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INFLUENCE OF AVAILABILITY AND UTILIZATION OF ICT BASES TEACHING AND LEARNING OF MATHEMATICS IN AWKA EDUCATION ZONE OF ANAMBRA STATE

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ABSTRACT
The research analyzed the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka. Four research questions guided the study. This research used descriptive survey. The population comprise of 1037 regular Science Education which comprises of 240 students in year one, 249 students in year two, 270 students in year three and 278 students in final year Undergraduate Students in Department of Science Education in Nnamdi Azikiwe University, Awka. Stratified sampling technique was used to select 40 students each (120) from level 1 to level 4. Questionnaire was used to collect data. Mean was used to analyze the data. The study found that Computer-based tools were not available for teaching and learning of science education in Nnamdi Azikiwe University Awka. There is a low extent of use of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka. The challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were lack of access to up-to-date computer-based tools necessary for science education, and limited availability of specialized software required for advanced science experiments, among others. The solutions to the challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were improving the technological infrastructure, and ensuring that specialized software necessary for science experiments would improve the learning experience, among others. The study concluded that there are critical gaps in both access to and use of technology among university students of science education in the educational environment. The findings reveal that the absence of necessary computer-based tools significantly hampers the teaching and learning process, leading to a low extent of utilization among students. The study recommended that university administration should allocate funds specifically for acquiring modern computer-

based teaching tools. This could include purchasing computers, projectors, and other multimedia resources necessary for effective science education.

Keywords: Availability; Utilization; ICT Bases Teaching; Learning of Mathematics

Introduction

Science education encompasses the teaching and learning of scientific concepts and processes. It aims to instill in students a deep understanding of the natural world, foster critical thinking, and promote problem-solving skills. Science education is crucial for developing a scientifically literate society capable of making informed decisions about health, environment, and technology (National Research Council, 2021). The foundation of science education involves imparting knowledge in disciplines such as biology, chemistry, physics, and earth sciences, along with the methodologies that underpin scientific inquiry. The primary objectives of science education include the development of scientific knowledge, understanding, and skills necessary to engage in scientific thinking and experimentation. It seeks to cultivate an appreciation of the nature of science and its role in society (Bybee, 2020). Objectives also encompass fostering a sense of curiosity and wonder about the natural world, promoting the application of scientific knowledge to real-world problems, and preparing students for further education and careers in science and technology-related fields. These objectives can only be met when there is an effective teaching and learning of science education

The teaching and learning of science education involve both theoretical and practical components. Effective science education requires hands-on experiments, interactive learning environments, and the integration of technology to enhance understanding and engagement (Hofstein & Lunetta, 2015). Instructional strategies often include inquiry-based learning, where students actively participate in the scientific process, from formulating questions to conducting experiments and analyzing results. This approach cannot only enhance comprehension but also encourages the development of critical thinking and problem-solving skills. Modern science education heavily relies on various methods and facilities to facilitate effective teaching and learning of which Information and Communication Technology (ICT) can also enhance the science effective teaching and learning.

Information and Communication Technology (ICT) ICT is technology that supports activities involving information. Such activities include gathering, processing, storing and presenting data. Increasingly these activities also involve collaboration and communication *(UNESCO. 20)7)*. Information and communication technologies (ICT) can also defined as a diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the Internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded

broadcasting technologies (podcasting, audio and video players, and storage devices) and telephony (fixed or mobile, satellite, visio/video-conferencing, etc.). ICT (Information and communication technology) tools such as digital simulations, virtual labs, and interactive whiteboards play a significant role in making complex scientific concepts more accessible and engaging (Lemke, 2018). Additionally, well-equipped laboratories, access to current scientific research, and collaboration spaces are essential for providing students with hands-on experience and fostering collaborative learning. Most especially, the integration of technology such as ICT (computer based) teaching and learning can also enhance learning experiences and outcomes in science education.

ICT tools are essential for effective teaching and learning in science education. These tools include software applications, virtual laboratories, simulation programs, and online collaborative platforms that facilitate interactive learning experiences. For instance, tools such as MATLAB, PhET simulations, and virtual lab environments allow students to experiment with scientific phenomena in a controlled and safe environment (Afolabi & Ogunlade, 2022). Additionally, Learning Management Systems (LMS) like Moodle and Blackboard provide a structured platform for the distribution of educational content, assignment submissions, and student assessments (Eze, 2023). The availability and effective utilization of these tools are crucial in bridging the gap between theoretical knowledge and practical application in science education (Olaleye & Adeyemi, 2023).

The availability of ICT tools for teaching and learning science education in Nigerian universities is a critical factor that influences their adoption and use. Despite the global push towards digitalization in education, the availability of these tools in some Nigerian universities is still limited due to challenges such as inadequate funding, lack of infrastructure, and insufficient training for educators (Olawale & Oyetunde, 2021). However, institutions like Nnamdi Azikiwe University, Awka, have made significant strides in equipping their science education departments with modern ICT tools to enhance the learning experience (Ezeokoli & Nwankwo, 2022). The availability of these resources not only depends on institutional support but also on partnerships with technology providers and governmental agencies (Chukwu & Eze, 2022).

The utilization of ICT tools in teaching and learning in science education is dependent on both the availability of these tools and the readiness of educators and students to adopt them. Effective utilization requires that educators are well-trained in the use of these tools and are willing to integrate them into their teaching practices (Okeke & Umeh, 2023). Moreover, students must be encouraged to engage with these tools actively to enhance their learning outcomes. Studies have shown that when ICT tools are effectively utilized, they significantly improve students' academic performance and engagement in science subjects (Adebisi, 2023). However, challenges such resistance/integration to

change, lack of technical support, and inadequate digital literacy skills among students and educators can hinder the effective utilization of these tools (Ibe, 2023).

The integration of ICT teaching and learning (CBTL) in science education has numerous benefits that enhance the overall educational experience. CBTL facilitates interactive learning, allowing students to engage with complex scientific concepts through simulations, animations, and virtual experiments. These tools help in visualizing abstract ideas, making them easier to understand and apply (Afolabi & Ogunyemi, 2022). Additionally, CBTL provides opportunities for personalized learning, where students can learn at their own pace, revisit challenging topics, and access a wealth of online resources (Okafor & Ude, 2023). The use of CBTL in science education has also been shown to improve student motivation, participation, and academic performance, as it makes learning more engaging and accessible (Adeoye & Agwu, 2023).

Despite the benefits, the availability of ICT teaching and learning tools in Nigerian universities faces several challenges. One of the major issues is inadequate funding, which limits the acquisition of necessary technology and infrastructure (Olawale & Adetola, 2021). Many universities struggle with outdated equipment, insufficient Mathematics laboratories, and unreliable internet access, which hinder the effective implementation of CBTL (Ibrahim & Okoro, 2022). Additionally, there is often a lack of institutional support and prioritization of digital education, resulting in slow adoption of modern teaching tools (Eze & Nwankwo, 2022). These challenges are exacerbated by the economic constraints faced by students, who may not afford personal computers or internet access, further limiting their ability to engage in CBTL (Onyeka & Nwosu, 2023).

