate to achieve shared objectives. In science, problem-solving, Students can develop into competent problem solvers in basic science by using teaching strategies that emphasize problem-solving abilities, such as practical experiments, case studies, and real-world applications. Strategy implementation and identification are critical competencies. (Ebrahim & Lisa, 2022). Students' ability to interact with and understand fundamental scientific concepts improves when these learning abilities are developed and strengthened, which boosts their academic performance in science subjects (Norsyazwani, Syafiq, Muhammad, & Salbiah, 2024). Consequently, education in the twenty-first century indirectly influences students' accomplishments in basic science by encouraging the development of critical learning abilities that support students' comprehension and mastery of scientific concepts (Saavedra & Opfer, 2012). To succeed in science, one must find, assess, and use information efficiently (Lai & Hwang, 2016). Students can learn how to access and use scientific information by participating in research projects, data analysis exercises, and digital literacy tasks, all of which are teaching strategies that support information literacy skills.

Developing critical thinking, problem-solving, scientific reasoning, and information-processing skills is essential for success in the scientific classroom. The relationship between teaching abilities in the twenty-first century and students' achievement in basic science is heavily mediated by learning skills. Acquiring competencies like critical thinking, problem-solving, and collaboration aids students in comprehending and assimilating the basic science ideas that educators impart. Students who actively participate in the subject can enhance their understanding and retention of scientific concepts by applying these skills (Udu, Nmadu, Uwaleke, Anudu, 2022). Acquiring skills allows students to use the knowledge learned in the classroom with contemporary teaching techniques in practical settings. Students can demonstrate their understanding of basic science topics by effectively applying their learning to real-world circumstances and refining their communication, cooperation, and problem-solving skills. Students who acquire new abilities are better equipped to take charge of their education and seek it out independently by building information literacy and self-regulation skills. Students can augment classroom learning with self-directed study, further enhancing their understanding and achievement in basic science.

Acquiring knowledge and abilities promotes metacognitive awareness, enabling learners to evaluate their own learning experiences, track their comprehension, and modify their approaches accordingly. Students can maximize their learning opportunities, pinpoint areas for growth, and ultimately improve their achievement in basic science by developing metacognitive skills (Stanton, Sebesta, and Dunlosky, 2021). With the help of these abilities, students can properly evaluate data, interact with scientific ideas, and use their knowledge to tackle challenging issues. Gaining skills encourages students to continue expanding their knowledge and abilities outside of the classroom by fostering an attitude of lifelong learning. Long-term success in basic science is facilitated by learning skills that promote a fascination for science, a willingness to collaborate, and a commitment to ongoing growth in students (Gaier, Kramer, and Braxton 2022). Students with exceptional learning skills are more likely to acquire fundamental science topics and perform better academically, regardless of their educational setting. Consequently, even if education in the twenty-first century shapes students' learning experiences, students' achievement in basic science is ultimately determined by their innate learning skills, demonstrating the significance of individual capacities in academic

progress. This study emphasizes how crucial it is to help students develop 21st-century abilities to better equip them to meet the needs of a rapidly changing world society. Gaining knowledge of these relationship dynamics can assist teachers in selecting teaching tactics that will help students develop 21st-century abilities and achieve better academic results. This study aims to determine how the acquisition of these 21st-century abilities will affect students' achievement in basic science and how much the 4Cs learning skills will mediate this relationship. Teachers can select instructional strategies that promote 21st-century skill acquisition and enhance students' academic achievement by having a better understanding of these relationship dynamics.

