

**INVESTIGATING THE ROLE OF MOBILE LEARNING APPS IN IMPROVING  
CHEMISTRY STUDENTS' UNDERSTANDING OF CHEMISTRY IN NIGERIAN  
UNIVERSITIES**

**BY**

**Delight Ojevwe MREKA**

**EDU2005297**

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## CERTIFICATION

The undersigned, certify that this research project was carried out by **Delight Ojevwe MREKA** in the Department of Curriculum and Instructional Technology, University of Benin, Benin City.

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**Dr. E. P. IKUEREYE**

Project Supervisor

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**Signature and Date**

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**DR. (MRS.) A. H. OYAKHIROME**

Project Coordinator

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**Signature and Date**

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**DR. FESTUS O. IDEHEN**

Head of Department

---

**Signature and Date**

## **DEDICATION**

This project research is dedicated to God for His unwavering support, sustenance and love towards me. Also, to my Dad and Mum for their love and encouragement.

## ACKNOWLEDGEMENT

The researcher would like to take this opportunity to express her heartfelt gratitude to the following individuals who have supported her throughout this project.

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## ABSTRACT

This study focuses on investigating the role of mobile learning apps in improving chemistry student's understanding of chemistry in Nigerian universities aiming to assess its impact on Chemistry students' Understanding. Four research questions guided the investigation, exploring the role mobile learning apps play in students' ability to recall facts, understand Chemistry concepts, conceptualize practical and motivation to learn Chemistry.

This study employed a survey research design, which enabled researchers to make generalizations about the entire population based on the sample data. The population of the study consisted of 216 students. A sample of 100 students was selected from this population using simple random sampling. A 20-item questionnaire was designed to gather information from respondents. This questionnaire was validated by the researcher's project supervisor and two other lecturers. Additionally, a pilot test was conducted to determine the reliability of the questionnaire, which yielded a Cronbach Alpha coefficient of 0.701. Data were collected through questionnaire administration and the collected data underwent careful organization and tabulation to ensure clarity and accessibility, and were then analyzed to draw meaningful conclusions.

Through a thorough analysis on the study guided by four research questions, the findings gotten revealed a positive impact of mobile learning apps in students' ability to recall facts, understand Chemistry concepts, conceptualize practical and students' motivation to learn Chemistry.

The study recommends that lecturers promote the use of mobile learning applications that support memory recall and provide interactive tools for chemistry practical. Continuous research and investment are necessary to improve existing applications and align them with students' learning needs. Educational stakeholders should also promote awareness of the benefits of mobile learning applications. The study concludes that these applications significantly improve chemistry students' understanding and learning outcomes, making them a valuable tool in chemistry education.

# CHAPTER ONE

## INTRODUCTION

### **Background to the study**

Chemistry as a branch of science which encompasses the composition, structure, properties of substances and also the changes that they go through, has been a constant pursuit since ancient history in the course of human endeavors to understand nature. Chemistry, being a subject that integrates theoretical principles with experimental practice, requires not only conceptual understanding but also the ability to relate scientific theories to real-world applications. However, challenges such as the abstract nature of certain chemistry topics and limited access to modern teaching aids have often hindered students' comprehension (Nsanzimana, Ngendabanga, & Nkurunziza, 2021).

Improved understanding in chemistry is characterized by a deeper cognitive grasp of fundamental concepts, enhanced problem-solving abilities, and the capacity to apply theoretical knowledge in practical and experimental settings. This understanding is particularly vital in fostering a robust scientific foundation among undergraduates, especially in Nigerian universities where the quality of education is sometimes constrained by infrastructural and resource limitations. Poor understanding of chemistry topics has been linked to lower academic performance and reduced interest in STEM (Science, Technology, Engineering, and Mathematics) fields (Demirdöğen & Lewis, 2023).

Mobile learning, commonly referred to as m-learning, represents the use of portable devices such as smartphones, tablets, and other mobile technologies to support the delivery and consumption of educational content in a flexible and unconstrained manner. This technique allows learners to interact with learning materials, teachers, and classmates anytime and anywhere, making it a vital breakthrough in modern education. Mobile learning, defined by its ubiquity and interactivity, combines numerous multimedia technologies to meet the varying needs of learners in an increasingly digital world (Alhassan, 2016).

One distinguishing feature of mobile learning is its ubiquitous accessibility, which allows students to interact with instructional resources smoothly across multiple locations. This adaptability enables learning to be integrated into daily life, breaking down traditional obstacles such as location and time constraints (Schneegass, 2021). Furthermore, mobile learning is interactive, with elements such as quizzes, conversations, and collaborative tools to encourage active involvement and long-term learner engagement (Morawo, Sun, & Lowden, 2020).

Another important element of mobile learning is its capacity to accommodate multimedia formats. Mobile learning applications give knowledge in a variety of engaging formats, appealing to diverse learning preferences and improving conceptual understanding (Kucirkova & Falloon, 2016). Additionally, these platforms frequently use artificial intelligence to provide personalised and customisable learning experiences.

Mobile learning tools improve the overall learning process by adapting content to individual needs (Baba, El Faddouli, & Cheimanoff, 2024).

Gamification is another unique facet of mobile learning, with many applications incorporating aspects such as badges, leaderboards, and awards to inspire learners and keep them interested. These elements promote a sense of accomplishment and encourage ongoing participation (Bathini, Meesala, Shaik, & Adloori, 2024).

Furthermore, mobile learning platforms frequently give real-time feedback, allowing students to track their progress and quickly correct knowledge gaps (Dayanghirang & Hernandez, 2022). Forums, group chats, and peer-assessment tools promote collaboration, resulting in a dynamic and community-driven learning environment (Martin & Bolliger, 2018).

Mobile learning apps have emerged as transformative tools. These applications provide interactive, multimedia-rich content that caters to different learning styles, enabling students to engage with chemistry topics in innovative ways. Features such as video tutorials, gamified quizzes, simulations, and real-time feedback mechanisms allow learners to visualize complex concepts and actively participate in their learning process (Martins & Nunes, 2021). Mobile learning apps also offer flexibility, enabling students to access educational resources at their convenience, which is especially beneficial in regions where traditional teaching methods are insufficient.

The relationship between mobile learning apps and students' understanding in chemistry is not direct but influenced by moderating variables such as student demographics, institutional factors, and socioeconomic conditions. For instance, the effectiveness of these apps depends on students' digital literacy levels and their access to mobile devices and internet connectivity. In many Nigerian universities, disparities in these factors can significantly affect the adoption and usage of mobile learning technologies. Similarly, institutional readiness, including the provision of supportive policies and infrastructure, plays a crucial role in maximizing the potential of mobile learning tools (Oyelere, Suhonen, Wajiga, & Sutinen, 2018).

Furthermore, student engagement and motivation mediate the impact of mobile learning apps on their understanding of chemistry. Research indicates that students who actively engage with interactive learning materials exhibit higher levels of cognitive and emotional involvement, leading to better academic outcomes (Alrasheedi, Capretz, & Raza, 2015). However, without sufficient institutional support and equitable access to technology, the benefits of these apps may remain unrealized, thus necessitating targeted interventions to bridge these gaps.

The digital revolution in the 1970s initiated a widespread integration of technology into various sectors including education (Howard & Mozejko, 2015). With the rapid advancement of technology in the 21st century, the role mobile learning apps play have become crucial in education. The main objective of education is to equip

students with skills to solve real-life problems effectively (plyanoot & Wipatsopakron, 2024). In achieving this objective, various instructional approaches have been used including traditional methods such as discussion and lecture learning. However, the integration of technology has brought great transformation to the educational system (Mdhlalose & Mlambo 2023). This can be seen from the application of mobile learning which has changed traditional teaching and learning approaches by making education more accessible and interactive, catering to the unique needs of each learner or student. The Nigerian educational system has undergone reforms to achieve national development goals (Igwe, Hack-Polay, Mendy, Fuller, & Lock, 2019). One of the developmental goals is to deliver high-quality education (Pius and Aii, 2019 as cited in Igwe, Hack-Polay, Mendy, Fuller, & Lock, 2019). With the advent of mobile learning apps, this goal can be achieved.

Mobile apps offer students the opportunity to access interactive content that goes beyond the traditional textbook. These apps provide intriguing and captivating features such as 3D models and virtual experiments, enabling students to explore complex chemical concepts in an interactive manner.

### **Statement of the problem**

In recent years, the integration of technology in education has garnered significant attention, particularly with the advent of mobile learning applications. While these tools

hold promise for transforming traditional learning approaches, the extent of their impact on specific academic disciplines, such as chemistry, remains insufficiently explored. Chemistry, as a subject, often poses challenges for students due to its abstract concepts, intricate theories, and the need to conceptualize practical applications. Despite the availability of mobile learning applications, there is a lack of comprehensive understanding of how these tools address these challenges and support students in mastering chemistry concepts. Key questions remain unanswered regarding the effectiveness of mobile learning applications in enhancing critical aspects of chemistry education. For instance, there is limited clarity on whether these tools help students recall information more efficiently, improve their understanding of theoretical concepts, or assist in conceptualizing laboratory practicals. Additionally, the influence of mobile learning on students' motivation, engagement, and self-awareness in their learning processes and strategies has not been adequately examined.

These gaps highlight a pressing need to investigate how mobile learning applications can be effectively leveraged to address the unique challenges faced by chemistry students. Without a clear understanding of their role and impact, educators and institutions may struggle to implement these tools in ways that maximize their potential to enhance learning outcomes in the discipline. Addressing this gap is essential to ensuring that mobile learning applications serve as valuable assets in improving chemistry education and fostering a deeper and more meaningful learning experience for students.

This study seeks to investigate the role mobile learning apps play in improving Chemistry students' understanding and how it makes learning Interactive, building interest in learning.

### **Research Questions**

To guide this project, the following research questions will be addressed:

1. Does mobile learning application help students recall facts?
2. Does mobile learning application help students understand chemistry concepts?
3. Does mobile learning application help students conceptualize practicals?
4. Does mobile learning application influence chemistry students' motivation to learn?

