

Handheld Mobile Devices, Artificial Intelligence, and Study Habits Among Secondary School Biology Students in Abia State, Nigeria

Samuel PIUS, Raphael Chukwuebuka OJINNAKA & Stella Ifeoma OSONDU

Department of Science Education,

Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria

Authors Email: pius.samuel@mouau.edu.ng; ojinnaka.ebuka@mouau.edu.ng;
osondu.stella@mouau.edu.ng

Abstract

This study investigated handheld mobile devices and artificial intelligence as predictors of study habits among secondary school Biology students in Abia State, Nigeria. There were two research questions and two hypotheses. The population for the study was 13,947 Senior Secondary Three (SS III) students in public schools in Abia State, Nigeria in 2025/2026 academic session. A sample of 386 SS III students was drawn through the use of simple random sampling technique. Three instruments were used for the study. They included Handheld Mobile Devices Questionnaire (HHMDQ), Artificial Intelligence Questionnaire (AIQ), and Students' Study Habits Questionnaire (SSHQ). The instruments were validated by three experts. The instruments were subjected to reliability tests using Cronbach's Alpha formula. Reliability indices of 0.83, 0.70, and 0.89 were obtained for Handheld Mobile Devices Questionnaire (HHMDQ), Artificial Intelligence Questionnaire (AIQ), and Students' Study Habits Questionnaire (SSHQ) respectively. Pearson Product Moment Correlation was used to answer the research questions, while Simple Regression was used to test the null hypotheses at 0.05 level of significance. Results showed that Secondary School Students' use of handheld mobile devices significantly and positively predicts their study habits in Biology to a high extent. It was also found that Secondary School Biology Students' use of Artificial Intelligence significantly and positively predicts their study habits in Biology to a high extent. Based on the findings, it was recommended that government and school administrators should give guidelines on the use of handheld mobile devices and artificial intelligence among secondary school students in order to bring about good study habits.

Keywords: Artificial Intelligence, Biology, Handheld Mobile Devices, Information and Communication Technology, Study Habits

Introduction

Information and Communication Technology (ICT) has produced significant shifts in all spheres of human endeavours such as industries, agriculture, medicine, business, engineering,

and education. The effective integration of ICT into the teaching and learning process has the potential to engage learners, improve academic progress, encourage and motivate students, promote collaboration, supervisory research, and to develop new student-focused learning culture (Ezugwu and Ezeudu, 2022). It is important to bring the integration of information and communication technology ideas, materials and tools into school education because ICT allows teachers and learners to tailor teaching and learning to individual needs (Nnaekwe and Ugwu, 2019). According to Obeka (2019), information and communication technologies or electronic devices that are useful in teaching and learning include televisions, microphone, cell phones, radio, google slides, google meet, zoom, whatsapp, google scholar, among others. Some of these devices are handheld mobile devices while others are not.

Handheld mobile devices refer to information and communication technological gadgets that can be carried by hand or purse to assist/support learning anywhere and anytime. Ezugwu & Ezeudu (2022) stated that handheld mobile devices allow individuals to be more productive while consuming, interacting with, or creating information mediated through a portable digital device which has reliable connectivity that the individual carries on a regular basis, and fits in a pocket or purse. Bachore (2018) states that handheld mobile devices include cell phones, personal digital assistants (PDAs), smart phones, pads, pods etc. The main features of handheld mobile devices are accessibility, immediacy, and interactivity (Ogata and Yano, 2004). As cell phones, smart phones, ipads, tablets are readily available, learners can connect to internet and utilise the opportunity to learn often. It is also possible for learners to have adequate communication with each other, or with other colleagues and professionals in different locations through the use of handheld mobile devices which have various applications.

Learning through handheld mobile devices provides the learners with the opportunity to learn easily when they are in a vehicle or anywhere outside the classroom, thus learning can take place everywhere and at any time. The use of handheld mobile devices in learning derives its advantages from two main characteristics of mobile devices which are portability and connectivity (Bachore, 2018).

Portability makes learners to move with the devices to various places due to size and weight. Connectivity on the other hand refers to the possibility of handheld mobile devices to be connected to other devices, or a common network by creating a shared network. With the availability of electronic technologies, learners can access a multitude of information online and use them to explore their potentials. Ezugwu and Ezeudu (2022) stated that the use of handheld mobile devices in the process of teaching and learning improves the relationship between teachers and learners, promoting their interaction which will lead to a more active learning, and influence their study habits. In the same vein, Okoroafor (2022) opined that mobile learning as a form of learning is on the increase, as education has outgrown the physical constraints of the

classrooms. It improves students' study habits and gives them liberty to have almost limitless access to the content of any subject area as information are handy on the internet.

Many handheld mobile devices were developed specifically for learning purposes, for example e-readers. Moreover, many learning/educational applications (software) have been developed to run on mobile devices. They include google meet, zoom, whatsapp, google scholar among others (Mgboro et al., 2024). Software leverage on the portability and connectivity of regular handheld mobile devices. However, some of the devices that are appropriate for specific learning tasks are too expensive for most of the learners in secondary schools. There are other limitations such as small screen size, limited presentation of graphics, dependence on network that may not be readily available when needed, distractions from other applications on the same device such as social media, music, movies, games and so on. In fact, due to the aforementioned advantages and disadvantages of handheld mobile devices to secondary school learners, there has been debate on whether learners in secondary schools should be allowed to use smart phones and the likes in school and at home. It is very important to note that Artificial Intelligence (AI) application is now installed in many handheld mobile devices. Teachers and learners now use it to simplify the process of teaching and learning.