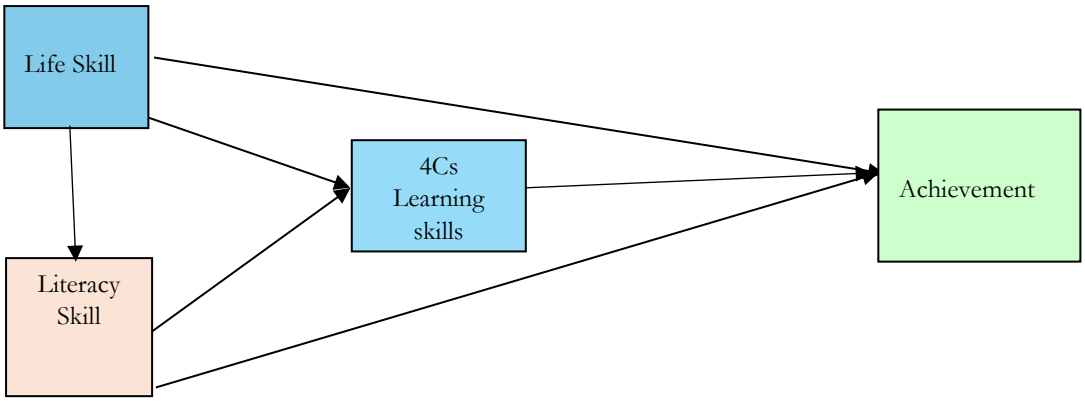

Figure 1. The mediating effect of the 4Cs

1.1. Research Objectives

1. To explore the direct relationship between student achievements in basic science and the teaching skills necessary for effective 21st-century education.
2. To identify and categorize the specific learning skills that influence student achievements in basic science, and how these skills interact with teaching methods.
3. To determine the mediating effects of learning skills on the relationship between student achievements in basic science and the provision of teaching skills relevant to the 21st century.

1.2. Research Questions

1. What is the direct relationship between student achievements in basic science and the teaching skills necessary for effective 21st-century education?
2. Which specific learning skills influence student achievements in basic science, and how do these skills interact with various teaching methods?
3. How do learning skills mediate the relationship between student achievements in basic science and the effectiveness of teaching skills relevant to the 21st century?

2. METHODOLOGY

The methodology used in this study is described below:

2.1. Research Design

The cross-correlational research design was used to investigate the relationship between the variables. A cross-sectional research design is a type of observational study that the researcher commonly utilizes in the exposure, outcome, and other variables (such as confounding variables) at the same time (Setia, 2023). It is a research design that is utilized for many statistical techniques (Hamaker, 2023). This research design enables the researchers to explore and understand the relationship between teaching skills, learning skills, and student achievement in the twenty-first century.

2.2. Research Approach

The study used a quantitative approach to assess the relationships and mediating effects.

2.3. Area of the study

The study was conducted in 17 government-aided secondary schools in the Ebonyi Local Government Area of Ebonyi State, Nigeria.

2.4. Target population

The total population for this study was 9062 Junior Secondary School students of the 2023/2024 session (Secondary Education Board, 2024) from 17 government-aided secondary schools.

2.5. Sample size

The sample size was determined using Cochran's formula, and it gave a sample size of 340 from students in the government-aided secondary schools in the Ebonyi Local Government area of Ebonyi State. Therefore, the total number of participants in the study is 340 students from the government-aided secondary schools in Ebonyi Local Government Area, Ebonyi State.

2.6. Sampling Techniques

A stratified random sampling technique was used to select students for this study. This technique ensures a representative sample of students across different demographics, which is important in understanding the nuances of learning and teaching skills related to basic science achievements.

2.7. Validity of the Instruments for Data Collection

Three science education specialists approved the self-structured questionnaire. The items in the questionnaire were examined for coherence, pertinence, and clarity regarding the research study's objective. Then, they were reviewed to ensure they met the study's aim, and the final version of the data collection tool incorporated the expert revisions.

2.8. Reliability of the Instruments

Forty-five respondents from outside the sample area participated in a pilot study to evaluate the questionnaire's reliability. SPSS version 27 was used to analyze their answers. The construct's reliability was assessed using the benchmark of $\alpha = 0.70$. According to Cronbach's alpha, the students' questionnaire has a reliability rating of 0.775. The reliability of the questionnaire was shown by the analysis exceeding the 0.70 criterion.

2.9. Data Collection

A five-point Likert scale self-structured questionnaires were developed, which is made up of three sections (A, B, and C), and each section has ten items. The questionnaire was administered to the sampled participants to measure the students' achievements in basic science, perceived teaching skills, and learning skills.