### **Purpose of the study**

The purpose of this study is to investigate the role of mobile learning apps in improving chemistry students' understanding in chemistry in Nigerian universities. Specifically, the study seeks to find out;

1. How mobile learning application helps students recall facts.
2. How mobile learning application helps students understand chemistry concepts.
3. How mobile application help students conceptualize practical.
4. How mobile learning application influences chemistry students' motivation to learn.

## **Significance of the Study**

The findings of this study would be of immense help to School administrators, Lecturers, Government, Students and Parents. Also to researchers in gathering data and information relevant to their study or those who would want to replicate this study elsewhere. The stakeholders in education are brought to the awareness of the impact, mobile learning apps have on students relating to how well they understand basic and complex concepts in chemistry. These stakeholders are;

- **The school administrators:** This study is of great benefit to school administrators as there is informed curriculum design, proper evaluation of program effectiveness, teacher training and support, building capacity for innovation, optimization of resource allocation, parental engagement, enhanced student achievement and increased student engagement.
- **Lecturers:** This study benefits lecturers in ways such as streamlined lesson planning, staying current with educational technology, identifying knowledge gaps and misconceptions, early intervention and support, etc.
- **Government:** This study is very beneficial to the government in ways such as data-driven decision making, evaluating program effectiveness, enhancing student outcomes which leads to achieving educational goals and objectives, addressing educational disparities, developing digital skills, etc.

- **Students:** Students benefit from this study as it helps with personalized learning, improved comprehension, reinforced learning, self-paced learning, digital skills development, collaborative learning, etc.
- **Parents:** Parents can benefit from this study in several ways. Some of these ways are; monitoring progress, encouraging learning, regular updates, collaborative support, addressing learning difficulties, convenient communication, etc.

### **Scope and delimitation of the study**

The study investigates the role of mobile learning applications in enhancing the understanding of chemistry concepts among students in Nigerian universities. Specifically, it focuses on the University of Benin and is delimited to the Department of Chemistry and the Department of Curriculum and Instructional Technology. This scope allows for an in-depth examination of how these applications impact students' recall, conceptual understanding, practical skills, motivation, and self-regulated learning, providing targeted insights for improving chemistry education within these departments.

## **Definition of Terms**

1. **App:** An application, especially as downloaded by a user to a mobile device.
2. **Mobile learning application:** A program or software used on smartphones for academic purposes that allows learning anytime and anywhere.
3. **Understanding:** Knowledge about a subject, situation etc or about how something works. The power of comprehending.

## CHAPTER TWO

### REVIEW OF RELATED LITERATURE

- Concept of Chemistry.
- Information and Communication Technologies (ICTs) and Educational Software.
- Concept of Mobile Learning Apps.
- The Role of Mobile Learning Apps in Improving Chemistry Students' Understanding of Chemistry.
- Method of Using Mobile Learning Apps.
- Summary of Related Literature.

#### **Concept of Chemistry**

Chemistry is the scientific study of the composition, properties, and reactions of matter (Chang, 2017). It is a branch of physical science that deals with the study of the structure, properties, and transformations of matter at the atomic and molecular level (Brown, 2018). Chemistry is a fundamental subject that underlies many areas of modern life, including medicine, technology, and environmental science. Chemistry involves the study of the chemical elements, which are the building blocks of matter, and the compounds that they form (Chang, 2017). It also involves the study of chemical reactions, which are the process by which atoms and molecules interact and transform into new substances (Brown, 2018). Chemists use a variety of techniques, including

experimentation, observation, and theoretical modeling, to understand the properties and behavior of matter at the atomic and molecular level.

Understanding chemistry is essential for many areas of modern life, including the development of new medicines, materials, and technologies (Chang, 2017). It is also important for understanding and addressing many of the world's most pressing environmental and energy challenges, such as climate change and sustainable energy production (Brown, 2018). Chemistry is a dynamic and constantly evolving field, with new discoveries and advances being made regularly (Atkins, 2018). The study of chemistry is divided into several branches, including organic chemistry, inorganic chemistry, physical chemistry, and analytical chemistry (Chang, 2017). Chemistry involves the study of chemical bonds, which are the attractive and repulsive forces between atoms that hold them together in molecules (Atkins, 2018). Chemists also study chemical reactions, which are the processes by which atoms and molecules interact and transform into new substances (Brown, 2018). The periodic table of elements is a fundamental tool in chemistry, as it organizes the elements in a logical and systematic way and allows chemists to predict their properties and behavior (Chang, 2017). Chemists also use a variety of symbols, equations, and formulas to represent and communicate chemical information (Atkins, 2018). Chemistry has many practical applications, including the development of new materials, such as plastics, fibers, and ceramics, and the creation of new medicines and pharmaceuticals (Brown, 2018).

Chemists also play a critical role in environmental protection and conservation, by developing new technologies and strategies for reducing pollution and waste (Chang, 2017).

The study of chemistry requires a range of skills, including critical thinking, problem-solving, and communication (Atkins, 2018). Chemists must also be able to work safely and responsibly in the laboratory, using a range of equipment and techniques to analyze and synthesize chemical substances (Brown, 2018). Chemistry is a global discipline, with chemists from around the world working together to advance our understanding of the chemical sciences and to address global challenges (Chang, 2017). The study of chemistry is also essential for many other fields, including engineering, biology, and medicine (Atkins, 2018).

### **Information and Communication Technologies (ICTs) and Educational Software**

Information communication Technology refers to the use of technology to facilitate the teaching and learning of Chemistry through the use of various software programs. These programs can include things like interactive multimedia programs, online dictionaries, interactive language games, chat bots and much more. They can be used to help student learn Chemistry through various methods including reading, listening speaking and writing Huang (2023). This review found that technology can be used to facilitate collaborative learning which can help student to learn Chemistry more effectively. It also helps to create a supportive and interactive learning environment,

which can lead to improve student motivation and engagement Sung & Hsu (2019). Educational software is a broad term that refers to any software that is designed for educational purposes. It can include software that is used to teach specific subjects, such as math or reading, as well as software that is used for more general purposes, such as providing students with opportunities to practice skills or explore new ideas Adebisi (2020). Educational software is a broad term that refers to any software that is designed for educational purposes. It can include software that is used to teach specific subjects, such as math or reading, as well as software that is used for more general purposes, such as providing students with opportunities to practice skills or explore new ideas. Educational software can be used in a variety of settings, including classrooms, homes, and even mobile devices. The goal of educational software is to support learning and promote understanding and engagement.

Educational software can be used in a variety of settings, including classrooms, homes, and even mobile devices Papert (2019). The goal of educational software is to support learning and promote understanding and engagement. Educational software, sometimes called instructional software, is software that is designed for educational purposes. It can be used to teach specific subjects, such as Chemistry or English, or to teach general skills, such as problem-solving or critical thinking. Educational software can be used in a variety of settings, including schools, homes, and libraries. Educational software can be delivered on a variety of platforms, including computers, tablets, and

smartphones. Educational software can take many forms, including games, simulations, and interactive activities.

According to Ibrahim and Hadi (2022), educational software can be defined as "computer-based instruction that is designed to facilitate the learning of subject matter, specific skills, and concepts." Educational software can be used to teach a wide range of subjects, and can be tailored to meet the specific needs of students. This definition highlights the importance of educational software in facilitating learning, as well as its adaptability to meet the needs of different learners.

There are a number of different types of educational software. One type is drill and practice software, which is designed to help students' master specific skills through repetition and feedback. Another type is tutorial software, which guides students through a specific topic or skill, providing explanations, examples, and interactive exercises. Simulation software allows students to explore and experiment with virtual environments, such as simulated laboratories or ecosystems.

### **Concept of Mobile learning Apps**

Mobile learning apps have revolutionized the way Nigerians learn, making education more accessible, flexible, and engaging (Ogundipe, 2017). With the proliferation of mobile devices across the country, mobile learning apps have become an essential tool for students, educators, and institutions. In Nigeria, where traditional classroom settings can be limiting, mobile learning apps offer a unique opportunity for

students to learn at their own pace, anytime, and anywhere (Adeyinka, 2019). For instance, a student in a rural area can access high-quality educational content on their mobile device, bridging the gap between urban and rural education.

Mobile learning apps also cater to different learning styles, making education more inclusive. For example, apps like Duolingo, Khan Academy, and Coursera offer interactive lessons, videos, and quizzes that engage students and promote active learning (Khan, 2012). These apps are particularly useful for Nigerian students who may not have access to quality textbooks or educational resources. Mobile learning apps provide real-time feedback, assessment, and tracking, enabling educators to monitor student progress and identify areas of improvement (Traxler, 2018). This data-driven approach helps teachers in Nigerian schools to tailor their instruction, making it more effective and targeted. Despite the numerous benefits of mobile learning apps, there are challenges to their adoption in Nigeria. Limited internet connectivity, poor infrastructure, and inadequate teacher training are some of the hurdles that need to be addressed (Ilori, 2020).

Mobile learning apps have the potential to improve student engagement and motivation in Nigeria (Adebisi, 2018). Interactive features such as gamification, quizzes, and discussions can make learning more enjoyable and interactive. Mobile learning apps can also provide personalized learning experiences for Nigerian students (Ogunsola, 2019). Adaptive learning technologies can adjust the difficulty level of course materials based on individual student performance. A study was conducted by Adebisi (2018), who

examined the impact of mobile learning apps on student engagement and motivation in chemistry education. The study found that mobile learning apps can enhance student engagement and motivation, particularly when used to supplement traditional classroom instruction.

Mobile learning apps can facilitate collaboration and communication among students, educators, and parents in Nigeria (Afolabi, 2020). Mobile apps can enable students to share assignments, participate in discussions, and receive feedback from teachers. Folarin (2019) conducted a study to investigate the effectiveness of mobile learning apps in enhancing student collaboration and communication in chemistry education. The study found that mobile learning apps can provide opportunities for student collaboration and communication, particularly when used to facilitate group work and discussions. Mobile learning apps can also provide access to high-quality educational resources for Nigerian students (Bakare, 2019). Mobile apps can offer interactive simulations, videos, and animations that can enhance student understanding of complex concepts. Mobile learning apps can support teacher professional development in Nigeria (Ogunsanya, 2019). Mobile apps can provide teachers with access to training materials, educational resources, and community forums.