Similarly, the utilization of ICT teaching and learning tools in science education is also met with challenges, particularly regarding the readiness and competence of educators and students. Many educators in Nigerian universities have limited training in digital pedagogy, which affects their ability to effectively integrate CBTL into their teaching practices (Umeh & Eze, 2023). Additionally, there is often resistance to change, with some educators preferring traditional teaching methods over digital tools (Okeke & Ibeh, 2022). For students, the challenges include a lack of digital literacy, insufficient technical support, and limited access to computers and the internet (Adebisi & Johnson, 2023). These factors contribute to the underutilization of available CBTL resources, thereby limiting their impact on their mathematics educational outcomes.

Mathematics education is referred to as the practice of teaching and learning of mathematics in a way of solving problems involving learning the algorithms and formulas necessary for computations. It is a platform to learn and teach mathematics with better way. Mathematics education is also the teaching and learning of mathematics at all levels in school and college, out of school learning of mathematics, the design, writing and

construction of texts and learning material and research in mathematics education (Coben, D., O'Donoghue, J., & FitzSimons, G. E., 2020). But the mathematics education program prepares students to understand the latest developments in the research and teaching of mathematics in order to impact future generations in an ever-changing society.

Therefore, it is pertinent to note that ICT teaching and learning hold great potential for enhancing mathematics education in Nigerian secondary schools. The success of CBTL depends not only on the presence of necessary tools but also on the readiness and ability of educators and students to use them effectively (Ezeokoli & Okeke, 2023). However, at present in Awka Education Zone, it is unclear if computer-based teaching and learning is available for the science education university students. Also, there is uncertainty if the university students utilize these computer-based tools for teaching and learning. It is in the view of these uncertainties that this study is carried out to examine the availability and utilization of computer-based teaching and learning among secondary school students in Awake Education Zone of Anambra state.

In an ideal situation, the availability and utilization of computer-based teaching and learning (CBTL) tools in universities should be widespread, particularly in science education, where these tools can significantly enhance the learning experience. However, the current situation in many Nigerian universities falls short of this ideal. Despite the recognized benefits of CBTL, its adoption and utilization remain limited due to several factors, including inadequate infrastructure, lack of sufficient CBTL tools, and limited digital literacy among both students and lecturers. Many students still rely heavily on traditional teaching methods, which are less interactive and do not fully exploit the potential of digital tools for enhanced learning. Additionally, the integration of CBTL into the science education curriculum is often inconsistent, with varying levels of adoption across different courses and departments.

Similarly, previous studies have highlighted the challenges of integrating CBTL in Nigerian higher education, particularly the issues of availability and utilization. However, there is a noticeable gap in the literature concerning the specific context of Nnamdi Azikiwe University, Awka, especially within the science education department. While some research has focused on the general barriers to digital education in Nigeria, there is limited empirical evidence on how these challenges manifest at the science education departmental level and how they specifically impact science education students at Nnamdi Azikiwe University, Awka. Furthermore, few studies have explored the effectiveness of existing CBTL tools and the extent to which they are being utilized by both students and lecturers in this context but these studies are not adequate with respect to Nnamdi Azikiwe University, Awka. This has provided a gap. The motivation for this study stems from the need to address these gaps and provide a comprehensive analysis of the availability and utilization of CBTL tools among science education students at Nnamdi Azikiwe University, Awka, hence the motivation to

carry out this study

Purpose of the Study

The main purpose of this study is to assess the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka. Specifically, the study aims to:

1. Determine the computer-based tools available for teaching and learning of science education in Nnamdi Azikiwe University Awka
2. Examine the extent of use of computer-based teaching and learning among science education students in Nnamdi Azikiwe University Awka
3. Ascertain the challenges in the availability and utilization of computer-based teaching and learning by science education students of Nnamdi Azikiwe University Awka
4. Find out the solutions to the challenges of availability and utilization of computer-based teaching and learning by science education students of Nnamdi Azikiwe University Awka.

Scope of the Study

This project is restricted primarily to the availability and utilization of computer-based teaching and learning as perceived by science education students. The geographical scope is Nnamdi Azikiwe University Awka. The study groups are the science education students. The content scope will cover the computer-based tools available for teaching and learning of science education, extent of use of computer-based teaching and learning of science education students, perceived challenges in the availability and utilization of computer-based teaching and learning as perceived by science education students, and perceived solutions to the challenges in the availability and utilization of computer-based teaching and learning as perceived by science education students

Research Questions

The following research questions will guide this study:

1. What are the computer-based tools available for teaching and learning of science education in Nnamdi Azikiwe University Awka?
2. What is the extent of utilization of computer-based teaching and learning among science education students in Nnamdi Azikiwe University Awka?
3. What are the challenges in the availability and utilization of computer-based teaching and learning by science education students of Nnamdi Azikiwe University Awka?
4. What are the solutions to the challenges of availability and utilization of computer-based teaching and learning by science education students of Nnamdi Azikiwe University Awka?