2.10. Data Analysis

The quantitative data were analyzed using descriptive statistics to answer the research questions, utilizing a statistical package for the social sciences (SPSS).

3. RESULTS

The above column chart in Figure 2 shows the total number of participants (students) from 17 secondary schools labeled A-Q in Ebonyi Local Government Area of Ebonyi State that participated in this study. This shows a total of 340 participants (students), and the students are from the junior sections.

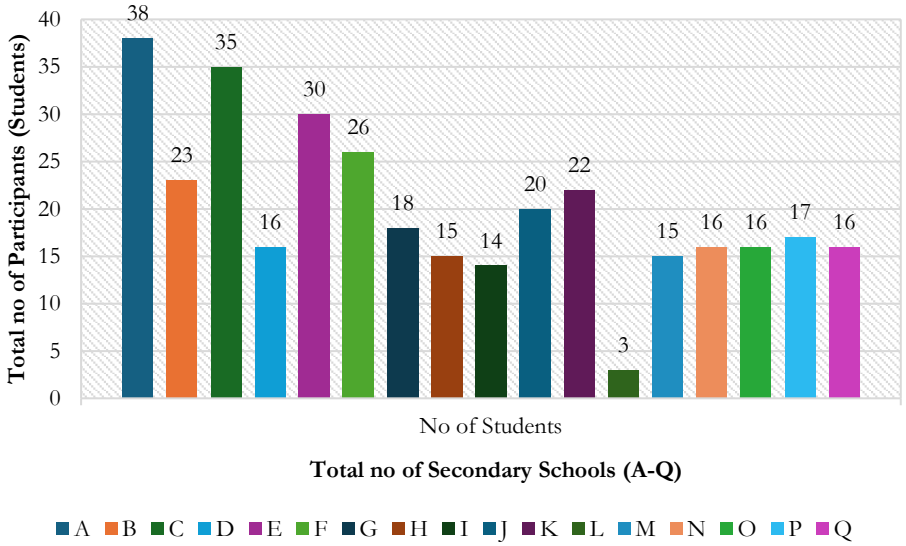

Figure 2. Demographic Characteristics of Students From 17 Secondary Schools

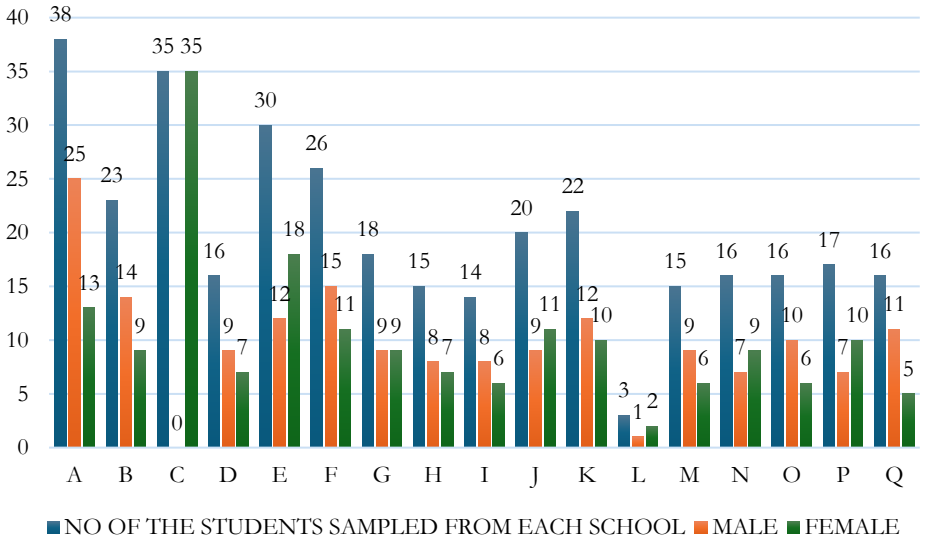

Figure 3. Demographic Characteristics of the Gender of Students From 17 Secondary Schools

The above column chart in Figure 3 shows the gender of participants (students) from 17 secondary schools labeled A-Q in Ebonyi Local Government Area of Ebonyi State that participated in this study. This shows a total of 340 participants (students). The blue color shows the total number of students sampled from each school, the orange colors show the total number of males in each school, and the ash color shows the total number of females in each school.