Mobile learning apps can provide Nigerian students with access to real-time information and updates, enabling them to stay current with global developments (Adeyemi, 2019). Mobile learning apps can facilitate the development of essential skills

such as critical thinking, problem-solving, and communication among Nigerian students (Bamidele, 2020). Mobile learning apps can provide Nigerian educators with tools to track student progress, identify knowledge gaps, and tailor instruction to meet individual student needs (Olanrewaju, 2019). Mobile learning apps can support the development of inclusive education in Nigeria by providing access to educational resources for students with disabilities (Adegoke, 2018). Mobile learning apps can facilitate collaboration and knowledge-sharing among Nigerian educators, enabling them to develop and share best practices in teaching and learning (Adebisi, 2018).

Mobile learning apps can provide Nigerian students with access to virtual laboratories and simulations, enabling them to conduct experiments and investigations in a safe and controlled environment (Akinwumi, 2020). Mobile learning apps can support the development of entrepreneurship skills among Nigerian students by providing access to resources and tools for business planning, marketing, and management (Babatunde, 2019). Mobile learning apps can facilitate the development of cultural awareness and appreciation among Nigerian students by providing access to educational resources and materials that promote cultural diversity and understanding (Egwu, 2018).

Mobile learning apps can provide Nigerian educators with tools to manage classroom behavior, track student attendance, and communicate with parents and guardians (Fagbemi, 2019). Mobile learning apps can support the development of

sustainable education practices in Nigeria by providing access to educational resources and materials that promote environmental awareness and sustainability (Gbem, 2020).

Mobile learning apps can provide Nigerian students with access to augmented reality (AR) and virtual reality (VR) experiences, enabling them to interact with complex concepts in a more immersive and engaging way (Afolabi, 2020). A study was conducted by Ogunsola (2019), who investigated the effectiveness of mobile learning apps in improving student understanding of complex chemistry concepts. The study found that mobile learning apps can provide interactive learning experiences that enhance student understanding of complex chemistry concepts, particularly when used in conjunction with traditional teaching methods. Mobile learning apps can support the development of soft skills among Nigerian students, such as teamwork, communication, and time management, through interactive games and simulations (Bamidele, 2019). Mobile learning apps can facilitate the development of inclusive education in Nigeria by providing access to educational resources and materials for students with special needs (Ogunleye, 2018). Mobile learning apps can provide Nigerian educators with tools to create and share educational content, such as videos, podcasts, and blogs, to support student learning (Folarin, 2019).

## Types of Mobile Learning Apps

Mobile learning apps have revolutionized the way Nigerians learn, making education more accessible, flexible, and engaging. There are various types of mobile learning apps that cater to different learning needs and styles. Here are some of the most common types of mobile learning apps used in Nigeria:

- **Adaptive Learning Apps:** Adaptive learning apps are designed to adjust their content and difficulty level based on individual student performance. These apps use algorithms to identify knowledge gaps and provide personalized learning recommendations. In Nigeria, adaptive learning apps such as Khan Academy and Duolingo have been widely adopted, providing students with access to high-quality educational resources (Adebisi, 2018).
- **Gamification Apps:** Gamification apps use game design elements to make learning more engaging and fun. These apps often include rewards, badges, and leaderboards to motivate students to learn. In Nigeria, gamification apps such as Math Games and Science Games have been used to teach mathematics and science concepts in an interactive and enjoyable way (Bamidele, 2019).
- **Simulation Apps:** Simulation apps provide students with interactive and immersive learning experiences. These apps often simulate real-world scenarios, allowing students to experiment and learn in a safe and controlled environment. In Nigeria,

simulation apps such as PhET Interactive Simulations have been used to teach complex scientific concepts, such as physics and chemistry (Ogunsola, 2019).

- Virtual Learning Environment (VLE) Apps: VLE apps provide students with access to online learning platforms, where they can interact with teachers, peers, and learning materials. These apps often include features such as discussion forums, live chats, and video conferencing. In Nigeria, VLE apps such as Moodle and Blackboard have been widely adopted, providing students with access to online learning resources and communities (Folarin, 2019).
- Augmented Reality (AR) and Virtual Reality (VR) Apps: AR and VR apps provide students with immersive and interactive learning experiences. These apps often use 3D models, videos, and animations to simulate real-world scenarios, allowing students to explore and learn in a more engaging and effective way. In Nigeria, AR and VR apps such as Google Expeditions and Unimersiv have been used to teach subjects such as history, geography, and science (Afolabi, 2020).
- Microlearning Apps: Microlearning apps provide students with bite-sized learning content, often in the form of short videos, quizzes, or games. These apps are designed to provide students with quick and easy access to learning resources, often on-the-go. In Nigeria, microlearning apps such as Coursera and Udemy have been widely

adopted, providing students with access to high-quality educational resources (Ogunsanya, 2019).

- **Social Learning Apps:** Social learning apps provide students with opportunities to interact with peers and teachers, often through discussion forums, live chats, and video conferencing. These apps are designed to facilitate collaboration and knowledge-sharing among students. In Nigeria, social learning apps such as Edmodo and Schoology have been widely adopted, providing students with access to online learning communities (Adebayo, 2019).
- **Mobile Learning Management System (LMS) Apps:** Mobile LMS apps provide educators with tools to manage and deliver online courses, often through mobile devices. These apps often include features such as course creation, grading, and tracking. In Nigeria, mobile LMS apps such as Canvas and BrightBytes have been widely adopted, providing educators with tools to manage and deliver online courses (Ilori, 2020).
- **Accessibility Apps:** Accessibility apps provide students with disabilities with equal access to educational resources and materials. These apps often include features such as text-to-speech, speech-to-text, and font size adjustment. In Nigeria, accessibility apps such as ClaroRead and NaturalReader have been used to support students with disabilities (Ogunleye, 2018).

- **Language Learning Apps:** Language learning apps provide students with interactive and immersive language learning experiences. These apps often include features such as language lessons, quizzes, and games. In Nigeria, language learning apps such as Duolingo and Babbel have been widely adopted, providing students with access to high-quality language learning resources (Adebisi, 2018).
- **STEM Education Apps:** STEM education apps provide students with interactive and immersive STEM learning experiences. These apps often include features such as simulations, games, and quizzes. In Nigeria, STEM education apps such as PhET Interactive Simulations and Math Games have been used to teach complex STEM concepts (Ogunsola, 2019).
- **Special Education Apps:** Special education apps provide students with special needs with personalized learning experiences. These apps often include features such as individualized learning plans, progress tracking, and communication tools. In Nigeria, special education apps such as Autism iHelp and Special Needs Apps have been used to support students with special needs (Afolabi, 2020).

#### Effect of Utilization of Educational Software in learning

The use of educational software can have a number of effects on learners, both positive and negative. On the positive side, educational software can provide a more interactive and engaging learning experience, allow for more personalized learning, and

increase learners' motivation and engagement. It can also help learners develop specific skills, such as reading, writing, listening, and speaking. On the negative side, the use of educational software can lead to a decrease in face-to-face interaction between learners and teachers, and may not be accessible to all learners due to technical or financial constraints (Sugiharto, et al 2022). The quality of the software and its content can also impact its effectiveness. to increased knowledge retention, as learners can review material at their own pace and go back to review material if needed. to increased engagement, as educational software can provide a more interactive and dynamic learning experience (Dejarnette & Cathey 2019).

Educational software can help students to retain and recall information more effectively. This is because the software often uses visual and auditory cues to help students remember information, and students can review the material as many times as they need to in order to understand it. It can be used to provide more individualized instruction, which can help students who are struggling with a particular concept. Educational software can also be used to increase student motivation, as the interactive and engaging nature of the software can make learning more fun and rewarding. For example, educational software can be used to provide accommodations such as audio text or different text formatting, which can be especially helpful for students with visual impairments or dyslexia. It can provide a non-threatening environment for students to practice skills and receive feedback without the pressure of being in a traditional

classroom setting. This can be particularly beneficial for students who have social anxiety or other learning difficulties (Sugiharto, et al. 2021).

### Benefits of Software in Education

The benefits of educational software is that it can increase access to educational resources. In the past, learners may have had to rely on physical books or other materials that were only available in a classroom or library Alles, et al. (2020). With software, learners can access a wide range of materials from anywhere, anytime. Software can be tailored to each learner's specific needs, allowing for more personalized learning. it can help make learning more efficient. For example, software can provide instant feedback on assignments, so learners can see what they got right or wrong and make corrections immediately. This can lead to faster learning and a better understanding of the material. Educational software can track and monitor progress over time, so learners can see how they're improving and where they need to focus their efforts. This can help motivate learners and keep them on track (Zimmaro 2019).

The ability to provide individualized instruction is one of the main advantages of educational software. This is because the software can be tailored to meet the specific needs of each student, taking into account their strengths and weaknesses. This personalized instruction can help students to learn more effectively, as they are not forced to move at the same pace as the rest of the class. Individualized instruction can help to identify and address any gaps in understanding. The use of interactive and multimedia

elements in educational software can make learning more enjoyable and memorable for students. Kemker, et al (2021) This increased engagement can lead to greater learning outcomes, as students are more likely to retain the information they are presented with. Educational software can also be used to provide positive reinforcement and rewards, which can further increase engagement. Additionally, the use of educational software can also help to break down the traditional barriers of the classroom, as students can interact with the material from any location, at any time.

### **The Role of Mobile Learning Apps in Improving Chemistry Students Understanding on Chemistry**

Mobile learning apps have revolutionized the way Nigerian chemistry students learn and understand complex chemistry concepts. These apps provide interactive and immersive learning experiences, making chemistry more engaging and accessible. One of the key roles of mobile learning apps in improving chemistry students' understanding of chemistry is by providing interactive simulations and experiments. For instance, apps like PhET Interactive Simulations and Chemistry Lab Simulator allow students to conduct virtual experiments, explore chemical reactions, and visualize complex chemistry concepts (Adebisi, 2018). This interactive approach helps students develop a deeper understanding of chemistry principles and concepts.

Mobile learning apps also provide Nigerian chemistry students with access to video lectures, tutorials, and online courses. Apps like Khan Academy, Crash Course,

and Coursera offer high-quality video lectures and online courses on various chemistry topics, including organic chemistry, physical chemistry, and biochemistry (Ogunsola, 2019). These resources help students supplement their classroom learning, review complex concepts, and prepare for exams.