Artificial Intelligence (AI), once seen as a futuristic concept, has become a practical and transformative tool in many sectors, including education. In the process of teaching and learning, Artificial Intelligence (AI) is being increasingly employed to personalise learning, provide immediate feedback, support differentiated instruction, and boost students' engagement and achievement through interactive platforms. It serves as an intelligent tutor, offering real time assistance, answering student queries, and guiding learners through problem solving processes. It also promotes individualised learning, helping students understand abstract concepts at their own pace. According to Kaplan and Haenlein (2019), Artificial Intelligence (AI) mimics human intelligence by learning, reasoning, and making decisions. Similarly, Luckin (2021) and UNESCO (2022) affirm that Artificial Intelligence (AI) in teaching, enhances students' study habits, comprehension and provides teachers with insights into learners' progress and challenges. As noted by Luckin (2021), AI technologies can analyse learners' responses, detect misconceptions, and adjust lesson paths to suit individual needs—something human teachers might struggle to accomplish with large class sizes. In the global context, AI-driven tools such as Carnegie Learning's "MATHia" and IBM's "Watson Tutor" have demonstrated measurable improvements in students' performance (Holmes and Bialik, 2020). In Nigeria, studies such as that done by Ajibade (2022) show that AI-based instructional supports can reduce students' anxiety, improve their study habits and improve conceptual understanding, particularly in urban secondary schools with basic digital infrastructure.

Artificial Intelligence (AI) affects learners at all levels of education including secondary school level, and all subjects including Biology (Okoli and Emenike, 2023).

Biology is a popular subject among science students. It is a natural science subject consisting of contents from microscopic organisms to the biosphere in general, encompassing the earth's surface and all living organisms (Ibrahim et al., 2018). Similarly, Kyado et al. (2019) defined Biology as the study of plants and animals and their interactions with their physical environment. Biology can be said to be the study of plants and animals, and how they relate with their environment. Biology is an important subject as it provides the basis for important fields in the society such as pharmacy, nursing, medicine, agriculture and so on. Successful teaching and learning of any subject could be influenced by factors that come from within learners and those from without (Popoola et al., 2021). Factors from within include psychological and physiological factors, while factors from without are environmental and instrumental factors. Among the psychological factors is study habit.

Study habit is the combination of both the classroom learning and out of classroom learning (Sakirudeen and Sanni, 2017). Adinna and Anene (2024) defined study habit as learner's repeated actions to study from the beginning to the end of all educational programmes. Study habit could be said to be the degree to which the student engages in regular acts of learning characterised by appropriate learning routines. Furthermore, Adinna and Anene (2024) posited that study habits that could lead to higher academic performance include visiting library, note taking, appropriate use of internet, reading books and attending classes. These activities can enhance Biology students' study habits which could improve academic performance.

There has been argument among parents, teachers, learners, and other education stakeholders on the use of handheld mobile devices both in school and at home by secondary school students. While some are of the view that secondary school students be allowed to use mobile phones as it will help them have access to information and education applications, others disagree with the view stating that it will distract the learners and introduce them to the ills of social media. More so, Okore et al. (2023) investigated on the influence of mobile phone services on students' study habits in Nigeria. The study showed that chatting on facebook, online sport betting, downloading and playing music, whatsapp chatting, e-mail services are among the mobile phone internet services used by the students. The study found that using these mobile phone services during private study and lesson periods negatively affect study habits. Biswajit and Biswajit (2024) carried out a study on the impact of handheld mobile devices on the study habits of students in Raiganj University, West Bengal, India. The study found that 88.64% agreed that mobile technology has improved their study habits. A research was conducted by Esan et al. (2025) on the impact of smart phones use on learning effectiveness: A case study of college students in Nigeria. It was found that majority of the respondents spent more than five hours on their mobile phones daily. About 57% of the respondents had poor pattern of mobile phone usage, and 59% had bad study habits. There were significant relationships between mobile phone use and study habits. This study therefore sought to find out how handheld mobile devices

and Artificial Intelligence (AI) predict the study habits of secondary school Biology students in Abia State, Nigeria.

Literature Review

In this section, the related literature was reviewed based on the variables in this study.

- **Handheld Mobile Device Learning**

Handheld Mobile Device is one of the Information and Communication Technology (ICT) tools used in various fields of human endeavour including education. The learning process supported by handheld mobile devices is known as Handheld Mobile Device Learning (Ezugwu and Ezeudu, 2022). Bachore (2018) defined handheld mobile device learning as the process of learning which includes any kind of handheld mobile device such as cell phones, Personal Digital Assistants (PDAs), smart phones, pads, pods etc. Handheld Mobile Device Learning can also be seen as the use of technologies in learning particularly where device portability gives specific merits (Kukulska-Hulme, 2023). Spifonova and Ronchetti (2016) see it as a computational device that is small, self-directed and unnoticeable for every day's use. Furthermore, a description of what defines a device to be mobile is that it is wearable (De Frietas and Levene, 2018). By being wearable, it becomes part of a person's daily wardrobe, filling a need as important as a piece of clothing, fitting into a pocket or purse, and very likely being kept with the person everytime (Livingstone, 2019). The discussion on handheld mobile device in this study does not include laptop computers since they do not fit into the category of being wearable; although they are portable, they are not currently mobile in the sense of being wearable.

- **Benefits of Handheld Mobile Device Learning**

The importance of handheld mobile device learning across institutions of learning must not be ignored. The process of teaching and learning has now become innovative because of smartphones and other devices in promoting and advancing 21st century skills and knowledge (Emerson and Berge, 2018). Learners have experiences of digital surroundings through the use of mobile devices such as tablets and smart phones. Mokoena (2022) posits that learners' engagement in the use of smart phones improves collaborative learning through its connection to the internet. This implies that the use of handheld mobile devices makes learners to be more engaged in learner centred participatory learning. This is a clear indication on numerous supports that handheld mobile devices have made learners to advance in their understanding by increasing academic performance, social media participation and information sharing, which helps their social skills.