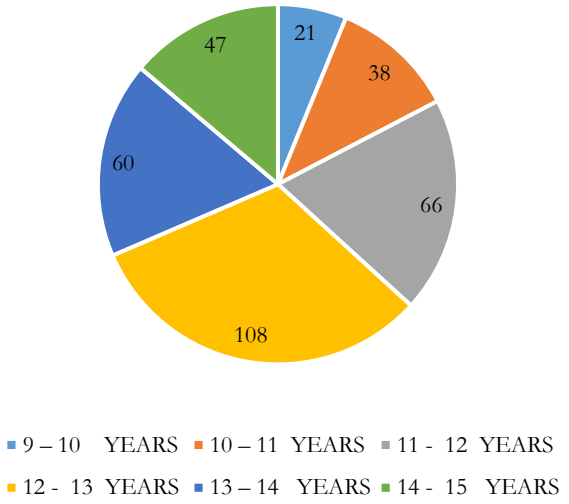

Figure 4. Demographic Characteristics of the Ages of Students From 17 Secondary Schools

The above pie chart in Figure 4 shows the ages of participants (students) from 17 secondary schools labeled A-Q in Ebonyi Local Government Area of Ebonyi State that participated in this study. This shows a total of 340 participants (students) between the ages of 9 and 15 years in junior secondary schools. The sky blue color shows the age range of 9 – 10 years, orange color shows the range of 10 – 11 years, ash color shows the range of 11 – 12 years, yellow color shows the range of 12 – 13 years, blue color shows the range of 13 – 14 years, and the green color shows the range of 14 – 15 years.

Table 1. Demographic characteristics of the educational background of students from 17 secondary schools

Name of the Schools	Number of Students Sampled From Each School	Educational Background		
		JSS 1	JSS2	JSS3
A	38	12	10	16
B	23	6	7	10
C	35	5	10	20
D	16	3	7	6
E	30	4	10	16
F	26	7	11	8
G	18	3	6	9
H	15	4	3	8
I	14	3	3	8
J	20	4	6	10
K	22	4	6	12
L	3	0	1	2
M	15	3	5	7
N	16	2	6	8
O	16	4	3	9
P	17	2	6	9
Q	16	3	5	8
Total	340	69	105	166

Table 1 shows the educational background of participants (students) from 17 secondary schools labeled A-Q in Ebonyi Local Government Area of Ebonyi State that participated in this study. The table shows participants from Jss1, Jss2, and Jss3.

Research Question One: What is the direct relationship between student achievements in basic science and the teaching skills necessary for effective 21st-century education?

Table 2. The Direct Relationship Between Student Achievements in Basic Science and the Teaching Skills Necessary For Effective 21st-Century Education

SN	Questionnaire Item	SD	D	N	A	SA	Mean
1	I comprehend the fundamental basic science concepts taught in class.	10	6	03	38	283	4.70
2	I am confident in my capacity to tackle basic science problems.	42	20	-	100	178	4.04
3	I consistently finish my assignments in basic science.	-	-	12	98	230	4.64
4	I enjoy learning about topics in basic science.	25	16	20	102	177	4.14
5	I actively participate in basic science classes.	21	12	05	107	195	4.30
6	I frequently look for further materials to improve my comprehension of basic science.	52	32	12	96	148	3.75
7	I score well on assessments in basic science.	64	44	-	160	72	3.39
8	I work with my classmates on science projects.	108	59	09	76	88	2.93
9	I make use of technology to assist me in learning basic science.	187	53	03	45	52	2.18
10	I believe my teachers support my learning of basic science.	-	-	-	94	246	4.72

Research Question Two: Which specific learning skills influence student achievements in basic science, and how do these skills interact with various teaching methods?

Table 3. Specific Learning Skills That Influence Student Achievements in Basic Science, and How Do These Skills Interact With Various Teaching Methods?