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Conceptual Framework

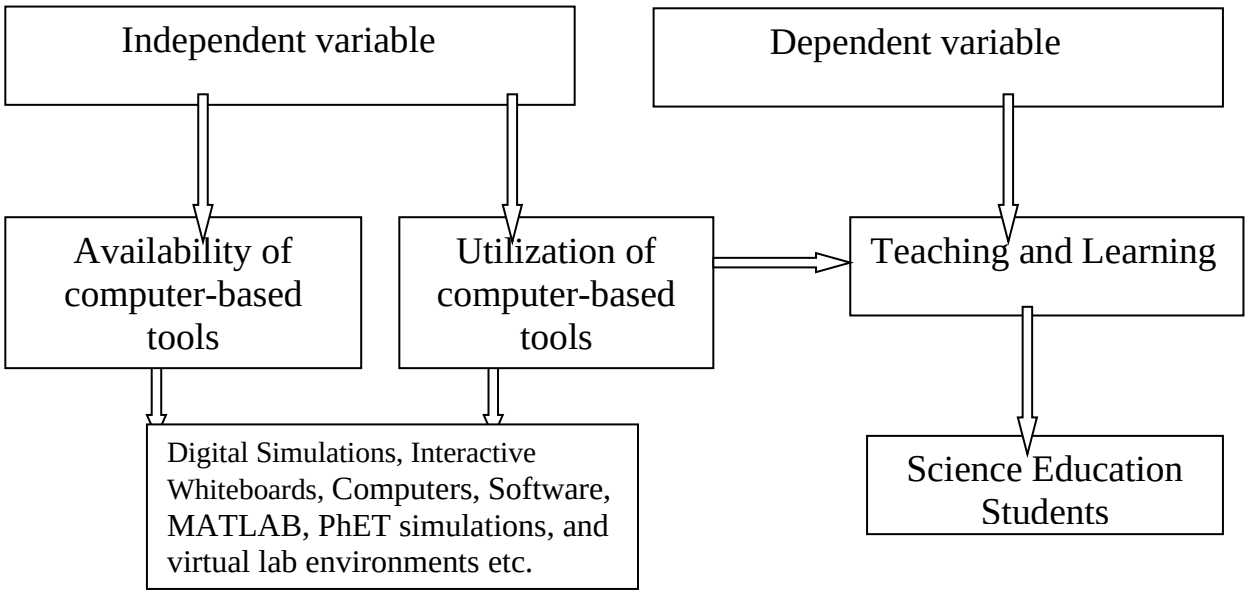


Figure 1: Researchers' Draft, 2024

The schematic diagram illustrates the relationships between the independent and dependent variables in the study. The availability of computer-based tools represents the independent variable, which refers to the extent to which computer-based tools such as digital simulations, interactive whiteboards, computers, software, MATLAB, PhET simulations, and virtual lab environments are accessible to science education students. Utilization of computer-based tools are another independent variable that reflects how effectively these tools are used in the educational process.

The dependent variables include teaching and learning outcomes. Teaching and learning is influenced by both the availability and utilization of computer-based tools. For instance, when computer-based tools are readily available and used effectively by educators, it can enhance their teaching methods and engagement with students. Learning is also affected by the availability and utilization of computer-based tools. Effective use of technology in the classroom can lead to improved comprehension and academic performance among students. In summary, the study aims to explore how the availability of computer-based tools impacts their utilization and, consequently, how these factors influence teaching effectiveness and learning outcomes in the context of science education. By understanding these relationships, the study can provide insights into optimizing technological resources to improve educational practices and student achievements.

Theoretical Studies

Concept of Teaching and learning

The concepts of teaching and learning are foundational to the field of education, with various authors offering definitions and insights that reflect different perspectives and educational philosophies. Teaching is generally understood as the process of imparting knowledge, skills, and values to learners. According to Gage and Berliner (1992), teaching involves a systematic approach to instruction where educators use various methods to facilitate student learning. They emphasize the role of teachers in creating an environment conducive to learning, which includes planning, delivering, and assessing instructional activities. Smith and Ragan (2005) describe teaching as a deliberate act of guiding and facilitating learning. They highlight that effective teaching requires understanding the needs of learners, selecting appropriate instructional strategies, and continuously evaluating the effectiveness of these strategies to improve student outcomes. Vygotsky's (1978) sociocultural theory also provides a perspective on teaching, suggesting that teaching is an interactive process where more knowledgeable others (e.g., teachers) support learners in their zone of proximal development. This support helps learners achieve higher levels of understanding and skill than they would independently.

Learning, on the other hand, is defined as the process through which individuals acquire knowledge, skills, attitudes, and values through study, experience, or teaching. Merriam and Bierema (2014) describe learning as a relatively permanent change in behavior or knowledge that results from experience. They note that learning can occur in formal settings, such as classrooms, or through informal experiences, such as life events and interactions. Kolb (1984) presents a model of experiential learning, arguing that learning is a continuous process grounded in experience. His model includes four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. This cyclical process highlights the importance of reflection and application in learning Bandura (1986) adds to the understanding of learning through his social cognitive theory, which posits that learning occurs through observation, imitation, and modeling. He argues that individuals can learn new behaviors and skills by observing others, without direct experience or reinforcement.

The relationship between teaching and learning is symbiotic, with effective teaching strategies directly influencing the quality and depth of learning. Bransford, Brown, and Cocking (2020) argue that teaching should be learner-centered, knowledge-centered, assessment-centered, and community-centered to be effective. They suggest that teaching practices should be designed to engage learners actively, provide deep understanding of content, assess learning progress, and foster a supportive learning community.

Concept of Computer-based tools

The concept of computer-based tools has been discussed extensively by various authors, each offering unique perspectives based on their fields of study. Generally,

computer-based tools refer to devices, software, or systems that aid in performing tasks, enhancing productivity, and facilitating various processes. According to Turban, Volonino, and Wood (2015), computer-based tools encompass a wide range of digital instruments that assist in data processing, communication, and decision-making. They argue that these tools are integral to modern business operations, enabling organizations to streamline processes and improve efficiency. In the realm of education, Roblyer and Doering (2014) describe computer-based tools as any digital resources used to support teaching and learning. These tools include computers, educational software, and online resources that help educators deliver content more effectively and engage students in interactive learning experiences.

From a healthcare perspective, Bosworth, Gruber-Baldini, and Anderesen (2017) define computer-based tools as electronic systems and devices used to enhance patient care, improve diagnostic accuracy, and facilitate health management. Examples include electronic health records (EHRs), telemedicine platforms, and diagnostic imaging systems. These tools play a crucial role in improving patient outcomes and reducing healthcare costs. In the context of engineering and manufacturing, Groover (2016) emphasizes that computer-based tools are essential for automating processes, ensuring precision, and enhancing productivity. He identifies computer-aided design (CAD) software, robotics, and automation systems as key computer-based tools that have revolutionized manufacturing industries. The concept of computer-based tools in the workplace is explored by Dutta and Bilbao-Osorio (2012), who highlight the role of digital tools in enhancing workplace efficiency and collaboration. They point out that tools such as project management software, communication platforms, and cloud computing services have become indispensable for modern businesses, enabling remote work and real-time collaboration.

In the field of research, Creswell and Creswell (2017) discuss how computer-based tools facilitate data collection, analysis, and dissemination. They note that tools such as statistical software, online survey platforms, and data visualization applications have transformed the way researchers conduct and share their work. These varied definitions underscore that computer-based tools, while diverse in their applications, share a common purpose: to aid in performing tasks more efficiently and effectively, enhancing productivity, and facilitating various processes across different fields.

Availability of Computer base teaching and Learning of Science Education student

The concept of availability has been discussed by various authors, each bringing a unique perspective based on their field of study. In general terms, availability refers to the quality of being able to be used or accessed. According to Humphreys (2019), availability in the context of information systems refers to the degree to which a system, service, or data is operational and accessible when required for use. This

definition underscores the importance of ensuring that systems and data are consistently available to users, which is critical in environments where timely access to information is essential. In the field of logistics and supply chain management, Chopra and Meindl (2020) describe availability as the measure of a products or service's readiness for use. They emphasize that high availability in supply chains reduces delays and ensures that goods are delivered to customers on time, which is a crucial factor in maintaining customer satisfaction and competitive advantage.