Furthermore, Mokoena (2022) continued that group projects and/or work given to learners by their teachers are simply and comfortably carried out through the use of handheld mobile devices. The challenge of communication in classrooms with learners is solved with the use of smartphones. This is because learners are now able to record their teachers' lessons in real time. With the advent of handheld mobile devices, what the learners do outside the classroom is

very much similar to what they do inside the classroom. This is possible because many lesson applications can be used to listen and learn from a tutor just as one listens to the teacher.

In another submission, Adomi et al. (2024) stated that handheld mobile devices when used for the purpose of learning improves learners' engagement in learning by surfing the web for information to solve individual and group assignments, communicating through e-mail, connecting with peers and friends, and for entertainment. The authors continued that these technologies help secondary school learners to communicate with one another, to be able to search for educational information that will help them in their school tasks and be able to know what is happening around the world. The introduction and use of mobile devices can help learning and make education more entertaining for secondary school students. In fact, many schools in Abia State, Nigeria have started using handheld mobile gadgets to promote education, keep students up to date with assignments, and offer help to those in need (Boyd and Ellison, 2007). Despite all the benefits of handheld mobile devices among secondary school learners, many arguments can still be made about the possible challenges associated with it.

- Challenges of Handheld Mobile Device Learning

Many learners are able to carry out tasks through handheld mobile device in both the classroom and at home, while others experience some level of distraction. The mere visibility and presence of handheld mobile devices attract the attention of students in school or even adults at home. Many learners can be shifting their focus between the handheld mobile devices as a medium of entertainment, and at the same time, a learning device (Barnwell, 2016). The use of handheld mobile device for learning means that learners have to combine information and at the same time stay focused on their lesson in the class. For learners who have low literacy skills and the steady urge to multitask on social media, blending the purposeful use of smart phones into classroom activities can be particularly challenging. Then, the objective of the device (which is learning) tends to be forgotten (Ifeanyi and Chukwuere, 2018). Young learners who are still within the level of adolescents use handheld mobile devices to invite and initiate social circles where friendships are initiated. Friendships that are initiated over social media tend to be more recreational and are less based on educational purposes, especially when such relationships are among adolescents (Ifeanyi and Chukwuere, 2018). The implication of the above sentence is that, it is a clear indication that less attention is given by learners to their academic work and activities in the presence of handheld mobile devices. Some schools have banned the use of smart phones and other mobile devices in classes or during lessons; the reason being that it aids cheating during their tests and examinations (Buck et al., 2023).

The easy access to internet on the handheld mobile devices helps the learners to simply find answers to their test or examination questions online, thereby enabling the learners to pass their examination, but not helping them to have real knowledge about what they are being taught by their teachers. Odofin (2024) opined that handheld mobile devices through the use of the

internet on them has disconnected children from their parents, peers and academic activities, making it impossible to acquire social skills, communication skills, emotional skills, and basic problem solving skills, which may have adverse effect on the child's morale, attitude, psychological well-being, habits and learning behaviour, because so much time and attention could be wasted by the child on engaging in internet. The author summarised some adverse effects of handheld mobile devices usage among learners to include source of distraction to the child, disengaging the child from social interaction, aids examination malpractice, sleep deprivation, risky sexual behaviours, aggressive behaviours, social and psychological problems, unreliable sources of information online among others. Furthermore, young people who are mostly secondary school students pay great attention to their internet-enabled phones, also to what their peers think of them. The use of handheld mobile devices does not only cause mental effects, but there also exist other impacts caused by the continuous use of such devices, which has been identified as addiction.

Recently, psychologists have issued cautions that cell phone users face the risk of being addicted to their phones. There have also been some medical concerns that have been raised in connection with the use of smart phones. Such concerns include insomnia, anxiety, misery and others (Ezemenaka, 2023). Furthermore, Arike et al. (2013) posited that educational technology and media are still not sufficiently applied in secondary schools because of reasons such as lack of equipment, necessary resources, and lack of technical knowledge of teachers for the implementation of new technologies. For these reasons, the researchers suggested that mobile learning could stand in the gap. From the foregoing, the benefits and challenges of mobile electronic technology learning linger the argument of whether learners in secondary schools should be allowed to engage in handheld mobile learning both in school and at home or not.

- **Artificial Intelligence (AI) in Education**

Artificial Intelligence has revolutionised instructional delivery by enabling adaptive learning, personalised feedback, and automated tutoring systems. As noted by Luckin (2021), AI technologies can analyse learners' responses, detect misconceptions, and adjust lesson paths to suit individual needs—something human teachers might struggle to accomplish with large class sizes. In the global context, AI-driven tools such as Carnegie Learning's "MATHia" and IBM's "Watson Tutor" have demonstrated measurable improvements in student performance (Holmes and Bialik, 2020). In Nigeria, studies such as that by Ajibade (2022) show that AI-based instructional supports can reduce students' anxiety toward Mathematics and improve conceptual understanding, particularly in urban secondary schools with basic digital infrastructure.

- **Artificial Intelligence Chatbots in Education**

Artificial Intelligence chatbots are one of the most practical applications of AI in teaching and learning. These conversational agents simulate human dialogue and provide instant explanations, reminders, and personalised support. Chua and Annamalai (2025) explain that AI

chatbots act as virtual tutors capable of engaging students through natural language interaction, encouraging self-paced learning and confidence building. Similarly, Labadze et al. (2023) highlight that AI chatbots have enhanced formative assessment by providing immediate feedback, though they caution that excessive dependence may reduce critical thinking if not supervised by teachers.