SN	Questionnaire Item	SD	D	N	A	SA	Mean
1	My teachers use different teaching methods to teach students.	75	58	32	67	108	3.22
2	My teachers encourage critical thinking and problem-solving among students	196	48	-	19	77	2.21
3	My teachers skillfully use technology effectively in their lessons.	173	67	01	42	57	2.24
4	My teachers provide constructive feedback on assignments and classwork.	18	22	-	98	204	4.26
5	My teachers promote collaborative learning experiences among students	25	17	07	193	98	3.95
6	My teachers make use of different teaching strategies to teach basic science, which meet different learning needs in the classroom	88	47	19	68	118	3.24
7	My teachers foster a positive classroom environment	39	52	03	87	159	3.81
8	My teachers support and encourage student-led discussions	47	34	-	197	62	3.57
9	My teachers provide opportunities for hands-on learning	-	43	-	95	202	4.34
10	My teachers are approachable and available for questions.	-	-	-	83	257	4.76

Research Question Three: How do learning skills mediate the relationship between student achievements in basic science and the effectiveness of teaching skills relevant to the 21st century?

Table 4. Learning Skills Mediate the Relationship Between Student Achievements in Basic Science and the Effectiveness of Teaching Skills Relevant to the 21st Century.

SN	Questionnaire Item	SD	D	N	A	SA	Mean
1	I actively create goals for my learning of basic science	56	33	-	73	178	3.84
2	I ask questions when I do not understand a concept in basic science	-	-	07	77	263	4.74

SN	Questionnaire Item	SD	D	N	A	SA	Mean
3	I am open to receiving feedback on my assignments and projects in basic science.	09	23	01	98	209	4.40
4	I take notes effectively during lessons in basic science.	-	-	11	242	87	4.22
5	I seek assistance from my teachers when needed and necessary	03	15	-	91	231	4.56
6	I participate in peer discussions to strengthen my understanding of basic science concepts.	57	37	18	78	150	3.67
7	I reflect on what I have learned after completing my assignments on basic science.	77	23	-	146	84	3.42
8	I make use of available resources in the library to enhance my learning of basic science	66	31	13	31	200	3.79
9	I feel comfortable expressing my thoughts and ideas in class during basic science lessons.	87	33	-	129	91	3.31
10	I collaborate with my teachers to improve my methods of learning basic science.	14	11	41	153	121	4.05

4. DISCUSSION

The findings from the student questionnaire throw more light on the direct relationship between student achievement in basic science and the corresponding teaching skills necessary for effective 21st-century education. Analyzing these results reveals strengths in certain areas of student learning experiences while highlighting critical gaps that could impede further success. One of the most striking results is the high mean score of 4.70 for students' comprehension of fundamental basic science concepts (item 1). This score suggests that students feel confident in their understanding, indicating effective teaching methodologies that align well with their learning needs. Research by Hattie (2009) supports this observation, which emphasizes that students' perception of their understanding is closely linked to the effectiveness of teaching. Teachers who utilize clear explanations and meaningful examples can significantly enhance students' comprehension. In contrast, the data also highlight a lower mean score of 4.04 for confidence in problem-solving abilities (item 2). While many students feel confident tackling basic science problems, the comparatively lower score suggests that there may be a discrepancy between knowledge acquisition and practical application. This alignment is crucial, as Milian's (2023) research indicates that developing problem-solving skills is essential for mastering scientific concepts. This disconnection could pose challenges for students transitioning from theoretical knowledge to real-world applications, underscoring the need to incorporate problem-based learning strategies more effectively.

Additionally, the results reveal an impressive mean score of 4.64 for assignment completion (item 3) and a solid score of 4.14 for enjoyment of learning (item 4). These findings indicate that students are not only motivated to complete their work, but they also find joy in exploring basic science concepts. This aligns with Deci and Ryan's (2015) Self-Determination Theory, which posits that intrinsic motivation plays a significant role in students' engagement and academic achievement. Participation in class activities is also relatively high, with a mean score of 4.30 (item 5), which points to an engaging learning environment. However, the mean score for seeking further materials is lower, with a score of 3.75 (item 6), suggesting a need for improvement in fostering self-directed learning, and despite these positive indicators, there are concerning trends highlighted by the data. The mean score for students scoring well on assessments (item 7) is significantly lower at 3.39, suggesting a potential disconnection between comprehension and assessment performance. This could indicate that traditional assessment methods may not effectively measure students' understanding or their ability to apply knowledge in assessments. Price, Pierson, and Light (2011) point to the limitations of conventional testing, advocating for assessment strategies that align more closely with students' actual competencies and higher-order thinking skills.