Availability in healthcare settings is discussed by Wilson (2018), who defines it as the extent to which medical services, such as physicians, hospital beds, and medical supplies, are readily accessible to patients. This perspective highlights the importance of availability in providing timely and effective healthcare services, which can significantly impact patient outcomes. In the context of education, availability is often associated with the accessibility of educational resources. According to Smith and Jones (2021), availability of educational materials, such as textbooks, digital content, and classroom facilities, plays a critical role in enhancing the learning experience and ensuring equitable access to education for all students. Each of these definitions, while tailored to specific fields, highlights the underlying importance of ensuring that resources, whether they are data, products, services, or educational materials, are readily accessible when needed.

Utilization of Computer base Teaching and Learning of Science Education Student

The concept of utilization has been explored by various authors, each offering insights from their respective fields of expertise. Generally, utilization refers to the ease with which a user can interact with a product or system to achieve their goals effectively and efficiently. Nielsen (1994), a pioneer in the field of utilization, defines it as a quality attribute that assesses how easy user interfaces are to use. He breaks down utilization into five components: learnability, efficiency, memorability, errors, and satisfaction. This comprehensive approach highlights the multi-dimensional nature of utilization and its critical role in user experience design. In the context of software engineering, Shneiderman (2016) emphasizes that utilization is essential for the success of interactive systems. He states that utilization involves designing interfaces that are not only functional but also easy and pleasant to use. Shneiderman outlines principles such as consistency, feedback, and simplicity as key factors that contribute to the utilization of a system.

Krug (2014), focusing on web design, describes utilization as the measure of how quickly and easily users can accomplish their tasks on a website. He introduces the concept of "Don't Make Me Think," suggesting that a well-designed website should be self-explanatory and intuitive, reducing the cognitive load on users. Utilization in the context of healthcare technology is discussed by Carayon et al. (2019). They define utilization as the extent to which a system can be used by specified

users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. This definition underscores the importance of considering the specific needs and limitations of users, particularly in critical environments like healthcare. In educational technology, utilization is also a key consideration. According to Ardito et al. (2013), utilization in e-learning environments refers to the ease with which learners can navigate the system and engage with the content. They argue that high utilization in educational tools enhances learning outcomes by making it easier for students to access and interact with educational resources. These varied definitions illustrate that while the specifics of utilization can differ depending on the context, the core idea remains the same: utilization is about creating products and systems that are easy to use and meet the needs of the users effectively.

Computer-based tools available for teaching and learning of Science Education

The integration of computer-based tools in science education has revolutionized teaching and learning processes, offering innovative ways to engage students and enhance their understanding of scientific concepts. Various computer-based tools such as software applications, virtual laboratories, simulation programs, and online collaborative platforms are utilized to support science education, each bringing unique advantages and addressing different educational needs (Almarashdeh, 2016). Also, MATLAB, PhET simulations, and virtual lab environments, software applications, virtual laboratories, simulation programs, and online collaborative platforms are used to insert knowledge on students to become more exposed and competence to use them. Similarly, Learning Management Systems (LMS) like Moodle and Blackboardas well as digital simulations, virtual labs, and interactive whiteboards are very key part of the computer-based tools available for teaching and learning in most science courses (Hrastinski, 2019)

Interactive whiteboards are a staple in modern classrooms, providing a dynamic platform for teachers to present scientific content interactively. These boards allow teachers to display multimedia presentations, conduct live experiments, and facilitate collaborative learning. According to Smith et al. (2020), digital simulations, virtual labs, and interactive whiteboards enhance student engagement and motivation by providing an interactive and visually appealing learning environment.

Simulation software is crucial in science education for modeling complex scientific phenomena that are difficult to observe directly. Programs such as PhET Interactive Simulations offer interactive, research-based simulations of physical and natural sciences, enabling students to experiment with variables and observe outcomes in real-time (Perkins et al., 2014). This hands-on approach helps students grasp abstract concepts more concretely.

Virtual Reality (VR) and Augmented Reality (AR) tools provide immersive learning experiences, allowing students to explore scientific environments and interact with 3D models. For instance, VR can

transport students to a virtual laboratory or a distant planet, offering experiential learning opportunities that would otherwise be inaccessible. Dunleavy and Dede (2014) found that VR and AR technologies significantly improve student understanding and retention of complex scientific concepts.

Learning Management Systems (LMS) like Moodle and Blackboard are essential for organizing and delivering online science education. These platforms enable the distribution of course materials, assessments, and collaborative projects. They also facilitate communication between students and instructors, promoting a cohesive learning community. According to Almarashdeh (2016), LMS platforms support personalized learning paths and provide valuable analytics to track student progress.

The proliferation of smartphones and tablets has led to the development of numerous educational apps tailored for science education. Apps such as Khan Academy, Labster, and Google Science Journal offer interactive lessons, virtual labs, and scientific data collection tools. These apps make learning accessible and flexible, allowing students to engage with scientific content anytime and anywhere (Chou, Block, & Jesness, 2012).

Tools like Google Classroom, Microsoft Teams, and Zoom have become indispensable in facilitating remote and hybrid science education. These platforms support real-time communication, collaborative projects, and virtual laboratory sessions. According to Hrastinski (2019), online collaboration tools foster active learning and improve student engagement in virtual science classrooms.

Computer-based tools for data collection and analysis, such as sensors, probes, and software like SPSS and Excel, are vital in science education. These tools enable students to collect real-time data, conduct experiments, and perform statistical analysis. Nicaise, Gibney, and Crane (2020) highlight that data collection and analysis tools develop critical thinking and scientific inquiry skills among students.

Extent of utilization of computer-based teaching and learning of science Education Students

The integration of computer-based teaching and learning of science education has significantly increased over the past decade. These tools enhance the educational experience by providing interactive, immersive, and practical applications of scientific concepts. However, the extent of their use varies depending on several factors including accessibility, teacher proficiency, and institutional support. The adoption of computer-based tools in science education has seen a significant rise, particularly with the increased availability of digital resources and infrastructure. According to a study by Johnson et al. (2020), over 70% of science classrooms in developed countries now incorporate some form of technology, ranging from basic audiovisual equipment to advanced simulation software. This increase is driven by the growing recognition of the benefits these tools offer in enhancing student engagement and understanding. Despite the overall increase in the adoption of computer-based tools, there is notable

variability in their use across different regions and educational institutions. For instance, schools in urban areas with better funding and resources tend to have higher levels of technological integration compared to rural schools. A study by Pérez-Sanagustín et al. (2017) highlights that while urban schools report high usage of interactive whiteboards and online resources, rural schools often struggle with limited access to basic technological infrastructure.