In Nigeria, the use of AI chatbots is gradually gaining ground. Eze and Olawale (2024) found that students exposed to chatbot-based Mathematics lessons demonstrated better retention of algebraic concepts compared to those taught through traditional lectures. The researchers attributed this to the interactive question–answer format that maintains students’ attention and curiosity. This shows that chatbot integration can bridge the feedback gap in resource-constrained classrooms. This research also sought to investigate the predictive potency of Handheld Mobile Devices and Artificial Intelligence on secondary school Biology students’ study habits.

▪ Study Habits

Different people have different ways and methods to study at any level of education. Study habits according to Jafari et al. (2019) refer to different individual behaviours related to learning, and how methods and skills are put together during studying. In another submission, Okoli and Emenike (2023) stated that study habits consist of behaviours and skills that can improve motivation and convert learning in an effective process with high returns, which ultimately improves learning. Furthermore, Mendezabal (2023) posited that study habits refer to the pattern of behaviours exhibited by learners in the pursuit of their studies that serve the drive for learning. The author continued that study habits comprise the degree to which the learner engages in regular acts of learning that are characterised by appropriate study routines. Study habits can therefore be seen as the aggregate of all behaviours adopted in the process of studying.

Jafari et al. (2019) opined that study habits can be categorised as good or bad. Good study habits include studying daily, studying in a quiet environment, keeping good notes, being organised, reading text books and other materials, attending classes, listening to the teacher in the class, turning off TV, phones and other devices that could interfere with studies, solving and submitting assignments, writing tests and examinations, participating in practical sessions, asking questions where necessary etc. Bad habits could be procrastination, skipping classes, noise making in the class, not doing assignments, not writing tests and examinations, not participating in practical sessions, watching television or playing games instead of studying, not keeping notes, reading in an inappropriate environment, and so on. Handheld Mobile Devices and AI can influence learners’ study habits. There are previous studies that are related to handheld mobile devices and study habits. Biswajit and Biswajit (2024) carried out a study on the impact of handheld mobile devices on the study habits of PG students in Raiganj University, West Bengal, India. It was found that 88.64% of the students agreed that handheld mobile

devices have improved their study habits. On the other hand, Okore et al. (2023) investigated on the influence of mobile phone services on students' study habits in tertiary institutions in Nigeria. The study found that using these mobile phone services during private study and lecture periods negatively affect study habits. These differences in the findings of previous researchers necessitated the present study. To further buttress the necessity of this research, Technology Acceptance Model, and Constructivist theory were reviewed.

- Technology Acceptance Model (TAM)

The Technology Acceptance Model is an information system theory propounded by Fred Davis in 1989. The theory explains how users form attitudes and intentions to use technology, leading to actual adoption and usage. The model debunked the idea that people hurriedly embrace new technologies such as handheld mobile devices rather, opined that when users are presented with a new technology, dual constructs influence their decision about how and when they will use it. The two constructs are Perceived Usefulness (PU) and Perceived Ease of Use (PEU).

Perceived Usefulness is the degree to which a person believes that using a particular technology will improve their performance or achieve a specific goal, while Perceived Ease of Use is the degree to which a person believes that using a particular technology will be free from effort. Technology Acceptance Model has been widely applied in various fields including information and communication technology to predict and explain technology adoption behaviours, including when and how to use technology of any kind for the optimum benefit of the users.

Technology Acceptance Model has strong behavioural inclination. It presupposes that when someone forms an intention to act, they will be free to act without limitations. In the real sense, there will be many constraints to act out the intent. Because technologies such as handheld mobile devices are complex and there exists elements of uncertainty on whether secondary school students have good intentions of using handheld mobile devices, study habits of the students may be affected. Technology Acceptance Model explains the perceived usefulness and usage intentions in terms of social influence and cognitive instructional processes of the technology. The purpose of this model is to predict the acceptability of a tool and to identify the modifications which must be brought to the system in order to make it acceptable to users. This model postulated that the use of an information system is determined by the behavioural intentions, but on the other hand, the behavioural intentions are determined by the person's attitudes towards the use of the system, and also by his perception of its utility. According to the proponent, the attitude of an individual is not the only factor that determines his use of a system, but is also based on the impact which it may have on the performance.

The model is used in this study because it explains technology adoption behaviours, including when and how to use technology of any kind for the optimum benefits of the user. Technology usage can influence learners' attitudes and study habits.

- Constructivist Learning Theory (CLT)

Constructivist Learning Theory was introduced by Jean Piaget in 1936. The theory states that human knowledge is innate and learning is attained through 'construction' of knowledge. It explains how children construct knowledge and understanding through active learning and experience. By implication, the learner is not just to be fed with information all the time but should be given the opportunity to organise his/her schemas to develop knowledge. Piaget continued that constructivist theory has three basic components; schemas, adaptation process, and stages of cognitive development. Schemas, according to Piaget are the building blocks of knowledge. The learner already has an existing knowledge and it is directly shaped by experience.

Piaget stated that adaptation process comprises of assimilation, accommodation, and equilibration. Assimilation refers to using an existing schema to deal with a new object or situation. Accommodation happens when the existing schema (knowledge) needs to be changed to deal with a new object or situation, and equilibration is the force that moves development along. Assimilation and accommodation require an active learner, not a passive one, because problem solving skills cannot be taught, they must be discovered. The foregoing points to the fact that handheld mobile devices can make learners to discover new knowledge and information by themselves. Similarly, AI can enable the learners to have confidence in themselves that they can explore and discover new knowledge and facts by themselves, as stated in this theory.