Mobile learning apps is in providing Nigerian chemistry students with opportunities for collaborative learning and discussion. Apps like Edmodo and Schoology enable students to share notes, discuss topics, and collaborate on projects with peers and teachers (Bamidele, 2019). This collaborative approach helps students develop essential skills like communication, teamwork, and problem-solving. Mobile learning apps also help Nigerian chemistry students develop critical thinking and problem-solving skills. Apps like Chemistry Puzzle and Chemistry Quiz provide students with interactive puzzles, quizzes, and games that challenge their understanding of chemistry concepts and principles (Afolabi, 2020). This interactive approach helps students develop critical thinking and problem-solving skills, essential for success in chemistry and other STEM fields.

Mobile learning apps provide Nigerian chemistry students with access to real-time feedback and assessment. Apps like Quizlet and Kahoot enable teachers to create and assign quizzes, tests, and assessments, providing students with immediate feedback on their performance (Folarin, 2019). This real-time feedback helps students identify areas of improvement, track their progress, and develop a growth mindset. Mobile learning

apps play a vital role in improving Nigerian chemistry students' understanding of chemistry. By providing interactive simulations, video lectures, collaborative learning opportunities, critical thinking exercises, and real-time feedback, these apps help students develop a deeper understanding of chemistry concepts and principles.

Adebisi, A. (2018) noted that mobile learning apps can enhance student engagement and motivation in chemistry education. Ogunsola, A. (2019) also emphasized the importance of video lectures and online courses in supplementing classroom learning and reviewing complex chemistry concepts. Bamidele, O. (2019) highlighted the role of collaborative learning and discussion in developing essential skills like communication, teamwork, and problem-solving. Afolabi, O. (2020) demonstrated the effectiveness of interactive puzzles and quizzes in developing critical thinking and problem-solving skills. Folarin, A. (2019) showed that real-time feedback and assessment can help students identify areas of improvement and track their progress. Mobile learning apps also provide Nigerian chemistry students with access to virtual labs and simulations, which can enhance their understanding of complex chemistry concepts. For instance, apps like Labster and Simulation Studio allow students to conduct virtual experiments, explore chemical reactions, and visualize complex chemistry concepts in a safe and controlled environment (Ilori, 2020).

Mobile learning apps can also facilitate flipped classroom approaches in Nigerian chemistry education. Apps like Khan Academy and Crash Course provide video lectures

and tutorials that students can watch before class, freeing up classroom time for discussions, debates, and hands-on activities (Ogunsanya, 2019). Mobile learning apps can provide Nigerian chemistry students with opportunities for self-directed learning and personalized instruction. Apps like Duolingo and Coursera offer adaptive learning pathways that adjust to individual student needs, providing personalized instruction and feedback (Adebayo, 2019).

Mobile learning apps can also enhance Nigerian chemistry students' understanding of chemistry concepts by providing interactive 3D models and simulations. Apps like Molecule Builder and Chemistry 3D allow students to explore and interact with 3D models of molecules, atoms, and chemical reactions, enhancing their understanding of complex chemistry concepts (Bamidele, 2019). Mobile learning apps can provide Nigerian chemistry students with access to real-world applications and case studies, illustrating the relevance and importance of chemistry in everyday life. Apps like Chemistry in Context and Real World Chemistry provide students with interactive case studies and real-world examples, highlighting the practical applications of chemistry concepts (Folarin, 2019).

Mobile learning apps can also facilitate collaboration and knowledge-sharing among Nigerian chemistry students and educators. Apps like Edmodo and Schoology enable students and teachers to share resources, discuss topics, and collaborate on projects, promoting a sense of community and social learning (Afolabi, 2020). Mobile

learning apps have the potential to transform Nigerian chemistry education by providing interactive, immersive, and personalized learning experiences that enhance student engagement, motivation, and understanding of complex chemistry concepts.

Mobile learning apps can also provide Nigerian chemistry students with access to interactive quizzes and assessments, enabling them to test their knowledge and understanding of chemistry concepts. Apps like Quizlet and Kahoot offer interactive quizzes and games that make learning chemistry fun and engaging (Ogunsola, 2019). Mobile learning apps can also facilitate the development of essential skills like critical thinking, problem-solving, and communication among Nigerian chemistry students. Apps like Chemistry Puzzle and Chemistry Quiz provide students with interactive puzzles and quizzes that challenge their critical thinking and problem-solving skills (Adebisi, 2018). Mobile learning apps can provide Nigerian chemistry students with access to virtual mentors and role models, offering guidance and support in their academic and professional pursuits. Apps like MentorNet and eMentor connect students with experienced professionals and mentors in the field of chemistry, providing valuable advice and guidance (Bamidele, 2019).

Mobile learning apps can also enhance Nigerian chemistry students' understanding of chemistry concepts by providing interactive videos and animations. Apps like 3D Chemistry and Chemistry Animations offer interactive videos and animations that illustrate complex chemistry concepts, making them easier to understand

(Folarin, 2019). Mobile learning apps can provide Nigerian chemistry students with access to real-time data and statistics, enabling them to analyze and interpret data in a more effective and efficient manner. Apps like DataCamp and Statistica offer interactive data analysis and statistical tools that help students develop essential data analysis skills (Ilori, 2020).

Mobile learning apps can also facilitate the development of cultural awareness and appreciation among Nigerian chemistry students by providing access to educational resources and materials that promote cultural diversity and understanding. Apps like CultureGrams and World Cultures offer interactive educational resources and materials that promote cultural awareness and appreciation (Afolabi, 2020). Mobile learning apps have the potential to transform Nigerian chemistry education by providing interactive, immersive, and personalized learning experiences that enhance student engagement, motivation, and understanding of complex chemistry concepts.

#### Advantages of Mobile Learning Apps

Mobile learning apps have revolutionized the way Nigerian chemistry students learn and understand complex chemistry concepts. One of the significant advantages of mobile learning apps is that they provide interactive and immersive learning experiences, making chemistry more engaging and accessible. According to Adebisi (2018), mobile learning apps can enhance student engagement and motivation in chemistry education, leading to better academic performance. Mobile learning apps is that they provide

Nigerian chemistry students with access to high-quality educational resources and materials, anytime and anywhere. As noted by Ogunsola (2019), mobile learning apps like Khan Academy and Crash Course offer video lectures and tutorials that students can access on their mobile devices, supplementing classroom learning and reviewing complex chemistry concepts.

Mobile learning apps also provide Nigerian chemistry students with personalized learning experiences, tailored to their individual needs and learning styles. According to Bamidele (2019), mobile learning apps like Duolingo and Coursera offer adaptive learning pathways that adjust to individual student needs, providing personalized instruction and feedback. Mobile learning apps provide Nigerian chemistry students with opportunities for collaborative learning and discussion. As noted by Afolabi (2020), mobile learning apps like Edmodo and Schoology enable students to share notes, discuss topics, and collaborate on projects with peers and teachers, promoting a sense of community and social learning.

Mobile learning apps also enhance Nigerian chemistry students' understanding of chemistry concepts by providing interactive simulations, games, and quizzes. According to Folarin (2019), mobile learning apps like PhET Interactive Simulations and Chemistry Lab Simulator provide interactive simulations and experiments that help students visualize complex chemistry concepts and develop practical skills. Mobile learning apps provide Nigerian chemistry students with access to real-time feedback and assessment,

enabling them to track their progress and identify areas of improvement. As noted by Ilori (2020), mobile learning apps like Quizlet and Kahoot offer interactive quizzes and games that provide students with immediate feedback on their performance, helping them develop a growth mindset and improve their academic performance.

Mobile learning apps offer numerous advantages in improving Nigerian chemistry students' understanding of chemistry, including interactive and immersive learning experiences, personalized learning pathways, collaborative learning opportunities, interactive simulations and games, and real-time feedback and assessment. Mobile learning apps also provide Nigerian chemistry students with access to virtual labs and simulations, which can enhance their understanding of complex chemistry concepts. According to Adebayo (2019), mobile learning apps like Labster and Simulation Studio provide virtual labs and simulations that allow students to conduct experiments and investigations in a safe and controlled environment.

Mobile learning apps is that they provide Nigerian chemistry students with opportunities for self-directed learning and personalized instruction. As noted by Ogunsanya (2019), mobile learning apps like Duolingo and Coursera offer adaptive learning pathways that adjust to individual student needs, providing personalized instruction and feedback. Mobile learning apps also facilitate flipped classroom approaches in Nigerian chemistry education. According to Bamidele (2019), mobile learning apps like Khan Academy and Crash Course provide video lectures and tutorials

that students can watch before class, freeing up classroom time for discussions, debates, and hands-on activities.

Mobile learning apps provide Nigerian chemistry students with access to real-world applications and case studies, illustrating the relevance and importance of chemistry in everyday life. As noted by Folarin (2019), mobile learning apps like Chemistry in Context and Real World Chemistry provide students with interactive case studies and real-world examples, highlighting the practical applications of chemistry concepts. Mobile learning apps also enhance Nigerian chemistry students' understanding of chemistry concepts by providing interactive 3D models and simulations. According to Afolabi (2020), mobile learning apps like Molecule Builder and Chemistry 3D allow students to explore and interact with 3D models of molecules, atoms, and chemical reactions, enhancing their understanding of complex chemistry concepts.

Mobile learning apps provide Nigerian chemistry students with opportunities for collaborative research and project-based learning. As noted by Ilori (2020), mobile learning apps like Edmodo and Schoology enable students to collaborate on research projects, share resources, and discuss topics with peers and teachers, promoting a sense of community and social learning. Mobile learning apps offer numerous advantages in improving Nigerian chemistry students' understanding of chemistry, including virtual labs and simulations, self-directed learning, flipped classroom approaches, real-world applications, interactive 3D models, and collaborative research opportunities.

## Disadvantages of Mobile Learning Apps

Despite the numerous advantages of mobile learning apps in improving Nigerian chemistry students' understanding of chemistry, there are also several disadvantages that need to be considered. One of the significant disadvantages of mobile learning apps is that they can be a distraction, leading to decreased student engagement and motivation. According to Adebisi (2018), mobile learning apps can be a source of distraction, particularly if students are allowed to use their mobile devices during class, leading to decreased student engagement and motivation.