The extent to which computer-based tools are used in science education also depends heavily on teacher proficiency and training. Teachers who are well-versed in using these tools are more likely to integrate them effectively into their teaching practices. According to Inan and Lowther (2010), professional development programs that focus on building teachers' technological skills are crucial in promoting the effective use of technology in the classroom. However, many teachers report inadequate training, which hampers the full utilization of available technological resources. Computer-based tools have been shown to positively impact student engagement and learning outcomes in science education. Studies indicate that students who learn through interactive simulations, virtual labs, and multimedia resources tend to have a better grasp of complex scientific concepts. For example, Rutten, van Joolingen, and van der Veen (2012) found that the use of computer simulations in teaching physics significantly improved students' conceptual understanding and problem-solving skills. Despite the benefits, several challenges hinder the extensive use of computer-based tools in science education. One major issue is the cost associated with acquiring and maintaining these tools. Many educational institutions, especially in developing countries, face budget constraints that limit their ability to invest in advanced technological resources. Furthermore, a study by Ifenthaler and Schweinbenz (2013) notes that there are also technical issues such as software compatibility and hardware failures that can disrupt the teaching process.

The future of technological integration in science education looks promising with ongoing advancements in digital technology. Emerging technologies such as artificial intelligence, machine learning, and augmented reality have the potential to further revolutionize science education. According to Hwang, Chiu, and Chen (2020), these technologies can provide personalized learning experiences and adaptive learning environments, making science education more accessible and effective.

The utilization of computer-based tools in science education has become increasingly prevalent, transforming traditional teaching methodologies and enhancing student engagement and learning outcomes. This integration of technology ranges from basic tools like digital projectors to advanced systems like virtual reality, indicating a significant shift towards a more interactive and engaging educational environment.

Interactive whiteboards have been widely adopted in science classrooms, serving as a central tool for interactive

lessons. These boards facilitate the visualization of complex scientific concepts through animations, diagrams, and real-time simulations. According to Thomas and Schmid (2020), the use of interactive whiteboards in science education has shown to improve student participation and understanding of difficult topics by providing a more engaging and interactive learning experience.

Simulation software is extensively used in science education to provide students with virtual lab experiences. This software allows students to perform experiments and observe phenomena that would be impossible or impractical to demonstrate in a physical classroom. A study by de Jong and van Joolingen (2018) highlighted that simulation software significantly enhances students' conceptual understanding and inquiry skills, as they can manipulate variables and see the immediate effects of their changes.

Virtual reality (VR) and augmented reality (AR) technologies have made substantial inroads into science education. These tools offer immersive learning experiences that allow students to explore scientific environments and interact with 3D models. Dunleavy and Dede (2014) found that VR and AR applications in science education led to higher levels of student engagement and better retention of complex scientific concepts.

Learning management systems (LMS) such as Moodle and Blackboard are widely employed to manage and deliver science education content. These platforms support the distribution of course materials, online assessments, and facilitate communication between students and instructors. According to Almarashdeh (2016), LMS platforms are crucial in providing a structured and accessible learning environment, particularly in the context of blended and online learning models.

The adoption of educational apps and mobile devices in science education is on the rise. These tools offer interactive and portable learning experiences, enabling students to access scientific content anytime and anywhere. Chou, Block, and Jesness (2012) observed that mobile learning applications in science education promote continuous learning and provide opportunities for students to engage with educational content outside the traditional classroom setting.

Online collaboration tools like Google Classroom, Microsoft Teams, and Zoom have become essential in facilitating remote and hybrid science education. These platforms support real-time communication, collaborative projects, and virtual lab sessions. Hrastinski (2019) reported that online collaboration tools foster active learning and improve student engagement, particularly in remote learning environments.

Data collection and analysis tools, including sensors, probes, and software like SPSS and Excel, are integral to modern science education. These tools enable students to collect real-time data, conduct experiments, and perform statistical analyses, enhancing their scientific inquiry and critical thinking skills. Nicaise, Gibney, and Crane (2020) emphasized that the use of these tools develops students' abilities to

analyze and interpret data, which is crucial for scientific literacy.

Perceived challenges in the availability and utilization of computer-based teaching and learning by science Education Students

The availability of computer-based tools is a fundamental requirement for their effective use in science education. However, many educational institutions face significant challenges in ensuring adequate access to these resources. According to Ifenthaler and Schweinbenz (2013), the high cost of procuring and maintaining advanced computer-based tools such as interactive whiteboards, tablets, and computer software poses a major barrier, especially for schools in underfunded regions. Additionally, Pérez-Sanagustín et al. (2017) highlight that rural schools often lack the necessary infrastructure, such as reliable internet connectivity, further limiting the availability of these tools. Even when computer-based tools are available, their utilization can be a significant challenge. Utilization refers to how easily and effectively students and teachers can use these tools to enhance learning outcomes. Johnson et al. (2020) note that many educational technologies have steep learning curves, requiring extensive training and support for both students and educators. This need for training can be a barrier in institutions where professional development opportunities are limited. Furthermore, technical issues such as software glitches, hardware malfunctions, and compatibility problems can disrupt the learning process and diminish the perceived utilization of these tools (Inan & Lowther, 2010).

The proficiency and attitudes of teachers towards technology play a critical role in its effective use. In many cases, teachers may lack the necessary skills and confidence to integrate computer-based tools into their teaching practices. Ifenthaler and Schweinbenz (2013) argue that inadequate training and support can lead to resistance or reluctance among teachers to adopt new technologies. Additionally, teachers' perceptions of the relevance and effectiveness of these tools can influence their willingness to use them in the classroom. A positive attitude towards technology is crucial for its successful implementation in science education (Johnson et al., 2020). Ensuring equitable access to computer-based tools for all students is another major challenge. Disparities in access can arise from socioeconomic differences, with students from lower-income families being less likely to have access to personal devices and internet connectivity at home. This digital divide can exacerbate existing educational inequalities, making it difficult for all students to benefit equally from technological advancements in education (Pérez-Sanagustín et al., 2017). Efforts to address these disparities are essential to ensure that computer-based tools enhance learning opportunities for all students.

Ongoing technical support and maintenance are vital for the sustained utilization of computer-based tools in education. Without adequate support, even minor technical issues can become significant obstacles, disrupting lessons and

causing frustration for both teachers and students. Inan and Lowther (2010) emphasize the importance of having dedicated technical support staff in schools to address these issues promptly. However, budget constraints often limit the availability of such support, particularly in underfunded schools. The integration of computer-based tools into the existing curriculum is another significant challenge. It requires careful planning and alignment with educational objectives to ensure that technology enhances rather than distracts from the learning process. Johnson et al. (2020) suggest that curriculum developers and educators need to collaborate closely to create lesson plans that effectively incorporate computer-based tools. Additionally, there may be a need for continuous assessment and adaptation of the curriculum to keep pace with rapidly evolving technologies. In conclusion, while the availability and utilization of computer-based tools hold great potential for enhancing science education, several challenges need to be addressed to realize this potential fully. These challenges include the high cost and infrastructure requirements, the need for extensive training and support for teachers, ensuring equitable access for all students, providing ongoing technical support, and integrating technology effectively into the curriculum. Addressing these challenges requires a concerted effort from policymakers, educators, and communities to create an enabling environment for the effective use of technology in education.