The last component of Piaget (1936) constructivist theory involves four stages of cognitive development. The stages include:

- Sensory motor stage (birth to age 2)

- Preoperational stage (age 2 to age 7)

- Concrete operational stage (age 7 to age 11)

- Formal operational stage (age 11 and above)

This study is related to the fourth stage as secondary school students belong to this category. At this stage (formal operational stage), people develop the ability to think about abstract concepts and logically test hypotheses. Piaget continued that within the classroom, learning should be student centred and accomplished through active discovery learning. The role of the teacher is to facilitate learning, rather than dominating the process. Therefore, teachers should encourage the following:

- Focus on the process of learning, rather than the end product.

- Allow learners to study on their own, with the confidence to rediscover and reconstruct 'truths'.
- Devising situations that present useful problems, that learners will find solution either individually or collaboratively.
- Evaluate the level of the child's development so that suitable tasks can be set.

This study therefore, may help to address the requirements suggested by Piaget because handheld mobile devices can make the learner active in the teaching and learning process at home or in school. By implication, Biology teachers in secondary school should be able to evoke and challenge the confidence level and the reasoning ability of the learner to enhance cognitive growth and advance the thinking ability of the child. Keeping the learners engaged in activities like handheld mobile devices may provide the opportunity for social interaction and cognitive learning which are characteristics of formal operational stage. The reports of some previous researchers were also reviewed.

Biswajit and Biswajit (2024) carried out a study on the impact of mobile technology on the study habits of PG students in Raiganj University, West Bengal, India. A descriptive survey design was used for the study. One hundred PG students constituted the population of the study, and census sampling technique was used as the whole population could be handled. Structured questionnaire was used as the instrument for data collection. Regression and ANOVA were adopted for data analysis. The study found that 88.64% agreed that handheld mobile devices have improved their study habits.

Okore et al. (2023) investigated on the influence of handheld mobile phone services on students' study habits in tertiary institutions in Nigeria. A descriptive survey design was used for the study. Questionnaire was adopted as the instrument for data collection from 448 respondents from six institutions offering Library and information Science in South-South and South-East, Nigeria. Simple random sampling technique was used to draw the sample of 448 respondents. Regression was used to test the hypotheses for the study. The study showed that chatting on facebook, online sport betting, downloading and playing music, whatsapp chatting, e-mail services are among the mobile phone internet services used by the students of tertiary institutions. The study found that using these mobile phone services during private study and lecture periods negatively affect study habits. It was concluded that if the use of handheld mobile phone services are not controlled, students may continue to have poor academic performance.

A research was conducted by Esan et al. (2025) on the impact of smart phones use on learning effectiveness: A case study of college students in Nigeria. The design of the study was a quantitative descriptive cross-sectional study. A sample of 382 students across various colleges and class levels in a private university in Nigeria were chosen using multi stage sampling technique. Data were obtained using a semi structured pretested questionnaire. Analysis of Variance (ANOVA) was used for data analysis. It was found that majority of the respondents

spent more than five hours on their mobile phones daily. About 57% of the respondents had poor pattern of handheld mobile phone usage, and 59% had bad study habits. There were significant relationships between handheld mobile devices and study habits.

The previous studies show different outcomes of the relationship between handheld mobile devices and study habits. These differences also necessitate this present research.

Research Questions

The following research questions were posed for the study.

- i. To what extent does Secondary School Students' use of handheld mobile devices predict their study habits in Biology?
- ii. To what extent does secondary school students' use of artificial intelligence predict their study habits in Biology?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance

- i. Ho1: Handheld mobile devices do not significantly predict Secondary School Students' study habits in Biology
- ii. Ho2: Artificial intelligence does not significantly predict Secondary School Biology Students' study habits

Methodology

This study adopted correlational research design. Correlational studies indicate the direction and magnitude of the relationship between variables, and is determined through the use of correlation coefficients. The population of this study was 13,947 senior secondary three (SS III) students in public secondary schools in Abia State, Nigeria in 2025/2026 academic session (Nigeria Digest of Education Statistics, 2025). The choice of SS III students was because the students in this class have passed through two years of teaching in Biology (SSI and SSII), which gives them more experience than other classes. A sample size of 386 SS III Secondary School Biology students were used for the study. The sample size was determined using Taro Yamane formula for sample size in survey research. Simple random sampling technique was employed to draw the sample. Simple random sampling by balloting was used to draw one education zone from the state. Thus, Umahia education zone was drawn. Simple random sampling was again used to draw two Local Government Areas that constituted Umuahia Education zone. Umuahia North and Ikwuano Local Government Areas were sampled. Simple random sampling technique was then employed to sample two schools from each Local Government Area. The schools sampled were Ibeku High School, Umuahia and Isieke Community Secondary School for Umuahia North Local Government Area, and Ikwuano Secondary School, Ariam and Awom Naebo Secondary School, Amawom for Ikwuano Local Government area. The instruments used for data collection in this study include Handheld Mobile Devices Questionnaire (HHMDQ),