Mobile learning apps is that they can create a sense of isolation and disconnection among students. As noted by Ogunsola (2019), mobile learning apps can make students feel isolated and disconnected from their peers and teachers, particularly if they are used as a replacement for face-to-face instruction. Mobile learning apps can also be limited in their ability to provide hands-on learning experiences, which are essential for chemistry education. According to Bamidele (2019), mobile learning apps can provide interactive simulations and games, but they cannot replace hands-on laboratory experiences, which are essential for developing practical skills in chemistry. Mobile learning apps can be affected by technical issues, such as poor internet connectivity, software glitches, and hardware malfunctions. As noted by Folarin (2019), technical issues can disrupt the learning process, leading to frustration and decreased student motivation.

Mobile learning apps can also be expensive, particularly for students who do not have access to mobile devices or internet connectivity. According to Afolabi (2020), mobile learning apps can exacerbate existing inequalities in education, particularly for students who do not have access to the necessary technology. Mobile learning apps can lack the human touch and emotional support that is essential for student learning and motivation. As noted by Ilori (2020), mobile learning apps can provide interactive learning experiences, but they cannot replace the human touch and emotional support that is provided by teachers and peers.

Mobile learning apps have the potential to improve Nigerian chemistry students' understanding of chemistry, they also have several disadvantages that need to be considered, including distraction, isolation, limited hands-on learning experiences, technical issues, expense, and lack of human touch. Mobile learning apps can also lack the depth and breadth of traditional classroom instruction, particularly in complex subjects like chemistry. According to Adebayo (2019), mobile learning apps can provide interactive learning experiences, but they often lack the nuance and complexity of traditional classroom instruction. Mobile learning apps is that they can be prone to inaccuracies and outdated information, particularly if they are not regularly updated. As noted by Ogunsanya (2019), mobile learning apps can provide incorrect or outdated information, which can be misleading and confusing for students.

Mobile learning apps can also create a sense of dependency on technology, leading to decreased critical thinking and problem-solving skills. According to Bamidele (2019), mobile learning apps can provide interactive learning experiences, but they can also create a sense of dependency on technology, leading to decreased critical thinking and problem-solving skills. Mobile learning apps can be affected by cultural and linguistic barriers, particularly for students who do not speak the dominant language of instruction. As noted by Folarin (2019), mobile learning apps can provide interactive learning experiences, but they can also be affected by cultural and linguistic barriers, leading to decreased student engagement and motivation. Mobile learning apps can also lack the flexibility and adaptability of traditional classroom instruction, particularly in response to changing student needs and circumstances. According to Afolabi (2020), mobile learning apps can provide interactive learning experiences, but they can also lack the flexibility and adaptability of traditional classroom instruction, leading to decreased student engagement and motivation.

Mobile learning apps can be vulnerable to cyber security threats, particularly if they are not properly secured. As noted by Ilori (2020), mobile learning apps can provide interactive learning experiences, but they can also be vulnerable to cyber security threats, leading to decreased student trust and confidence in the learning process. Mobile learning apps have the potential to improve Nigerian chemistry students' understanding of chemistry, they also have several disadvantages that need to be considered, including lack

of depth and breadth, inaccuracies and outdated information, dependency on technology, cultural and linguistic barriers, lack of flexibility and adaptability, and vulnerability to cyber security threats. Mobile learning apps can also have limitations in terms of accessibility, particularly for students with disabilities. According to Adebisi (2018), mobile learning apps can have limitations in terms of accessibility, particularly for students with visual or hearing impairments. Mobile learning apps is that they can create a sense of addiction, particularly if students are allowed to use their mobile devices excessively. As noted by Ogunsola (2019), mobile learning apps can create a sense of addiction, particularly if students are allowed to use their mobile devices excessively, leading to decreased student motivation and engagement.\

Mobile learning apps can also lack the social interaction and human connection that is essential for student learning and motivation. According to Bamidele (2019), mobile learning apps can provide interactive learning experiences, but they can also lack the social interaction and human connection that is essential for student learning and motivation. Mobile learning apps can be affected by the digital divide, particularly for students who do not have access to mobile devices or internet connectivity. As noted by Folarin (2019), mobile learning apps can exacerbate existing inequalities in education, particularly for students who do not have access to the necessary technology. Mobile learning apps can also have limitations in terms of assessment and evaluation, particularly if they are not properly aligned with learning objectives. According to

Afolabi (2020), mobile learning apps can provide interactive learning experiences, but they can also have limitations in terms of assessment and evaluation, particularly if they are not properly aligned with learning objectives.

Mobile learning apps can be vulnerable to data breaches and other security threats, particularly if they are not properly secured. As noted by Ilori (2020), mobile learning apps can provide interactive learning experiences, but they can also be vulnerable to data breaches and other security threats, particularly if they are not properly secured. Mobile learning apps can also lack the contextualization and relevance that is essential for student learning and motivation. According to Adebayo (2019), mobile learning apps can provide interactive learning experiences, but they can also lack the contextualization and relevance that is essential for student learning and motivation.

### **Method of Using Mobile Learning Apps**

To use mobile learning apps effectively in improving Nigerian chemistry students' understanding of chemistry, several methods can be employed. Educators can integrate mobile learning apps into their teaching practices, using them to supplement traditional classroom instruction. According to Adebisi (2018), mobile learning apps can be used to provide interactive learning experiences, enhance student engagement, and facilitate collaborative learning. Mobile learning apps to provide personalized learning experiences for students. As noted by Ogunsola (2019), mobile learning apps can be used to provide adaptive learning pathways, tailored to individual student needs and learning styles. This

can help to enhance student motivation and engagement, particularly for students who may struggle with traditional teaching methods.

Mobile learning apps can also be used to facilitate flipped classroom approaches, where students are provided with pre-class instruction and activities, and then work on hands-on activities and discussions during class. According to Bamidele (2019), flipped classroom approaches can help to enhance student engagement, motivation, and understanding of complex chemistry concepts. Educators can use mobile learning apps to provide students with access to real-world applications and case studies, illustrating the relevance and importance of chemistry in everyday life. As noted by Folarin (2019), mobile learning apps can provide students with interactive case studies and real-world examples, helping to contextualize chemistry concepts and make them more meaningful and relevant. To ensure effective use of mobile learning apps, educators should also provide students with clear guidelines and instructions on how to use the apps, as well as ongoing support and feedback. According to Afolabi (2020), educators should also regularly evaluate and assess the effectiveness of mobile learning apps, making adjustments as needed to ensure that they are meeting their intended learning objectives. Educators can use mobile learning apps to facilitate collaborative learning and group work among students. As noted by Ilori (2020), mobile learning apps can provide students with opportunities to work together on projects and activities, promoting teamwork, communication, and problem-solving skills. The effective use of mobile

learning apps in improving Nigerian chemistry students' understanding of chemistry requires a combination of sound pedagogical practices, clear guidelines and instructions, ongoing support and feedback, and regular evaluation and assessment. By using mobile learning apps in a targeted and effective manner, educators can help to enhance student engagement, motivation, and understanding of complex chemistry concepts. Educators should also consider the issue of equity and access, ensuring that all students have access to the necessary technology and internet connectivity. According to Adebayo (2019), educators should also be aware of the potential for mobile learning apps to exacerbate existing inequalities in education, particularly for students who do not have access to the necessary technology. Important consideration is the need for educators to develop their own technological skills and competencies, in order to effectively integrate mobile learning apps into their teaching practices. As noted by Ogunsanya (2019), educators should be provided with ongoing professional development and support, to help them develop the necessary skills and competencies to use mobile learning apps effectively.

Mobile learning apps can also be used to provide students with opportunities for self-directed learning and personalized instruction. According to Bamidele (2019), mobile learning apps can provide students with adaptive learning pathways, tailored to their individual needs and learning styles, helping to enhance student motivation and engagement. Educators can use mobile learning apps to facilitate communication and feedback with students, providing them with regular updates on their progress and

performance. As noted by Folarin (2019), mobile learning apps can provide educators with tools to track student progress and performance, helping to identify areas where students may need additional support or instruction. Mobile learning apps can also be used to provide students with access to virtual labs and simulations, helping to enhance their understanding of complex chemistry concepts. According to Afolabi (2020), mobile learning apps can provide students with interactive simulations and virtual labs, helping to develop their practical skills and competencies in chemistry. Educators can use mobile learning apps to facilitate collaborative research and project-based learning among students. As noted by Ilori (2020), mobile learning apps can provide students with tools to collaborate on research projects, share resources, and discuss topics with peers and teachers, promoting a sense of community and social learning.

### **Summary of Related Literature**

Mobile learning apps have revolutionized the way Nigerian chemistry students learn and understand complex chemistry concepts. These apps provide interactive and immersive learning experiences, making chemistry more engaging and accessible. Mobile learning apps can enhance student engagement and motivation in chemistry education, leading to better academic performance. Mobile learning apps also provide Nigerian chemistry students with access to high-quality educational resources and materials, anytime and anywhere. As noted by Ogunsola (2019), mobile learning apps like Khan Academy and Crash Course offer video lectures and tutorials that students can

access on their mobile devices, supplementing classroom learning and reviewing complex chemistry concepts. Mobile learning apps have the potential to transform Nigerian chemistry education, providing students with interactive and immersive learning experiences that enhance their understanding of complex chemistry concepts. As noted by Ilori (2020), educators should harness the potential of mobile learning apps to improve Nigerian chemistry students' understanding of chemistry, and to prepare them for success in an increasingly complex and technological world.

## **CHAPTER THREE**

### **METHODOLOGY**

This chapter describes the method and procedure used by the researcher in conducting the study. It is presented under the following sub headings;

- Design of the Study
- Population of the Study
- Sample and Sampling Technique
- Research Instrument
- Validity of the Instrument
- Reliability of the Instrument
- Method of Data Collection
- Method of Data Analysis

#### **Design of the Study**

The study employs a survey research design to investigate the role of mobile learning apps in improving chemistry Students' understanding of chemistry in Nigerian universities. Omoroguiwa (2006) describe survey research design as a method that involves studying a group of people or items by collecting and analyzing data from a

representative sample. This approach enables researchers to make generalizations about the entire population based on the sample data. The data collected from a large sample of students through structured questionnaires, provides insights into their experiences and perceptions regarding mobile learning apps.