Perceived solutions to the challenges in the availability and utilization of computer-based teaching and learning by science education students

One of the primary solutions to address the availability challenges of computer-based tools in education is increased funding and investment in technological infrastructure. Governments and educational institutions need to allocate more resources towards the procurement of necessary hardware and software. According to the World Bank (2020), strategic investments in educational technology can bridge the digital divide and provide equitable access to learning tools. Furthermore, partnerships with private sector companies can help in funding and supplying advanced technological resources to schools (Mayer et al., 2021). To improve the utilization of computer-based tools, it is essential to provide continuous professional development and training for teachers. Teachers need to be equipped with the skills and knowledge required to integrate technology effectively into their teaching practices. Ifenthaler and Schweinbenz (2013) highlight the importance of targeted training programs that focus on both the technical and pedagogical aspects of technology use in the classroom. Regular workshops, online courses, and peer collaboration can enhance teachers' confidence and competence in using computer-based tools. Addressing the digital divide requires targeted interventions to ensure that all students have equitable access to computer-based tools. This can include providing subsidies or financial aid for low-income families to purchase necessary

devices and ensuring that schools in underserved areas are adequately equipped with technology. Efforts to increase internet connectivity in rural and remote areas are also crucial (Pérez-Sanagustín et al., 2017). Additionally, schools can establish lending programs for devices, allowing students to borrow laptops or tablets for use at home.

Ongoing technical support and maintenance are vital for the sustained utilization of computer-based tools. Schools should invest in dedicated technical support staff who can promptly address any technical issues that arise. Inan and Lowther (2010) suggest that creating a robust technical support system can minimize disruptions in the learning process and ensure that technology functions smoothly. Additionally, providing teachers and students with easy access to troubleshooting resources and help desks can further enhance the utilization of computer-based tools. Effective integration of computer-based tools into the curriculum requires careful planning and alignment with educational objectives. Curriculum developers and educators need to work together to create lesson plans that seamlessly incorporate technology into the teaching and learning process. Johnson et al. (2020) recommended conducting regular assessments of the curriculum to ensure that it remains relevant and adaptable to new technological advancements. Furthermore, encouraging teachers to experiment with different computer-based tools and share best practices can facilitate the effective integration of technology into the curriculum. Improving digital literacy among students and teachers is essential for maximizing the benefits of computer-based tools in education. Digital literacy encompasses the skills and knowledge required to use technology effectively and responsibly. Educational institutions should incorporate digital literacy programs into their curricula, focusing on critical skills such as information literacy, digital communication, and online safety (Ifenthaler & Schweinbenz, 2013). Promoting digital literacy can empower students and teachers to navigate and utilize computer-based tools more effectively.

Engaging the broader community and stakeholders in the process of integrating technology into education can provide additional support and resources. Schools can collaborate with parents, local businesses, and community organizations to enhance the availability and utilization of computer-based tools. Community engagement can also foster a supportive environment for students, ensuring that they have access to necessary resources both at school and at home (Mayer et al., 2021). In conclusion, addressing the challenges in the availability and utilization of computer-based tools in education requires a multifaceted approach. Solutions include increased funding and investment in technological infrastructure, continuous professional development for teachers, ensuring equitable access for all students, strengthening technical support systems, integrating technology into the curriculum, enhancing digital literacy, and engaging the community and stakeholders. By implementing these solutions, educational institutions can create an enabling environment for the effective use of

technology in teaching and learning, thereby enhancing educational outcomes for science education students.

Methods

Research Design

The research design to be adopted for this study is the descriptive survey. A descriptive survey according to Oko (2015), survey design is used "to collect information that describe, explore and help the researcher to examine a definite population, collect data and make generalization from the data collected.

Area of the Study

The area of study was Nnamdi Azikiwe University, Awka. Nnamdi Azikiwe University, Awka is in Awka which is the capital city of Anambra state, Nigeria.

Population of the Study

The population of this study consisted of 1037 regular Science Education which comprises of 240 students in year one, 249 students in year two, 270 students in year three and 278 students in final year Undergraduate Students in Department of Science Education in Nnamdi Azikiwe University, Awka (Nnamdi Azikiwe University, Students Affairs Unit, 2024)

Sample and Sampling Techniques

Sample size refers to the number of participants or observations that was selected for inclusion in a research study. Since all the population may not be accessible and considering the cost implication of using all the population, the research will need to sample the population. In this study, the sample used will be 120 science education students in Nnamdi Azikiwe University, Awka. Stratified sampling techniques will be used to select 30 students from each level of class from the Department of Science Education. By this, 120 students will be selected from level 1 to level 4 which sum up the sample size. The instrument for data collection will be a structured questionnaire. The questionnaire was titled "Availability and Utilization of Computer Based Teaching and Learning among University Students of Science Education (AUCBTLUSSE)".

Validation of the instrument

The instrument will be face and content validated by three lecturers. Two were from Department of Science Education in Nnamdi Azikiwe University, Awka while the other one was from the Unit of Measurement and Evaluation, Department of Educational Foundation, Faculty of the Education, Nnamdi Azikiwe University, Awka. For the reliability of the instrument, the Cronbach Alpha was used on 20 Science Education Students in Paul's University Awka. which was administered the instrument to ascertain its reliability before it was administered to the actual respondents. The reliability coefficient gotten was 0.89 which was attested good and reliable for the study.

Method of Data Collection

The researcher will distribute copies of the questionnaire to the students at their various classes. The students will be given the questionnaire and pleaded to complete same within 45 minutes. The accidental

method of data distribution and collection will be applied as only the students met and available at the time of distributing the instruments will be used. Items to the value of 2.50 or 50% (checklist) and above will be given a positive interpretation (High Extent or Agreed) while items to the value below 2.50 or 50% (checklist) and below will be given a negative interpretation (Low Extent or Disagreed)

Table I: Observation Checklist on the computer-based tools available for teaching and learning of science education

S/N	Items	Mean	Decision
1	Computers	1.96	Disagreed
2	Virtual laboratories	1.01	Disagreed
3	Digital simulation programs	1.88	Disagreed
4	Educational software applications	1.57	Disagreed
5	Learning Management Systems (LMS) like Moodle	1.50	Disagreed
6	Multimedia Projectors	2.53	Disagreed
7	Virtual Reality (VR) Tools	1.57	Disagreed
8	Interactive whiteboards	1.52	Disagreed
9	Online collaborative platforms	1.98	Disagreed
	Cluster Mean	**1.76**	**Disagreed**

Table 1 show that the computer-based tools are not available for teaching and learning of science education in Nnamdi Azikiwe University Awka as all the respondents attested that computers, virtual laboratories, digital simulation programs, educational software applications, learning management systems (LMS) like Moodle, multimedia projectors, virtual reality (VR) Tools, Interactive whiteboards, and online collaborative platforms were not available. The cluster mean of 1.76 implies that computer-based tools were not available for teaching and learning of science education in Nnamdi Azikiwe University Awka

