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Development and Usability Evaluation of a Mobile Learning Application (Mla) On Periodicity For Nce Students

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ABSTRACT: Educational institutions are nowadays facing the reality of the widespread and high rate of development of mobile phones, this has involved an increase in both mobile phones storage capacity and speed which facilitate Mobile Learning. The teaching-learning materials need to be re-designed, re-developed and carried out in a way that fits this new kind of learning and makes it more effective. The advances in the use of technology in today's mobile phones qualify them to be instructional tools. Hence, the role of mobile phones/devices in presenting instruction for achieving effective teaching and learning cannot be over looked in the field of science generally and that of Chemistry in particular due to its perception as a difficult and abstract science subject by teachers and students. Hence, Chemistry has been identified as a field of knowledge that is of utmost importance to sustainable development of a nation. Since knowledge is required in the provision of human needs. Periodicity is one of the abstract concepts in Chemistry that requires better understanding by the students for further learning of Chemistry to take place. Thus, the teaching of the concept requires the use of effective instructional strategy such as mobile learning. As a result, the study developed and evaluated a Mobile Learning App on periodicity for Nigeria Certificate in Education (NCE) students using the heuristic evaluation guidelines. Two instruments (Experts' Usability Evaluation Questionnaire and Students' Usability Evaluation Questionnaire) were used to gather information from the two sets of respondents. The instruments for both experts and students were validated and tested for reliability by giving it to experts and students and subjecting them to analysis using inter rater reliability and Cronbach alpha from which 0.81 and 0.75 were arrived at respectively. The data collected were collated and analysed using descriptive statistics such as mean, standard deviation and inter rater agreement while the hypothesis was tested using t-test statistics. The analysis was carried out with the aid of SPSS version 20. Findings from the study revealed that students generally had positive perceptions towards MLA as a learning tool. The experts also agreed that MLA conformed with Heuristic guidelines technically and pedagogically. Also, there was no significant difference in the opinions of male and female students as regard usability of MLA. Hence, it is therefore concluded that MLA is a learning tool that can be employed for teaching periodicity. It is therefore recommended that students should be encouraged to use mobile learning App for learning of periodicity by their instructors for effective

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learning of the concept Experts in the field of Chemistry should encourage students to make use of the mobile learning App Gender should not be prioritised when encouraging students to use mobile learning App for learning of Chemistry concepts.

KEYWORDS: Mobile Learning App, Heuristic Evaluation, Instructional Strategy, Periodicity, Students' Performance

I. INTRODUCTION

The Internet, World Wide Web (WWW) and e-learning are major contributor to new forms of teaching and learning. E-learning has been described as a learning process that is supported by digital electronic tools and media and by analogy, m-learning is e-learning that engages mobile devices as well as wireless transmission [1]. Mobile Learning is a term that has been widely used in different parts of the world. For instance, in Nigeria, it has been encouraged to be used in higher institutions because of some advantages such as the availability of mobile phones, ability to motivate students, freedom and privacy they provide in the sharing of information. Mobile Learning is defined as E-learning that uses mobile devices or learning connected to a mobile device [2]. It is mainly based on technology mobility, mobility of learners and mobility of learning that complements the higher education institutions [3].

M-learning functions by integrating a number of hardware and software technologies into multimedia applications to facilitate the understanding of educational content, for instance, in the form of games and quizzes. The use of M-learning requires environments that are designed and evaluated in effective ways by considering both usability and pedagogical issues [4]. Usability is an important attribute that assists developers in the design and development processes to produce software or devices with a compelling user interface that is easy to use and thus allowing users to achieve specific task-oriented goals with efficiency, effectiveness, as well as satisfaction [5]. Usability as one of the focuses of the fields of human factors Psychology and Human-Computer Interaction assesses the quality of users' interaction with the system's environment; it is considered to be one of the most important characteristics when targeting systems that will be used by diverse audiences, such as students, without direct training or support [6].

The issue of usability is vital in e-learning, where students cannot begin to learn unless they can use the application before. Due to importance of usability in the use of devices for teaching and learning such as Mobile Learning Application (MLA), different methods have been employed in carrying out evaluation of usability of devices, one of such is Heuristic Evaluation (HE). The selection of Usability Evaluation Methods (UEMs) is influenced by the cost of a method and its effectiveness in addressing users' issues. Heuristic Evaluation (HE) is the most widely used Usability Evaluation Method (UEM) since it is inexpensive and easy to apply. However, according to [7]., over viewing 15 years of research and practice, 'The assessment of the effectiveness of Heuristic Evaluation continues as an active research thread. In the case of e-learning, selection of a UEM is particularly important because unless a system is easily usable, learning is obstructed and students spend more time learning how to use it than learning from it.