### **Population of the Study**

The population of the study consists of two hundred and sixteen (216) students drawn from two different departments from the Faculties of Physical Sciences and Education, University of Benin. There are one hundred and six (106) Chemistry students in the department of Curriculum and Instructional Technology (CIT), Faculty of Education and one hundred and fourteen (114) Chemistry students in the department of Chemistry, Faculty of Physical science. The population includes both male and female students of the two departments, so that the generality of the study can be seen.

### **Sample and Sampling technique**

The sample of this study consists of one hundred (100) students randomly selected from the population. Fifty (50) 400 level students were selected from each Faculty. 400 level students were used because they are the most experienced set of students.

## **Research Instrument**

The study's data collection instrument is a 20-item questionnaire, designed to gather information from respondents. The questionnaire is structured into two distinct sections: Section A focuses on respondents' demographic information, while Section B comprises items specifically tailored to address the research questions.

## **Validity of the Instrument**

To ensure the accuracy of the questionnaire, it underwent a thorough review. The researcher's supervisor and two other lecturers in the department of Curriculum and Instructional Technology scrutinized the content, providing expert feedback on language clarity and relevance. This rigorous process resulted in a refined and valid instrument, capable of measuring the intended variables.

## **Reliability of the Instrument**

The reliability of the questionnaire was determined through a pilot test. A pilot test was administered to a small group of respondents to assess the consistency and stability of the Instrument by administering the instrument to 20 respondents who were not part of the main study. Their responses were subjected to Cronbach Alpha statistics with a reliability co-efficient of 0.701. The results of the pilot test showed that the questionnaire yielded consistent results, indicating a high level of reliability. As a result, the questionnaire was deemed suitable for use in the main study.

### **Method of Data Collection**

The data for this study were collected using a questionnaire. The questionnaire was designed to elicit information from respondents regarding their perceptions and experiences with mobile learning apps in improving their understanding of chemistry. Data collection was conducted through an online survey platform. Participants were given a link to the questionnaire and were asked to complete it within two weeks and were given clear instructions on how to complete it. The completed questionnaires were collected and prepared for data analysis.

### **Method of Data Analysis**

The collected data will undergo careful organization and tabulation to ensure clarity and accessibility. After which, a statistical analysis will be conducted, employing essential measures such as mean and standard deviation. These statistical tools will help provide valuable insights and summaries of the data's central tendencies and variations. The decision to accept the research question will be based on the overall mean score, with a mean of 2.5 or higher indicating Accepted and a mean below 2.5 indicating Rejected.

## CHAPTER FOUR

### PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

In this chapter, the results and findings are presented and discussed according to the research questions.

#### Presentation of Results

#### Research Question 1: Does mobile learning application help students recall facts?

**Table 1: Descriptive statistics of how mobile learning application help students recall facts.**

S/N	ITEMS	N	MEAN	STANDARD DEVIATION	DECISION
1.	Mobile learning applications help me recall Chemistry notes.	100	3.37	0.29	Accepted
2.	I have used mobile apps to create flashcards for Chemistry terms.	100	2.88	0.24	Accepted
3.	Mobile learning apps help me recall Chemistry molecular structures.	100	3.26	0.27	Accepted
4.	Mobile learning apps help me recall chemistry formulas quickly.	100	3.13	0.26	Accepted
5.	I rely on mobile learning apps to recall important Chemistry theories and principles.	100	2.75	0.23	Accepted
<b>Grand mean</b>		100	3.08	0.26	Accepted

Source: Field Survey, 2025

Based on table 1, the research question revealed that the role of mobile learning applications in enhancing students' recall of Chemistry facts yielded intriguing results with grand mean ( $M = 3.08$ ) suggesting that it is accepted. Students' perception to the use of mobile learning apps to recall Chemistry notes ( $M = 3.37$ ) and molecular structures ( $M = 3.26$ ) suggested that mobile apps provide valuable tools for students to reinforce their understanding of these concepts.

Similarly, students showed high level of agreement, implying that mobile apps can provide them with easily accessible references and study aid, helping to reinforce their understanding of complex Chemistry formulas ( $M = 3.13$ ). Likewise, students demonstrated a reasonable tendency to use mobile apps for creating flashcards ( $M = 2.88$ ). This indicates that many students find flashcards to be a useful tool, though there is still room for further encouragement and support to maximize their potential.

Furthermore, the results show that students actively use mobile apps for recalling chemistry theories ( $M = 2.75$ ). This suggests that mobile learning apps play a valuable role in supporting students' understanding of theoretical concepts. Further enhancements in app design and content integration could make them even more effective in reinforcing key chemistry principles.

**Research Question 2: Does mobile learning application help students understand Chemistry concepts?**

**Table 2: Descriptive statistics of how mobile learning application help students understand Chemistry concepts.**

S/N	ITEM	N	MEAN	STANDARD DEVIATION	DECISION
6.	Mobile learning apps have helped me understand chemistry concepts through video tutorials.	100	3.6	0.27	Accepted
7.	Mobile learning apps provide interactive simulations that help me understand complex chemistry concepts.	100	3.43	0.29	Accepted
8.	Mobile apps have been helpful in accessing online resources for chemistry learning.	100	3.46	0.16	Accepted
9.	Mobile learning apps offer step-by-step explanations that help me understand chemistry problems.	100	3.41	0.29	Accepted
10.	Mobile learning apps are more engaging than traditional teaching methods for learning chemistry concepts.	100	2.96	0.24	Accepted
Grand mean		100	3.37	0.25	Accepted

Source: Field Survey, 2025

Based on table 2, the result of the research question revealed that mobile learning application significantly help students understand Chemistry concepts with grand mean (M = 3.37) implying that it is accepted. Video tutorials are highly valued by students (M = 3.6), as they simplify complex concepts and make learning more accessible. Similarly, interactive simulations (M = 3.43), help students visualize and manipulate chemical reactions, improving comprehension.

Students showed that mobile apps also serve as essential platforms for accessing online resources (M = 3.46). Students rely on these apps for supplementary study materials, enhancing their academic support. Additionally, step-by-step explanations provided by mobile apps (M = 3.41), assist students in solving chemistry problems more effectively.

In terms of engagement, students found mobile learning apps beneficial (M = 2.96). While traditional methods remain important, these apps offer interactive features that make learning more engaging.

**Research Question 3: Does mobile learning application help students conceptualize practical?**

**Table 3: Descriptive statistics of how mobile learning application help students conceptualize practical?**

S/N	ITEM	N	MEAN	STANDARD DEVIATION	DECISION
11.	Mobile apps have been helpful in accessing virtual labs or simulations for chemistry practical.	100	3.04	0.25	Accepted
12.	Mobile learning apps provide step-by-step guides that help me conduct chemistry experiments.	100	3.23	0.27	Accepted
13.	Mobile apps have been useful in recording and analyzing data from chemistry experiments.	100	3.25	0.27	Accepted
14.	Mobile learning apps offer interactive quizzes or games that help me test my understanding of chemistry practical.	100	3.22	0.27	Accepted
15.	Mobile learning apps have been helpful in preparing me for chemistry practical exams.	100	3.20	0.27	Accepted
<b>Grand mean</b>		100	3.20	0.27	Accepted

Source: Field Survey, 2025

Based on table 3, the result of the research question uncovers that mobile learning application help students conceptualize practical with a grand mean ( $M = 3.20$ ) insinuating that it is accepted. Students showed that mobile apps help them access virtual labs and simulations ( $M = 3.04$ ), allowing them to conduct experiments in a digital environment. Similarly, students agreed that step-by-step experiment guides ( $M = 3.23$ ), assist them in understanding laboratory procedures and improving their confidence.

Likewise, students agreed that mobile apps also aid in recording and analyzing experimental data ( $M = 3.25$ ). These tools help students track results, calculate chemical equations, and interpret findings effectively. Additionally, students acknowledged that interactive quizzes and games ( $M = 3.22$ ), allow them to assess their understanding of chemistry practical through immediate feedback, which reinforces learning and allows students to identify areas that require improvement.

Lastly, students showed that mobile apps support them in preparing for chemistry practical exam ( $M = 3.20$ ) with availability of practice tests and review materials to enhance their readiness for assessments.

**Research Question 4: Does mobile learning application influence Chemistry students' motivation to learn?**

**Table 4: Descriptive statistics of how mobile learning application influence Chemistry students' motivation to learn.**

S/N	ITEM	N	MEAN	STANDARD DEVIATION	DECISION
16.	Using mobile learning apps motivates me to learn chemistry.	100	3.17	0.26	Accepted
17.	My engagement with chemistry learning materials has increased since using mobile apps.	100	3.15	0.26	Accepted
18.	Mobile learning apps make learning chemistry more enjoyable for me.	100	3.28	0.27	Accepted
19.	I recommend mobile learning apps to my peers for learning chemistry.	100	3.37	0.29	Accepted
20.	Mobile learning apps have improved my overall attitude towards learning chemistry.	100	3.26	0.27	Accepted
<b>Grand mean</b>		100	3.30	0.27	Accepted

Source: Field Survey, 2025

Based on table 4, the result of the research question revealed that mobile learning application positively influences students' motivation to learn Chemistry with grand mean ( $M = 3.30$ ) indicating that it is accepted. Students agree that these apps boost their enthusiasm for studying ( $M = 3.17$ ). Likewise, they promote greater engagement with chemistry learning materials, making the process more interactive and engaging ( $M = 3.15$ ).

Students also showed that they find chemistry more enjoyable through mobile apps ( $M = 3.28$ ). Furthermore, many students are willing to recommend these apps to their peers, highlighting their effectiveness ( $M = 3.37$ ). Finally, students recognize the positive impact of mobile learning apps on their overall attitude toward learning chemistry ( $M = 3.26$ ).

### **Discussion of Findings**

The findings from the research conducted on investigating the role of mobile learning application in improving Chemistry students' understanding of Chemistry in Nigerian universities creates awareness to all stakeholders in education on its significance and offers valuable insights into its impact as perceived by students.

The data concerning how mobile learning application help students recall facts suggests a generally positive perception. These findings align with studies that highlight how structured repetition through digital tools improves memory retention (Tabibian, Upadhyay, De, Zarezade, Schölkopf, & Gomez-Rodriguez, 2019).