Furthermore, the adequacy of collaborative learning (item 8) received a low mean score of 2.93, indicating insufficient opportunities for students to work together on science projects. Ujjwal Paul and Nidhir Ghosh (2024) have demonstrated that collaborative learning enhances understanding and retention of knowledge. The low score suggests a need to integrate more cooperative learning strategies into the curriculum, as collaboration is essential for developing critical social and teamwork skills that are necessary in the 21st century. Equally concerning is the low score of 2.18 for technology use in learning (item 9). This

suggests that educators may not effectively incorporate technological tools to enhance learning experiences, which is critical in today's digital age. Research by Eden, Chima, Adeniyi, and Idowu (2024) indicates that effective technology integration can lead to increased student engagement and deeper learning. The underutilization of technology in the classroom represents a significant gap that must be addressed to prepare students for future educational and career challenges. A notable high mean score of 4.72 for teachers' support (item 10) indicates that students feel supported in their learning. This finding aligns with the research of Munna and Kalam (2021), which highlights the importance of teacher support in fostering a sense of safety and boosting student performance. The presence of supportive teachers can enhance student confidence and motivation, reinforcing the significance of teacher-student relationships in educational success.

The findings from the student questionnaire provide valuable insights into the specific learning skills that influence student achievement in basic science and how these skills interact with various teaching methods. Analyzing each item reveals crucial areas of strength and opportunities for improvement, illustrating the complex interplay between teaching strategies and student learning outcomes. With a mean score of 3.22, students perceive that their teachers employ diverse teaching methods. This suggests a recognition of varied instructional approaches, which can cater to different learning preferences. Research by Dhakal (2024) emphasizes the importance of differentiated instruction in meeting diverse student needs, focusing on how varied teaching methods can enhance comprehension. However, while the score indicates some variety, it falls short of a strong endorsement, signaling that further diversification of teaching methods may be needed to fully engage all learners. The low mean score of 2.21 for teachers encouraging critical thinking and problem-solving is concerning. This finding reflects a significant gap in fostering higher-order thinking skills, which are crucial for student success in science. Lisnawati, Yuni, Fien, Radiansyah & Dwiyanto (2024) indicate that effective learning environments must prioritize critical thinking to prepare students for real-world challenges. This lack of emphasis on critical thinking could limit students' abilities to analyze and synthesize information, potentially hindering their overall academic achievement.

The mean score of 2.24 for the effective use of technology in lessons suggests that students perceive a lack of adequate technological integration in their education. Rashid and Asghar (2016) affirm that effective technology use can enhance student achievement and learning outcomes. The low score indicates a missed opportunity to utilize technological tools that could support interactive learning and skill development vital in the 21st century. Educators need to explore ways to integrate technology more meaningfully into their curricula to boost student learning and engagement. Students rated their teachers' ability to provide constructive feedback highly, with a mean score of 4.26. This aligns with Mandouit & Hattie's (2023) research, which emphasizes that timely and constructive feedback is pivotal for student learning and the enhancement of student achievement. This positive indicator suggests that students feel guided in their learning journeys, which can significantly influence their ability to improve and excel academically. The mean score of 3.95 indicates a strong perception among students that their teachers promote collaborative learning experiences. Johnson and Johnson (2018) argue that cooperative learning strategies can enhance interpersonal skills and academic performance. This finding suggests that effective collaborative opportunities are being utilized, which can foster teamwork and a deeper understanding of complex scientific concepts among students.