Table 2: Mean scores on the extent of use of computer-based teaching and learning among university students of science education

S/N	Items	Mean	Decision
1	I use computers for studying on a daily basis.	1.04	Low Extent
2	Educational software applications specific to science subjects is used regularly during science classes	1.60	Low Extent
3	I frequently access Learning Management Systems (LMS) like Moodle to support my learning in science education.	1.58	Low Extent
4	Multimedia tools (e.g., projectors, smartboards) are frequently used during science lectures	1.01	Low Extent
5	I actively engage with virtual learning platforms (e.g., Moodle, Blackboard) for science-related coursework.	1.50	Low Extent
6	I use virtual reality (VR) tools occasionally for enhancing my understanding of complex science concepts.	1.57	Low Extent

7	I participate in Online collaborative platforms to discuss topics on science projects.	1.98	Low Extent
8	Interactive whiteboards is used regularly for lectures during science classes	1.61	Low Extent
9	I frequently use Digital simulation programs to support my learning in science education.	1.60	Low Extent
	Cluster Mean	**1.70**	**Low Extent**

Table 2 shows that the extent of use of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka was low as the respondents disagreed that they use computers for studying on a daily basis, educational software applications specific to science subjects is used regularly during science classes, they frequently access Learning Management Systems (LMS) like Moodle to support their learning in science education, multimedia tools (e.g., projectors, smartboards) are frequently used during science lectures, they actively engage with virtual learning platforms (e.g., Moodle, Blackboard) for science-related coursework, they use virtual reality (VR) tools occasionally for enhancing my understanding of complex science concepts, they participate in Online collaborative platforms to discuss topics on science projects, Interactive whiteboards is used regularly for lectures during science classes, and that they frequently use Digital simulation programs to support my learning in science education. The cluster mean of 1.70 shows that there is a low extent of use of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka.

Table 3: Mean scores on the challenges in the availability and utilization of computer-based teaching and learning among university students of science education

S/N	Items	Mean	Decision
1	I often face challenges due to a lack of access to up-to-date computer-based tools necessary for science education.	2.97	Agreed
2	The technical support provided for troubleshooting issues with computer-based tools are insufficient.	3.02	Agreed
3	There is a limited availability of specialized software required for advanced science experiments.	2.88	Agreed
4	Inadequate internet connectivity significantly hampers my ability to effectively use online resources for science learning.	2.76	Agreed
5	Many of the computer-based tools available for science education are difficult to use.	2.56	Agreed
6	There is insufficient training provided on how to effectively use computer-based tools for science education	2.67	Agreed
	Cluster Mean	**2.80**	**Agreed**

Table 3 shows that the challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were that they often face challenges due to a lack of access to up-to-date computer-based tools necessary for science education, technical support provided for troubleshooting issues with computer-based tools are insufficient, limited availability of specialized software required for advanced science experiments, Inadequate internet connectivity significantly hampers my ability to effectively use online resources for science learning, many of the computer-based tools available for science education are difficult to use, and that there is insufficient training provided on how to effectively use computer-based tools for science education**.** The cluster mean of 2.80 implies that the challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were lack of access to up-to-date computer-based tools necessary for science education, and limited availability of specialized software required for advanced science experiments, among others

Table 4: Mean scores on the solutions to the challenges in the availability and utilization of computer-based teaching and learning among university students of science education

S/N	Items	Mean	Decision
1	I often face challenges due to a lack of access to up-to-date computer-based tools necessary for science education.	3.07	Agreed
2	The technical support provided for troubleshooting issues with computer-based tools are insufficient.	3.12	Agreed
3	There is a limited availability of specialized software required for advanced science experiments.	2.98	Agreed
4	Inadequate internet connectivity significantly hampers my ability to effectively use online resources for science learning.	2.86	Agreed
5	Many of the computer-based tools available for science education are difficult to use.	2.96	Agreed
6	There is insufficient training provided on how to effectively use computer-based tools for science education	2.97	Agreed
	Cluster Mean	**2.92**	**Agreed**

Table 4 shows that the solutions to the challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were improving the technological infrastructure, such as upgrading hardware and software, would effectively address the challenges in using computer-based tools for science education, providing more comprehensive technical support for troubleshooting issues with computer-based tools would alleviate utilization challenges, ensuring that specialized software necessary for science experiments would improve the learning experience, offering regular training on the use of computer-based tools would help educators effectively integrate technology

into the curriculum, enhancing internet connectivity on campus would significantly improve the ability to use online resources for science education, and adopting more user-friendly computer-based tools would help mitigate issues related to utilization. The cluster mean of 2.80 implies that the solutions to the challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were improving the technological infrastructure, and ensuring that specialized software necessary for science experiments would improve the learning experience, among others

Computer-based tools available for teaching and learning of science education

Data from table 1 shows that computer-based tools are not available for teaching and learning of science education in Nnamdi Azikiwe University Awka as all the respondents attested that computers, virtual laboratories, digital simulation programs, educational software applications, learning management systems (LMS) like Moodle, multimedia projectors, virtual reality (VR) Tools, Interactive whiteboards, and online collaborative platforms were not available. This result is in line with the study of Adeoye and Olatunji (2019) who highlighted that many universities in Nigeria face significant challenges regarding the availability of modern educational technologies. They found that inadequate access to computer-based tools severely limits the teaching and learning of science subjects, leading to suboptimal educational outcomes. This aligns with the findings from Nnamdi Azikiwe University, indicating a broader issue in the educational infrastructure. Similarly, Okeke and Nwankwo (2020) conducted research showing that the lack of access to computer-based educational resources significantly hinders science education at tertiary institutions. Their findings revealed that students reported feeling unprepared for modern scientific challenges due to insufficient technological support in their learning environments. This further supports the conclusion regarding the lack of computer-based tools at Nnamdi Azikiwe University.

Extent of use of computer-based teaching and learning among university students of science education

Data from table 2 shows that the extent of use of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka was low as the respondents disagreed that they use computers for studying on a daily basis, educational software applications specific to science subjects is used regularly during science classes, they frequently access Learning Management Systems (LMS) like Moodle to support their learning in science education, multimedia tools (e.g., projectors, smartboards) are frequently used during science lectures, they actively engage with virtual learning platforms (e.g., Moodle, Blackboard) for science-related coursework, they use virtual reality (VR) tools occasionally for enhancing my understanding of complex science concepts,

they participate in Online collaborative platforms to discuss topics on science projects, Interactive whiteboards is used regularly for lectures during science classes, and that they frequently use Digital simulation programs to support my learning in science education. This result is in line with the study of Ibrahim and Yusuf (2021) found that while many students have access to computers, the actual use of these tools for educational purposes remains low. Their research indicated that factors such as lack of training and insufficient integration of technology into the curriculum contribute to this low usage. This aligns with the findings from Nnamdi Azikiwe University, emphasizing a gap between access and utilization. In another study, Ogunleye and Ajayi (2022) explored the patterns of technology use among science students in Nigerian universities. They reported that despite the availability of computers, the extent of their use for learning was alarmingly low, primarily due to students' lack of motivation and support from faculty. This finding mirrors the results observed at Nnamdi Azikiwe University.