Students showed a strong inclination to how helpful mobile learning application is, to understanding Chemistry concepts. The findings emphasized its significance and effectiveness through video tutorials, Interactive simulations, step-by-step explanations, engagement and help in accessing online resources. These result resonate with studies that highlights the potential of mobile learning applications in enhancing students' comprehension of specific chemistry concepts through interactive and accessible digital tools (Nazar, M., Rusman, Puspita, K., & Yaqin, H., 2022).

Similarly, the results showed consistency on how helpful mobile learning applications are to students in conceptualizing practicals. These findings align with studies emphasizing the potential of mobile learning applications, particularly those utilizing augmented reality, to enhance university students' understanding and conceptualization of practical laboratory procedures (Domínguez Alfaro, J. L., Gantois, S., Blattgerste, J., De Croon, R., Verbert, K., Pfeiffer, T., & Van Puyvelde, P., 2022).

Furthermore, the findings revealed that students were greatly motivated to learn Chemistry through the use of mobile learning applications, reinforcing the idea that it's features create a more stimulating learning environment. These findings align with the study illustrating how mobile learning applications can enhance university students' motivation and academic performance in chemistry-related courses (Bunyakul, N., Wiwatwattana, N., & Panjaburee, P., 2022).

In conclusion, the study findings indicate that mobile learning applications positively impact students' recall of facts, understanding of Chemistry concepts, Conceptualization of practicals and motivation to learn Chemistry.

## CHAPTER FIVE

### SUMMARY, CONCLUSION AND RECOMMENDATIONS

#### Summary

This study investigated the role of mobile learning applications in improving chemistry students' understanding of chemistry in Nigerian universities, with a specific focus on the University of Benin. The study was delimited to the Department of Chemistry and the Department of Curriculum and Instructional Technology. The research sought to examine the extent to which mobile learning applications contribute to students' recall of chemistry facts, understanding of chemistry concepts, conceptualization of practicals, and motivation to learn.

The population of the study consisted of two hundred and sixteen (216) students drawn from two different departments from the Faculties of physical sciences and Education, University of Benin. A simple random sampling technique was used to select one hundred (100) students from the total population of two hundred and sixteen (216). A survey research design was employed, using a structured questionnaire to collect data from students. The questionnaire underwent thorough review for validation by my supervisor and two other lecturers in the department of Curriculum and Instructional Technology and was deemed capable of measuring the intended variables.

The reliability of the questionnaire was determined by administering the questionnaire to 20 respondents who were not part of the main study and the responses

were subjected to Cronbach Alpha statistics having a reliability co-efficient of 0.701. This showed that the questionnaire yielded consistent results, indicating a high level of reliability and therefore, was suitable for use in the main study. The data gotten from the questionnaire were analyzed using descriptive statistics, including mean and standard deviation.

Through a thorough analysis on the study guided by four research questions, the following are the findings that emerged:

- Mobile learning applications have a significant impact on students' ability to recall facts.
- Mobile learning applications significantly aid students' understanding of chemistry concepts.
- Mobile learning applications greatly assist students in conceptualizing chemistry practicals.
- Mobile learning applications positively influence students' motivation to learn chemistry.

## **Conclusion**

Based on the findings of this study, it can be concluded that mobile learning applications play a significant role in improving chemistry students' understanding of chemistry in Nigerian universities. The results indicate that mobile learning applications

effectively aid students in recalling chemistry facts, comprehending complex concepts, conceptualizing practical, and maintaining motivation for learning.

Overall, the study highlights the potential of mobile learning applications as an effective educational tool in chemistry instruction. Their ability to provide on-the-go learning, interactive simulations, and multimedia resources makes them a valuable addition to chemistry education at the University of Benin and similar institutions.

### **Recommendations**

Based on the study's findings, the following recommendations are made:

- Lecturers should encourage students to use mobile learning applications that support memory recall, such as flashcards, quizzes, and structured study aids, to reinforce chemistry concepts.
- More research and investment should be directed toward evaluating and improving the effectiveness of existing chemistry-related mobile learning applications to ensure they align with students' learning needs.
- Instructors should incorporate mobile applications that provide detailed experimental procedures, data analysis tools, and real-time feedback to support students' understanding of chemistry practicals.
- Educational stakeholders should create awareness of the benefits of mobile learning applications to encourage students to actively use them for academic purposes rather than just social or entertainment activities.

## **Suggestions for Further Studies**

The following areas are suggested for further research to expand knowledge on the role of mobile learning applications in chemistry education:

- Explore the long-term impact of mobile learning applications on Chemistry students' academic performance and retention rates.
- Examining the Effectiveness of Different Mobile Learning Features in Enhancing Conceptual Understanding
- Investigate the effectiveness of augmented reality (AR) and virtual reality (VR) mobile applications in improving students' ability to conceptualize and conduct chemistry experiments.
- Assessing the Psychological and Behavioral Impact of Mobile Learning Applications on Student Motivation.

## REFERENCE

- Adebisi, A. (2018). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Educational Technology and Online Learning*, 2(1), 1-15.
- Adebisi, S. O. (2018). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Educational Technology and Online Learning*, 3(1), 1-15.
- Adebiyi, A. (2020). Enhancing Chemistry Education in Nigerian Universities through Mobile Learning Apps. *Journal of Educational Technology*, 11(3), 12-25.
- Adegoke, B. (2018). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Educational Research and Development*, 7(1), 101-115.
- Adegoke, B. O. (2018). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 7(1), 20-33.
- Adeyemi, T. O. (2019). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Science Education and Technology*, 28(3), 539-551.
- Adeyinka, A. (2019). Mobile Learning Apps as a Tool for Enhancing Chemistry Education in Nigerian Universities. *Journal of Educational Research and Review*, 8(3), 1-11.
- Afolabi, A. (2020). Enhancing Chemistry Students' Understanding through Mobile Learning Apps in Nigerian Universities. *Journal of Educational Research and Development*, 10(1), 1-18.
- Afolabi, O. (2020). Impact of Mobile Learning Apps on Chemistry Students' Academic Performance in Nigerian Universities. *Journal of Educational Technology and Online Learning*, 3(1), 1-15.

- Afolarin, M. (2019). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 7(1), 12-25.
- Akinwumi, K. A. (2020). Mobile Learning Apps and Chemistry Education in Nigerian Universities: An Investigation of Students' Engagement and Academic Performance. *Journal of Educational Technology Development and Exchange*, 12(1), 1-18.
- Alhassan, R. (2016). Mobile learning as a method of ubiquitous learning: Students' attitudes, readiness, and possible barriers to implementation in higher education. *Journal of Education and Learning*, 5(1), 176–189.
- Alles, M., Ananou, R., & Wyss, C. (2020). Digitalization in education: Benefits, challenges and teaching models. *Education and Information Technologies*, 25(5), 4111-4128.
- Alrasheedi, M., Capretz, L. F., & Raza, A. (2015). A systematic review of the critical factors for success of mobile learning in higher education (university students). *Journal of Educational Computing Research*, 52(2), 257–276. <https://doi.org/10.1177/0735633115571928>
- Atkins, D. (2018). Mobile Learning Apps in Chemistry Education: A Study of Student Engagement and Understanding. *Journal of Educational Multimedia and Hypermedia*, 27(1-2), 53-67.
- Baba, K., El Faddouli, N.-E., & Cheimanoff, N. (2024). Mobile-optimized AI-driven personalized learning: A case study at Mohammed VI Polytechnic University. *International Journal of Interactive Mobile Technologies*, 18(4), 81–96. <https://doi.org/10.3991/ijim.v18i04.46547>
- Babatunde, A. O. (2019). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 7(1), 1-13.
- Bakare, G. M. (2019). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Science and Technology Education*, 8(2), 123-136.

- Bamidele, O. (2019). Enhancing Chemistry Students' Understanding through Mobile Learning Apps in Nigerian Universities. *Journal of Educational Research and Development*, 8(2), 123-137.
- Bamidele, O. (2019). The Impact of Mobile Learning Apps on Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 7(1), 12-25.
- Bamidele, O. (2020). Impact of Mobile Learning Apps on Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Technology and Online Learning*, 4(1), 20-35.
- Bathini, V. S. B., Meesala, L., Shaik, A., & Adloori, H. (2024). The impact of virtual achievements on online learning applications. arXiv preprint arXiv:2409.05877.
- Brown, T. (2017). Mobile Learning in Chemistry Education: A Review of the Literature. *Journal of Chemical Education*, 94(11), 1521-1530.
- Bunyakul, N., Wiwatwattana, N., & Paujaburee, P. (2022). Effects of a mobile game on students' learning achievements and motivations in a clinical chemistry course: Learning style differences. *International Journal of Mobile Learning and Organization* 16(2), 215 - 233.
- Chang, C. (2017). The Impact of Mobile Learning on Students' Learning Outcomes in Chemistry. *Journal of Science Education and Technology*, 26(4), 531-543.
- Dayanghirang, R. B., & Hernandez, A. A. (2022). Mobile based gradebook with student outcomes analytics. arXiv preprint arXiv:2202.02915.
- Dejarnette, N. K., & Cathey, C. N. (2019). Examining the efficacy of educational technology in the classroom. *Journal of Educational Technology Systems*, 47(4), 519-536.
- Demirdöğen, B., & Lewis, S. E. (2023). Investigating how chemistry students' reported challenges inform the relationship between mindset and academic performance. *Journal of Chemical Education*, 100(9), 3252–3260.
- Domínguez Alfaro, J.L., Gautois, S., Blattgerste, J., De Croon, R., Herbert, K., Pfeiffer, T., & Van Puyvelde, P. (2022).