A mean score of 3.24 for the use of diverse teaching strategies suggests that while there are attempts to accommodate different learning needs, improvements are necessary. Research emphasizes the value of varying instructional strategies to cater to diverse learner profiles, and the findings indicate that a more explicit effort to tailor teaching methods to diverse learning needs could further enhance student achievement in basic science (Dhakal, 2024). With a mean score of 3.81, students generally perceive their teachers as fostering a positive classroom environment. Ryan and Deci (2015) have demonstrated that a supportive classroom atmosphere can lead to increased motivation and achievement. However, while the score reflects a mostly positive environment, it also highlights potential areas for further enhancement to ensure all students feel fully supported and safe in expressing themselves. The mean score of 3.57 indicates that while teachers support student-led discussions, there may be room for improvement in promoting student academic achievement. Research by Yu and Schunn (2023) shows that encouraging student-led discussions can enhance learning outcomes and promote deeper understanding. Encouraging more student participation would empower learners and enhance their communication skills, which are essential in scientific discourse.

The high mean score of 4.34 for opportunities for hands-on learning highlights the value students place on experiential learning. Research by Serdar (2016) supports this by showing how hands-on activities are crucial for promoting achievement and understanding in science education. This finding underscores the necessity of incorporating practical learning experiences into the curriculum to enhance student understanding and retention of scientific concepts. The impressive mean score of 4.76 for the approachability of teachers indicates that students feel comfortable seeking help and asking questions. Coristine, Russo, Fitzmorris, Beninato, and Rivolta (2022) found that approachable teachers foster a sense of safety and encouragement, positively influencing student achievement. This high rating reflects a strong positive teacher-student dynamic, which is essential for promoting student achievement and motivation.

The questionnaire results provide significant insights into the learning skills of students studying basic science and how these skills mediate the relationship between relevant teaching methods and student achievements. Each item sheds light on essential aspects of students' learning processes and highlights the importance of fostering skills necessary for success in the 21st century. This discussion will address each item, providing context and referencing relevant research to explore how these findings inform educational practices. The mean score of 3.84 suggests that students are moderately active in creating personal learning goals for their study of basic science. Research shows that self-regulated learning, including goal setting, is closely linked to student motivation and achievement (Ejubović & Puška, 2019). By fostering goal-setting practices, educators can enhance students' focus and commitment to their learning process. However, the moderate score implies that more explicit instruction on effective goal setting could further empower students in their educational journey. With a high mean score of 4.74, the overwhelming majority of students report a willingness to ask questions when they do not understand concepts in basic science. This openness to inquiry is crucial for deep learning and aligns with the findings by Ronilo & Maricar. (2023), who note that questioning fosters deeper engagement and comprehension. Such a positive response indicates that teachers are likely creating an environment that encourages curiosity and active participation, which is essential for effective science education.

A score of 4.40 indicates a strong acceptance of feedback among students. Mandouit & Hattie (2023) highlight the critical role of feedback in enhancing learning, suggesting that students who are receptive to constructive criticism are more likely to engage in self-improvement. This finding is encouraging, as it implies that teachers are providing valuable feedback that students view as beneficial for their learning progress. A mean score of 4.22 indicates that students feel they take notes effectively during lessons. Effective note-taking is vital for retention and understanding, as noted by Salame, Tuba, & Nujhat (2024). While this high score indicates a general comfort with this skill, schools might benefit from direct instruction on various note-taking strategies (e.g., Cornell Notes, mind mapping) to further enhance students' abilities to capture and process information during lessons. The mean score of 4.56 suggests that students actively pursue help from teachers when needed. This willingness to seek assistance aligns with Vygotsky's (1978) theory of the Zone of Proximal Development, which emphasizes the role of social interaction in learning. This strong indication suggests that students feel comfortable engaging with their teachers, a crucial factor in building a supportive educational environment.