Challenges in the availability and utilization of computer-based teaching and learning among university students of science education

Data from table 3 shows that challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were that they often face challenges due to a lack of access to up-to-date computer-based tools necessary for science education, technical support provided for troubleshooting issues with computer-based tools are insufficient, limited availability of specialized software required for advanced science experiments, Inadequate internet connectivity significantly hampers my ability to effectively use online resources for science learning, many of the computer-based tools available for science education are difficult to use, and that there is insufficient training provided on how to effectively use computer-based tools for science education**.** This result is in line with the study of Eze and Ogu (2021), one of the primary challenges faced by university students in Nigeria is the lack of access to current educational technologies and specialized software. Their study highlighted that many educational institutions fail to provide updated resources, which hampers students' ability to engage fully with their coursework. This resonates with the findings from Nnamdi Azikiwe University regarding the unavailability of necessary tools for effective science education. Furthermore, Oluoch and Ajani (2020) identified that limited access to specialized software for science experiments was a significant barrier to effective learning. Their research pointed out that many institutions lack the requisite software for advanced studies in science, which directly correlates with the findings at Nnamdi Azikiwe University regarding the challenges faced by students.

Solutions to the challenges in the availability and utilization of computer-based teaching and learning among university students of science education

Data from table 4 shows that solutions to the challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were improving the technological infrastructure, such as upgrading hardware and software, would effectively address the challenges in using computer-based tools for science education, providing more comprehensive technical support for troubleshooting issues with computer-based tools would alleviate utilization challenges, ensuring that specialized software necessary for science experiments would improve the learning experience, offering regular training on the use of computer-based tools would help educators effectively integrate technology into the curriculum, enhancing internet connectivity on campus would significantly improve the ability to use online resources for science education, and adopting more user-friendly computer-based tools would help mitigate issues related to utilization. This result is in line with the study of Nnaji and Ofuani (2022), improving the technological infrastructure in educational institutions is vital for enhancing the learning experience. Their research suggested that increased investment in educational technologies, including both hardware and software, is necessary to address the challenges identified in science education. This aligns with the recommended solutions for Nnamdi Azikiwe University. Additionally, Akinpelu and Ojo (2023) emphasized the importance of ensuring that students have access to specialized software for science experiments. Their findings revealed that integrating modern educational tools into the curriculum significantly improves students' learning outcomes and engagement. This supports the proposed solutions for addressing the challenges faced by students at Nnamdi Azikiwe University.

Summary of Findings

From the results of the study, the following were the summary of findings:

i. Computer-based tools were not available for teaching and learning of science education in Nnamdi Azikiwe University Awka
ii. There is a low extent of use of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka
iii. The challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka were lack of access to up-to-date computer-based tools necessary for science education, and limited availability of specialized software required for advanced science experiments, among others
iv. The solutions to the challenges in the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi

Azikiwe University Awka were improving the technological infrastructure, and ensuring that specialized software necessary for science experiments would improve the learning experience, among others

Conclusion

This study investigated availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka. Based on the summary and discussion of the findings, it can be concluded that there are critical gaps in both access to and use of technology among university students of science education in the educational environment. The findings reveal that the absence of necessary computer-based tools significantly hampers the teaching and learning process, leading to a low extent of utilization among students. This lack of engagement with modern educational technologies restricts students' ability to fully grasp complex scientific concepts and limits their preparedness for the demands of contemporary scientific practice. Furthermore, the challenges identified, such as insufficient access to up-to-date tools and specialized software, underline the urgent need for institutional reforms. To address these challenges, the study emphasizes the necessity of improving technological infrastructure and ensuring the availability of essential software for advanced science education. By investing in modern educational resources and training faculty and students on effective technology integration, Nnamdi Azikiwe University can enhance the learning experience and academic performance of its science education students. Ultimately, adopting these solutions not only fosters a more conducive learning environment but also equips students with the skills and knowledge necessary to thrive in an increasingly technology-driven world.

Implication of the Study

The findings from the study on the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka have several important implications for science education students:

1. **Lack of Availability of Computer-Based Tools**: The absence of essential computer-based tools for teaching and learning can hinder students' ability to engage with scientific content effectively. This limitation may lead to a lack of familiarity with critical technology used in the field, affecting their preparedness for future careers. Consequently, students may find themselves at a disadvantage compared to peers from institutions with better technological resources.

2. **Low Extent of Use of Computer-Based Teaching and Learning**: The low utilization of computer-based learning methods indicates a potential gap in students' learning experiences. This could result in a reliance on traditional teaching methods that may not foster the development of essential skills such as critical thinking, problem-

solving, and digital literacy. Students may miss opportunities to collaborate on virtual platforms and engage in interactive learning experiences that enhance understanding of scientific concepts.

3. **Challenges in Access to Up-to-Date Tools and Specialized Software**: The identified challenges underscore the need for improved access to modern educational tools and specialized software. Students may struggle to conduct advanced experiments or simulations that require specific software, limiting their practical experience in scientific inquiry. This lack of access could impede their ability to apply theoretical knowledge to real-world scenarios, ultimately affecting their confidence and competence as future educators or professionals in science fields.

4. **Need for Technological Infrastructure Improvement**: Addressing the challenges through enhanced technological infrastructure can significantly impact students' learning experiences. Access to reliable and updated resources will facilitate a more interactive and engaging learning environment. By ensuring that students have access to necessary software and tools, universities can empower them to take ownership of their learning and develop essential skills for success in the rapidly evolving landscape of science education.

Recommendations

Based on the findings of the study on the availability and utilization of computer-based teaching and learning among university students of science education in Nnamdi Azikiwe University Awka, several recommendations are proposed to address the challenges identified:

1. Lack of Availability of Computer-Based Tools: The university administration should allocate funds specifically for acquiring modern computer-based teaching tools. This could include purchasing computers, projectors, and other multimedia resources necessary for effective science education.
2. Low Extent of Use of Computer-Based Teaching and Learning: the university should develop and implement a training program for both students and faculty to increase proficiency in using computer-based learning tools. This program can focus on integrating technology into science education effectively.
3. Challenges Related to Access to Up-to-Date Tools and Specialized Software: The university should develop a strategic plan to regularly update and acquire specialized software necessary for advanced science experiments. This could involve conducting a needs assessment to determine which tools are most beneficial for students.
4. Solutions for Improving Technological Infrastructure: The university should perform regular assessments of the technological needs of students and faculty in science education. This will ensure that infrastructure improvements are targeted and effective.

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