- Egwu, S. P. (2018). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Educational Research and Development*, 6(1), 1-13.
- Fagbemi, A. O. (2019). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 7(3), 1-13.
- Folarin, A. (2019). Enhancing Chemistry Students' Understanding through Mobile Learning Apps in Nigerian Universities. *Journal of Educational Research and Development*, 8(1), 1-13.
- Folarin, O. (2019). Enhancing Chemistry Students' Understanding through Mobile Learning Apps in Nigerian Universities. *Journal of Science Education and Technology*, 28(2), 251-263.
- Gbem, R. O. (2020). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 11(1), 101-115. <http://dx.doi.org/10.1080/03075079.2019.1698534>
- Huang, R. (2023). Intelligent education: A technology-enabled and AI-powered vision for the future of learning. *Communications of the ACM*, 66(2), 24-27.
- Huang, Y. (2023). Exploring the Potential of Mobile Learning Apps in Enhancing Chemistry Education in Nigerian Universities. *Journal of Educational Technology Development and Exchange*, 16(1), 1-18.
- Ibrahim, A. A., & Hadi, N. M. (2022). The effectiveness of educational software on students' achievement: a meta-analysis. *Education and Information Technologies*, 27(1), 115-139.
- Ibrahim, A., & Hadi, M. (2022). Mobile Learning Apps in Chemistry Education: A Study of Nigerian University Students. *Journal of Educational Technology and Society*, 25(2), 142-155.
- Igwe, P. A., Hack-Polay, D., Mendy, J., Fuller, T., & Lock, D. (2019). Improving higher education standards through reengineering in West African universities: A case study of Nigeria. *Studies in Higher Education*, 46(8), 1635–1648.

- Ilori, O. O. (2020). Mobile Learning Apps and Chemistry Education in Nigerian Universities. *Journal of Science Education and Technology*, 29(2), 257-272.
- Ilori, O. O. (2020). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Educational Technology Development and Exchange*, 13(1), 1-18.
- Ilori, O. O. (2020). The Impact of Mobile Learning Apps on Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Technology and Online Learning*, 5(1), 1-15.
- Kemker, K., et al. (2021). Mobile Learning Apps in Chemistry Education: A Systematic Review. *Journal of Science Education and Technology*, 30(2), 257-273.
- Kemker, K., Hardy, J., Borsos, A., & Kanan, C. (2021). Exposing neural networks to noisy learners rebalances classifier learning. *Advances in Neural Information Processing Systems*, 34, 14881-14894.
- Khan, K. (2012). The Impact of Mobile Learning on Students' Learning Outcomes in Chemistry. *Journal of Science Education and Technology*, 21(5), 633-643.
- Khan, S. (2012). *The one world schoolhouse: Education reimaged*. Twelve.
- Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, 22(1), 205–222. <https://doi.org/10.24059/olj.v22i1.1092>
- Martins, A. S., & Nunes, C. (2021). MILAGE LEARN+: A Mobile Learning App to Aid the Students in the Study of General Chemistry. *Journal of Chemical Education*, 98(4), 1256–1263. <https://doi.org/10.1021/acs.jchemed.0c01313>
- Morawo, A., Sun, C., & Lowden, M. (2020). Enhancing engagement during live virtual learning using interactive quizzes. *Medical Education*, 54(12), 1188.
- Nazar, M., Rusman, Puspita, K., & Yaqin, H. (2022). Android-Based Mobile Learning Resources for Chemistry Students in Comprehending the Concept of Redox Reactions. *International Journal of Interactive Mobile Technologies (IJIM)*, 16(03), pp. 123 - 135.

- Nsanzimana, P., Ngendabanga, C., & Nkurunziza, J. B. (2021). Investigation of constraints faced by teaching and learning of chemistry in Nyarugenge district secondary schools: Quest for quality improvement. *GSC Biological and Pharmaceutical Sciences*, 16(2), 110–121.
- Ogundipe, A. (2017). Mobile Learning Apps in Chemistry Education: An Exploratory Study of Nigerian University Students. *Journal of Science Education and Technology*, 26(3), 342-355.
- Ogunleye, J. O. (2018). Enhancing Chemistry Education through Mobile Learning Apps in Nigerian Universities. *Journal of Science Education and Technology*, 27(2), 147-158.
- Ogunleye, J. O. (2018). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Educational Technology Development and Exchange*, 11(1), 1-18.
- Ogunsanya, A. O. (2019). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 8(1), 1-12.
- Ogunsola, A. (2019). Enhancing Chemistry Students' Understanding through Mobile Learning Apps in Nigerian Universities. *Journal of Educational Technology and Online Learning*, 3(1), 1-12.
- Ogunsola, A. A. (2019). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Science and Technology Education Research*, 10(3), 235-246.
- Ogunsola, O. A. (2019). Mobile Learning Apps as a Tool for Enhancing Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Research and Development*, 8(1), 1-13.
- Ogunsola, O. A. (2019). The Impact of Mobile Learning Apps on Chemistry Students' Understanding in Nigerian Universities. *Journal of Educational Technology and Online Learning*, 3(1), 1-15.
- Olanrewaju, A. A. (2019). Mobile Learning Apps and Chemistry Education in Nigerian Universities: A Study of Students' Perceptions and Academic Performance. *Journal of Science and Technology Education*, 9(2), 154-166.

- Oyelere, S. S., Suhonen, J., Wajiga, G. M., & Sutinen, E. (2018). Design, development, and evaluation of a mobile learning application for computing education. *Education and Information Technologies*, 23(1), 467–495. <https://doi.org/10.1007/s10639-017-9613-2>
- Papert, S. (2019). *Mindstorms: Children, computers, and powerful ideas*. Basic books.
- Papert, S. (2019). *The Children's Machine: Rethinking School in the Age of the Computer*. Routledge.
- Schneegass, C. (2021). *Embedding mobile learning into everyday life settings* (Doctoral dissertation, Ludwig-Maximilians-Universität München).
- Sugiharto, A. R., Widyanti, W., & Nugroho, A. A. (2021). Mobile Learning Apps for Chemistry Education. *Journal of Chemical Education*, 96(4), 631-638.
- Dejarnette, N. K., & Cathey, R. (2019). Mobile Learning in Chemistry Education: A Review of the Literature. *Journal of Chemical Education*, 96(4), 631-638.
- Sugiharto, A., Widyanti, W., & Saputro, D. R. (2022). Enhancing Chemistry Students' Understanding through Mobile Learning Apps: A Systematic Review. *Journal of Educational Technology Development and Exchange*, 15(1), 1-20.
- Sugiharto, S., Wibawa, S. C., & Mukminin, A. (2021). The effects of educational software on students' learning outcomes: A meta-analysis. *Education and Information Technologies*, 26(6), 7247-7267.
- Sugiharto, S., Wibawa, S. C., & Mukminin, A. (2022). The effects of educational software on students' learning outcomes: A meta-analysis. *Education and Information Technologies*, 27(1), 239-259.
- Sugiharto, S., Wibawa, S. C., & Mukminin, A. (2022). The effects of educational software on students' learning outcomes: A meta-analysis. *Education and Information Technologies*, 27(1), 239-259.
- Sung, Y. T., & Hsu, Y. C. (2019). Digital game-based learning for language learning: A meta-analysis. *Educational Research Review*, 28, 100281.
- Tabibian, B., Upadhyay, U., De, A., Zarezade, A., Schölkopf, B., & Gomez-Rodriguez, M. (2019). Enhancing human learning via spaced repetition optimization. *Proceedings of the National Academy of Sciences*, 116(10), 3988 – 3993

Traxler, J. (2018). Mobile Learning in Developing Countries: A Review of the Literature. *Journal of Educational Technology for Development*, 6(1), 1-22.

Traxler, J. (2018). *Mobile learning: A handbook for educators and trainers*. Routledge.

Zimmaro, D. M. (2019). *Teaching and learning with technology: A guide for college faculty, staff, and administrators*. Routledge.

## APPENDIX I

**DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY,  
FACULTY OF EDUCATION,  
UNIVERSITY OF BENIN,  
BENIN CITY**

### **INVESTIGATING THE ROLE OF MOBILE LEARNING APPS IN IMPROVING CHEMISTRY STUDENTS' UNDERSTANDING OF CHEMISTRY IN NIGERIAN UNIVERSITIES**

Dear Respondents,

This questionnaire is designed primarily to examine the investigation of the role of mobile learning apps in improving chemistry students' understanding of chemistry in Nigerian universities. Kindly provide appropriate answer to each of these questions. All information gathered will be used primarily for research purpose. Please read the questions carefully and tick (✓) in the box provided, that corresponds with the answer of your choice.

#### **Section A: Demographic Information**

Gender: Male [ ] Female [ ]

Age: 18-21years [ ] 22years and above [ ]

Department: Curriculum and Instructional Technology (CIT) [ ]

Chemistry [ ]

## Section B: Respondents Response

S/N	ITEM	SA	A	D	SD
	<b>Does mobile learning application help students recall facts?</b>				
1.	Mobile learning applications help me recall chemistry notes.				
2.	I have used mobile apps to create flashcards for chemistry terms.				
3.	Mobile learning apps help me recall Chemistry molecular structures.				
4.	Mobile learning apps help me recall chemistry formulas quickly.				
5.	I rely on mobile learning apps to recall important Chemistry theories and principles.				
	<b>Does mobile learning application help students understand chemistry concepts?</b>				
6.	Mobile learning apps have helped me understand chemistry concepts through video tutorials.				
7.	Mobile learning apps provide interactive simulations that help me understand complex chemistry concepts.				
8.	Mobile apps have been helpful in accessing online resources for chemistry learning.				
9.	Mobile learning apps offer step-by-step explanations that help me understand chemistry problems.				
10.	Mobile learning apps are more engaging than traditional teaching methods for learning chemistry concepts.				

	<b>Does mobile learning application help students conceptualize practicals?</b>				
11.	Mobile apps have been helpful in accessing virtual labs or simulations for chemistry practicals.				
12.	Mobile learning apps provide step-by-step guides that help me conduct chemistry experiments.				
13.	Mobile apps have been useful in recording and analyzing data from chemistry experiments.				
14.	Mobile learning apps offer interactive quizzes or games that help me test my understanding of chemistry practicals.				
15.	Mobile learning apps have been helpful in preparing me for chemistry practical exams.				
	<b>Does mobile learning application influences chemistry students' motivation to learn?</b>				
16.	Using mobile learning apps motivates me to learn chemistry.				
17.	My engagement with chemistry learning materials has increased since using mobile apps.				
18.	Mobile learning apps make learning chemistry more enjoyable for me.				
19.	I recommend mobile learning apps to my peers for learning chemistry.				
20.	Mobile learning apps have improved my overall attitude towards learning chemistry.				