The mean score of 3.67 for participation in peer discussions reflects moderate achievement. Collaborative learning is essential for developing critical thinking and analytical skills. To improve this area, educators should create more structured opportunities for peer learning, fostering an environment where students actively discuss and engage with one another, which can facilitate deeper understanding (Steenkamp & Brink, 2024). With a mean score of 3.42, students reflect moderately on their learning after assignments. Reflection is a metacognitive skill that enhances learning and retention. The relatively lower score suggests a need for educators to implement structured reflection practices, helping students evaluate their learning processes and outcomes more effectively (Dunne, Penman, & Nisbet, 2023). The mean score of 3.79 indicates that students generally use available library resources to enhance their learning in basic science. This finding supports research emphasizing the importance of resource availability for improving educational outcomes (Adebayo, Ntokozo & Ngema, 2020). However, educators might consider integrating information literacy instruction to ensure students can effectively navigate and utilize these resources for their academic benefit.

The score of 3.31 suggests that while some students feel comfortable expressing thoughts in class, there is still a level of discomfort present. Research indicates that creating a safe and supportive classroom environment is essential for students to feel free to express themselves (Partnership for 21st Century Skills,

2007; Hairul, Ira, Yunita, Faadhil & Doli, 2024). Teachers may need to employ strategies that actively promote inclusivity and encourage all students to share their ideas, contributing to a richer classroom dialogue. The mean score for collaboration with teachers at 4.05 indicates that students value working with their teachers to improve their learning methods. This collaborative approach to teaching reflects constructivist principles, promoting active student achievement, and teachers can enhance this collaboration by involving students in discussions about instructional strategies that best support their learning needs.

5. CONCLUSIONS AND RECOMMENDATIONS

Although there is evidence of strong comprehension and effective teacher support, there are still significant gaps in areas such as collaboration, technology integration, and assessment performance, which must be addressed to improve teaching practices and support student success. Students are strong at asking questions, seeking feedback, and interacting with teachers, but they struggle to develop critical thinking skills, use technology effectively, and participate in peer discussions. These findings from the student questionnaire offer important insights into the factors influencing student achievement in basic science education. In addition, it takes concentrated effort to promote reflective practices and create an open space for exchanging ideas. By building on the strengths and addressing the areas that need improvement, teachers can improve their teaching techniques and support the development of critical learning skills that positively impact students' achievement in basic science. This nuanced understanding not only benefits the immediate educational community but also makes a significant contribution to global discussions on effective teaching methods. It aligns with the efforts of researchers and educators to enhance educational outcomes in science. In the end, this study highlights how teaching strategies and learning abilities interact dynamically, demonstrating how both have an impact on student achievement. Teachers may better prepare students for the challenges of the future and provide them with the tools they need to succeed in the complex 21st-century environment by creating a more encouraging learning environment.

The results of the student survey on fundamental science education indicate that specific tactics that improve student performance and meet the demands of 21st-century learning must be put into place. The analysis identifies significant strengths in students' understanding of basic ideas and the assistance that teachers offer, creating a solid basis for learning opportunities. However, the stark deficiencies in problem-solving abilities, possibilities for collaborative learning, and technological integration highlight the need for a diversified strategy to successfully address these areas. Teachers should concentrate on developing a thorough learning environment that equips students to handle the intricacies of contemporary scientific inquiry and application in order to address these shortcomings. Integrating problem-based learning (PBL) techniques, which have been demonstrated to increase students' confidence in their ability to solve problems, is one of the main recommendations. Furthermore, creating opportunities for collaborative learning will promote peer interaction and teamwork, both of which are critical for the development of interpersonal skills in scientific settings. Given the low performance in critical thinking and higher-order abilities, it is equally important to prioritize these areas. Together with organized reflection opportunities, professional development for educators in creative teaching methods can enhance the learning environment and encourage a deeper comprehension and retention of scientific ideas. Additionally, improving student motivation and engagement requires using experiential learning and creating a supportive classroom environment. Teachers can better meet the varied requirements of students by promoting self-directed learning and diversifying their teaching methods. In addition to filling in the gaps found, putting these suggestions into practice fosters a vibrant and inclusive scientific curriculum. This strategy will integrate with international research initiatives to enhance scientific education outcomes by preparing students to flourish in a constantly changing educational environment and make significant contributions to future scientific endeavors.

Research Ethics. By completing the consent form on the questionnaire and verbally agreeing before the instruments were given to them, each participant in the study granted their permission to take part in the study.

Data Availability Statement. The authors declared the availability of the data used in the research.

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