Artificial Intelligence Questionnaire (AIQ), and Students' Study Habits Questionnaire (SSHQ). The instruments were divided into two sections. Section A sought information on personal data which include name of school and class of the respondents, while section B sought information about the respondents' opinions on the item statements. They were all adapted from DeVellis (2017). Each instrument contains 20 items with a modified 4-point Likert rating scale. The scoring for positively cued items was strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1). The scoring for negatively cued items was Strongly Agree (1), Agree (2), Disagree (3), Strongly Disagree (4). The instruments for this study were validated by three experts. Two experts in Biology Education and one in Measurement and Evaluation units of the Department of Science Education, Michael Okpara University of Agriculture, Umudike. The copies of the instruments after validation were administered to 20 SS III Biology students of Government College, Umuahia, Abia State, to determine their reliability. The data obtained were subjected to reliability tests using Cronbach's Alpha formula. Reliability indices of 0.83, 0.70, and 0.89 were obtained for Handheld Mobile Devices Questionnaire (HHMDQ), Artificial Intelligence Questionnaire (AIQ), and Students' Study Habits Questionnaire (SSHQ) respectively. The adoption of Cronbach's Alpha was because the items were polytomously scored, consisting of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). Research assistants (SS III Biology teachers) in all the sampled schools were used to administer the instruments to the respondents. This was done after obtaining permission from the school authorities to conduct research using their students as respondents. The research assistants were in charge of the administration of the instruments to the students and collation of filled instruments from them and handed over to the researcher. Data were recorded after the collation of all instruments. Only filled and returned instruments were used for data analysis. Pearson Product Moment Correlation was used to answer the research questions, while Simple Regression was used to test the null hypotheses at 0.05 level of significance. Pearson Product Moment Correlation and Regression were considered appropriate because the study intended to determine the extent of relationship and predictive potency of the variables respectively. The extent of the relationship between the variables was interpreted using the Nworgu (2015) correlation coefficient scale:

- 0.00 = No relationship
- 0.01–0.19 = Very low relationship
- 0.20 – 0.39 = Low relationship
- 0.40 – 0.59 = Moderate relationship
- 0.60 – 0.79 = High relationship
- 0.80 – 0.99 = Very high relationship
- 1 = Perfect relationship

Furthermore, any p-value that is equal to or greater than 0.05 is not significant and therefore, the null hypothesis was not rejected. Any p-value that is less than 0.05 is significant and therefore, the null hypothesis was rejected.

Results and Findings

The results of this study were presented according to the research questions and the corresponding hypotheses as follows:

▪ Research Question 1

To what extent does Secondary School Students' use of handheld mobile devices predict their study habits in Biology?

Table 1

Pearson Product-Moment Correlation Analysis of the Extent to Which Secondary School Students' Use of Handheld Mobile Devices Predicts Their Study Habits in Biology

Variable		Handheld Mobile Devices	Study Habits
Handheld Mobile Devices	Pearson correlation	1	.698**
	Sig. (2-tailed)		.000
	N	386	386
Study Habits	Pearson correlation	.698**	1
	Sig. (2-tailed)	.000	
	N	386	386

Note. ** Correlation is significant at the .05 level (two-tailed).

Result in Table 1 is correlation coefficient of extent to which Secondary School Students' use of handheld mobile devices predict their study habits. Results showed a correlation coefficient (r) of .698 which is a positive correlation and is within the coefficient limit of +/- 0.60–0.79 as high extent relationship. This indicates that secondary School Students' use of handheld mobile devices positively relates to their study habits to a high extent.

A corresponding hypothesis formulated to further address the research question is hypothesis 1.

▪ Hypothesis 1

Handheld mobile devices do not significantly predict Secondary School Students' study habits in Biology

Table 2

Regression Analysis of the Predictive Potency of Handheld Mobile Devices on Secondary School Biology Students' Study Habits

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	36,829.169	1	36,829.169	189.706	.000
Residual	38,827.668	384	194.138		

Model	Sum of Squares	Df	Mean Square	F	Sig.
Total	75,656.837	385			
R ²		.487			

Note. Dependent variable: Study Habits. Predictor: (Constant), Handheld Devices. df = degrees of freedom; F = calculated F value; correlation is significant at the .05 level (two-tailed).

Table 2 revealed the F-calculated value of 189.706 at 0.05 level of significance. The table also shows that the P-value of .000 is less than the alpha value at 0.05; the null hypothesis, which states that handheld mobile devices do not significantly predict secondary school Biology students' study habits, is therefore rejected. This implies that Secondary School Students' use of handheld mobile devices significantly and positively predict their study habits in Biology to a high extent. The coefficient of determination ($R^2 = 0.487$) shows that 48.7% of the variation in students' study habits is explained by their use of handheld mobile devices, while the remaining 51.3% is influenced by other factors not examined in this study.

▪ Research Question 2

To what extent does secondary school students' use of artificial intelligence predict their study habits in Biology?

Table 3

Pearson Product-Moment Correlation Analysis of the Extent to Which Secondary School Biology Students' Use of Artificial Intelligence Predicts Their Study Habits

Variable		Artificial Intelligence	Study Habits
Artificial Intelligence	Pearson correlation	1	.759**
	Sig. (2-tailed)		.000
	N	386	386
Study Habits	Pearson correlation	.759**	1
	Sig. (2-tailed)	.000	
	N	386	386

Note. ** Correlation is significant at the .05 level (two-tailed).

Result in Table 3 is correlation coefficient of extent to which Secondary School Biology Students' use of AI predicts their study habits. Results showed a correlation coefficient (r) of .759 which is a positive correlation and is within the coefficient limit of +/- 0.60–0.79 as high extent relationship. This indicates that secondary School Biology Students' use of AI positively relates to their study habits to a high extent.

A corresponding hypothesis formulated to further address the research question is hypothesis 2.

▪ Hypothesis 2

Artificial intelligence does not significantly predict Secondary School Biology Students' study habits

Table 4

Regression Analysis of the Extent to Which Artificial Intelligence Predicts Secondary School Biology Students' Study Habits

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	43,587.919	1	43,587.919	271.839	.000
Residual	32,068.917	384	160.345		
Total	75,656.837	385			
R ²		.576			

Note. Dependent variable: Study Habits. Predictor: (Constant), Artificial Intelligence. df = degrees of freedom; F = calculated F value; correlation is significant at the .05 level (two-tailed).

Table 4 revealed the F-calculated value of 271.839 at 0.05 level of significance. The table also shows that the P-value of .000 is less than the alpha value at 0.05; the null hypothesis, which states that the use of artificial intelligence does not predict secondary school Biology students' study habits, is therefore rejected. This implies that Secondary School Biology Students' use of Artificial Intelligence significantly and positively predicts their study habits in Biology to a high extent. The coefficient of determination ($R^2 = 0.576$) shows that 57.6% of the variation in students' study habits is explained by their use of AI, while the remaining 42.4% is influenced by other factors not examined in this study.

Discussion

Based on the results above, it was found that Secondary School Students' use of handheld mobile devices significantly and positively predicts their study habits in Biology to a high extent. This shows that parents and teachers alike have to focus on the use of handheld mobile devices and AI usage by students both in school and at home. If well implemented and controlled, handheld mobile devices and AI can improve learners' study habits. Good study habits could bring about better performance among students in Biology. This finding is in agreement with the findings of Ezugwu and Ezeudu (2022) who stated that the use of handheld mobile devices in the process of teaching and learning improves the relationship between teachers and learners, promoting their interaction which will lead to a more active learning, and influence their study habits. In the same vein, Okoroafor (2022) opined that mobile learning as a form of learning is on the increase, as education has outgrown the physical constraints of the classrooms. It improves students' study habits and gives them liberty to have almost limitless access to the content of any subject area as information are handy on the internet.

The implication here is that learners may find it easier to watch educational videos, read downloaded materials, surf the internet etc using their mobile devices anytime and anywhere than reading their notes and hard copies of their textbooks.

By contrast, the findings of the present study do not align with the findings of Okore et al. (2023) which stated that chatting on facebook, online sport betting, downloading and playing music, WhatsApp chatting, e-mail services are among the mobile services used by students during private time and even during lecture periods, and they negatively affect their study habits. The reason for the discrepancy between the present and the reviewed studies could be because of different levels of students used in both studies and the designs adopted. The reviewed study adopted descriptive research design using students in tertiary institutions, while the present study adopted correlation design using students in secondary schools.

Furthermore, the results of the study also show that Secondary School Biology Students' use of Artificial Intelligence significantly and positively determines their study habits in Biology to a high extent. This finding agrees with the findings of Luckin (2021) and UNESCO (2022) which affirm that Artificial Intelligence (AI) in teaching, enhances students' study habits, comprehension and provides teachers with insights into learners' progress and challenges. Similarly, Ajibade (2022) show that AI-based instructional supports can reduce students' anxiety, improve their study habits and improve conceptual understanding. This implies that the use of artificial intelligence presents an individual with the abilities to carry out academic tasks such as assignment, class work, practicals, class exercise among others. Effective completion of these tasks signifies that an individual has good study habits.

Limitations

1. Since the study covers Abia State only, the results may not generalize to other states in Nigeria with different infrastructure, culture, and curriculum implementation.
2. Not all students own smartphones or tablets. Some share devices with siblings or parents. These impede frequent use of the devices by the students.

Conclusion

This study investigated handheld mobile devices and artificial intelligence as predictors of Secondary School Biology students' study habits in Abia State, Nigeria. Based on the findings of the study, it could be concluded that handheld mobile devices and artificial intelligence significantly to a high extent relate to students' study habits in Biology. Thus, parents, guardians and teachers should ensure that they control the use of handheld mobile devices and other electronic gadgets among secondary school students so that the aim will not be defeated.

Recommendations

Based on the findings of the study, the following recommendations were made.

Government and school administrators should give guidelines on the use of handheld mobile devices and artificial intelligence among secondary school students in order to bring

about good study habits since it was found that handheld mobile devices and artificial intelligence significantly and positively determines study habits to a high extent.

School administrators should have Information and Communication Technology (ICT) units in their schools in order to train students on the use of handheld mobile devices and artificial intelligence.

References

Adinna, P. I. & Anene, C. O. (2024). Study habits as correlate of academic achievement among secondary school students in anambra State. *International Journal of Humanities and Social Science Invention*, 13(4), 93–101.

Adomi, T. T., Okiy, R. B. & Roteyan, J. O. (2024). A survey of cyber cafes in delta State, Nigeria. *Electronic Library*, 21(5), 487–495.

Ajibade, T. M. (2022). Artificial intelligence–assisted instruction and mathematics anxiety among senior secondary students in Lagos State. *Nigerian Journal of Educational Technology*, 19(2), 112–123.

Arike, B. N., Aniodoh, N. A. & Egbo, C. N. (2013). Gender and performance in Physics in anambra State. *Journal of Research and Method in Education*, 5, 13 – 21.

Bachore, M. M. (2018). Language learning through mobile technology: An opportunity for language learners and teachers. *Journal of Education and Practice*, 6(31), 50–53.

Barnwell, P. (2016). Do smartphones have a place in the classroom? The Atlantic. theatlantic.com

Biswajit, R. & Biswajit, N. (2024). Impact of mobile technology on the study habits of PG students in raiganj University, West bengal, India. *Journal of Science and Education*, 12, 127–139.

Boyd, D. & Ellison, N. (2007). Social network sites: Definition, history and scholarship. *Journal of computer-mediated communication*, 13(1), 1–11.

Buck, J. L., McInnis, E. & Randolph, C. (2023). The new frontier of education. The impact of smartphone technology in the classroom. In proceeding of ASEE Southeast section conference. American society for Engineering Education, 5(3) 533–542.

Chua, H. W., & Annamalai, N. (2025). A bibliometric analysis and systematic review in AI chatbots in language teaching and learning. *International Journal of Technology in Education*, 8(2), 274–331.

De Frietas, S. & Levene, M. (2018). Evaluating the development of wearable devices, personal data assistants and the use of other mobile devices in further and higher education institutions. JISC Techwatch.

DeVellis, R. F. (2017). Scale development: Theory and application (4th ed.). Sage.

Emerson, L. C. & Berge, Z. L. (2018). Micro learning: Knowledge management applications and competency based training in the work place. *Knowledge Management and e-Learning*, 10(2), 125–132.

Eze, C. N., & Olawale, A. O. (2024). Effect of artificial intelligence chatbot-based learning on secondary school students' retention in mathematics in enugu State. *Journal of Educational Research and Practice*, 14(3), 88–97.

Ezemenaka, E. (2023). The usage and impact of internet enabled phones on academic concentration among students of tertiary institutions: A case study at the University of ibadan, Nigeria. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 9(3), 162–173.

Ezugwu, I. J. & Ezeudu, F. O. (2022). Predictive potency of students' engagement in mobile electronic technology learning on their academic performance. *Journal of the Nigerian Academy of Education*, 18(2), 55–70.

Holmes, W., & Bialik, M. (2020). Artificial intelligence in education: Promises and implications for teaching and learning. OECD Publishing.

Ibrahim, A. T., Baba, A. & Ahmad, Y. (2018). Social networking sites and related techniques as catalyst for prepositioning ecology education curriculum in Nigerian colleges of education in 21st century. Proceedings of Multicultural African Conference held at Faculty of Education, Ahmadu Bello University, Zaria, 11th – 16th August, 2018.

Ifeanyi, I. P. & Chukwuere, J. E. (2018). The impact of using smart phones on the academic performance of undergraduate students. *Knowledge Management and e-Learning*, 10(3), 290–308.

Jafari, H., Aghaei, A. & Khatony, A. (2019). Relationship between study habits and academic achievement in students of medical science in kermanshah-iran. *Knowledge Management and e-Learning*, 11(2), 92–101.

Kaplan, A. & Haenlein, M. (2019). A brief history of artificial intelligence: On the past, present, and future of artificial intelligence. *California Management Review*, 61(4), 5–14. <https://doi.org/10.1177/0008125619864925>

Kukulska-Hulme, A. (2023). Mobile assisted language learning. *The Encyclopedia of applied linguistics*, 3701–3709, Willy.

Kyado, J. J., Abah, C. O. & Samba, R. M. A. (2019). Effect of collaborative concept mapping instructional strategy on secondary students' achievement in difficult Biology concepts. *American Journal of Social Sciences and Humanities*, 2(3), 201–212.

Labadze, L., Grigolia, M., & Machaidze, L. (2023). Role of AI chatbots in education: Systematic literature review. *International Journal of Educational Technology in Higher Education*, 20, 56.

Livingstone, A. (2019). Smartphones and other mobile devices: The swiss army knives of the 21st century. *Educause Quarterly*, 2, 48–52.

Luckin, R. (2021). Machine learning and human intelligence: The future of education for the 21st century learner. UCL Press.

Mendezabal, M. J. N. (2023). Study habits and attitudes: The road to academic success. Open Science Repository Education, Online, 3(1), 102–115.

Mgboro, C. U., Otubo, F. A., Achilike, B. A. & Ajude, K. C. (2024). Self-efficacy and locus of control as predictors of academic achievement of male and female students. *IOSR Journal of Humanities and Social Science*, 29(9), 64–71.

Mokoena S. (2022). Smartphones and regular cellular phones: Assessing their impacts on students' education at the University of Zululand. Doctoral Dissertation, University of Zululand.

Nigeria Digest of Education Statistics (2025). Statistics of students and teachers in Nigeria. Federal Republic of Nigeria

Nnaekwe, U. K. & Ugwu, P. (2019). The concept and application of ICT to teaching/learning process. *International Research Journal of Mathematics, Engineering and Technology*, 6(2), 207–210.

Nworgu, B. G. (2015). Educational research basic issues and methodology. University Trust Publishers.

Obeka, S. S. (2019). Effects of inquiry and demonstration methods on students' achievements and retention in some environmental education concepts. *Journal of Studies in Science and Mathematics Education*, 1(1), 52–58.

Odojin, T. (2024). The influence of digital technology on secondary school students' academic engagement behavior in Nigeria. *The Educational Psychologist*, 14(1), 1847–1879.

Ogata, H. & Yano, Y. (2004). Knowledge awareness for computer-assisted language learning using handhelds. *International Journal of Learning Technology*, 1(1), 435–449. doi.org

Okoli, J. N. & Emenike, O. E. (2023). Self-efficacy and study habits as predictors of secondary school students' interest in Biology in nsukka education zone. *International Journal of Research Publication and Reviews*, 4(11), 2632–2638.

Okore, N. E., Chimeze, O., Idahosa, M. & Ebele, R. (2023). The influence of mobile phone services on students' study habits in tertiary institutions in Nigeria. *The International Journal of Business and Management Research*, 1(1), 115–134.

Okoroafor, B. O. (2022). Technology-based learning: A panacea for improving teaching and learning of Chemistry in senior secondary schools in okigwe local government area of imo State. *Nigerian Journal of Educational Research and Evaluation*, 21, 199–213.

Popoola, G. A., Amoo, O. K., Umar, O. G., Popoola, A. A. & Olatunji, O. M. (2021). Influence of reading habits on students' academic performance in a senior secondary school in ibadan. *Research in Pedagogy*, 2(1), 141–162.

Sakirudeen, A. O. & Sanni, K. B. (2017). Study habits and academic performance of secondary school students in Mathematics: A case study of selected secondary schools in uyo local education council. *Research in Pedagogy*, 7(2), 283–297.

Spifonova, T. T. & Ronchetti, C. N. (2016). Research and development. Pearson press.

UNESCO. (2022). Reimagining our futures together: A new social contract for education. UNESCO Publishing. <https://unesdoc.unesco.org/ark:/48223/pf0000379707>.