The usability of mobile learning applications includes some features that differ from other computer systems. These include the mobile context, connectivity, screen size, and different display resolutions. These features can influence usability factors such as effectiveness, efficiency, satisfaction, learn ability, memory ability, errors, and the cognitive load [8]. Promotion of these usability factors in MLA is likely to result to effective learning of abstract concepts generally and that of Chemistry in particular.

Chemistry is a branch of physical science that deals majorly with the study of composition, properties and behaviour of matters. It is a scientific discipline that deals with interaction between atoms and group of atoms. Chemistry has major contribution to make in the provision of human needs as science discipline such as food, shelter, clothing etc. Despite the series of benefits that could be derived from Chemistry, it has been observed that students are not doing well in the subject at all levels of education. This has been attributed to the difficult and abstract nature of some Chemistry concepts [9][10]. According to [11] the abstractness of Chemistry could be due to the nature of the subject as well as the human way of teaching the subject. However, one of the Chemistry concepts that have been perceived difficult is periodicity [12]. Hence, this study is geared towards addressing the difficulty of the concept.

Periodicity in Chemistry is the recurring variations in elements' properties which is observed to be one of the fundamental aspects of

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periodic table [12][13]. It is one of the most important concepts in Chemistry that if students have conceptual understanding of it would improve the learning of Chemistry concepts effectively and generally. Thus, for effective learning of Chemistry concepts generally by College of Education students, there is a need for them to have sound knowledge of periodicity. This is to enhance the performance of their work when they get to the field.

Statement of the Problem

The development of a nation without sound science education especially Chemistry education may not be realisable because Chemistry is seen has a central science due to its relationship with other branches of science [11]. Despite the importance of Chemistry, it is full of difficult and abstract concepts, which Periodicity is one of them that need to be taught effectively in order to promote conceptual understanding of other concepts in order to enable Chemistry students to contribute positively to nation building. Researchers have not relented in their efforts to make Chemistry students achieve conceptual understanding of the subject and one of such is the inclusion of mobile learning in the teaching and learning of the subject. For instance, [14]. developed a mobile application to facilitate students' learning in organic Chemistry known as Tsoichem. For such application to be effective, emphasis has been laid on Usability Evaluation.

Usability Evaluation has been recognised as a necessity prior to use of Mobile learning tools. For example, [4] and [6]. evaluated e-learning applications in higher education and an Educational Tablet respectively. The two studies evaluated existing applications. However, the present study developed and evaluated a mobile app for learning of periodicity for NCE students. This is thought to be necessary because periodicity is one of the pre-requisite knowledge required for further learning of other Chemistry concepts such as ionisation, especially for pre-service teachers that are expected to teach the basic level students the Chemistry aspect of science and also to proceed further in learning of Chemistry at the University level.

Objectives

The main objective of this study is to conduct usability evaluation of a Mobile Learning App on periodicity for NCE students using the heuristics guidelines. Specifically, the study will determine the following:

(1) Students' general impression of MLA as a learning tool;
(2) Whether students are satisfied with MLA as a learning tool;
(3) Whether students find MLA efficient as a learning tool;
(4) Whether students find MLA as a learning tool that improves retention;
(5) Whether students find MLA learnable as a learning tool;
(6) Whether MLA reduces error rate when used for learning;
(7) Whether the experts find the MLA conform with heuristic guidelines technically;
(8) Whether the experts find the MLA pedagogically usable and
(9) Gender influence on students' general perceptions of MLA.

Research Questions

Answers will be sought to the following Research Questions:

1. What are students' impressions about MLA as a learning tool?
2. Are students satisfied about MLA as learning tool?
3. Does student find the MLA efficient as a learning tool?
4. Does student find MLA as a learning tool that retains retention?
5. Does student find MLA learnable as a learning tool?
6. Does MLA reduce error rate when used for learning?
7. Do experts find the MLA conforms with heuristic guidelines technically?
8. Do experts find the MLA pedagogically usable?
9. Do male and female students differ in their general perceptions of MLA

Research Hypotheses

The null hypothesis was formulated in line with the research question:

1. There is no significant difference between male and female students as regard their general perceptions of MLA

II. LITERATURE REVIEW

Theoretical Framework

A number of theories have been propounded and utilised to explain and establish what transpire between learners and the learning materials or environment. Prominent among these theories of learning are cognivitism, behaviourism, constructivism, situated learning, context

awareness learning, collaborative learning to mention but few [15]. However, most of these theories focused attentions on classroom learning but paid little or no attention to the learning that takes place outside the four walls of the classroom. It has been identified that learning does not take place in the classroom alone but could as well take place outside the claasroom. In line with this fact, researchers like [16] [15] [17] and [18]. made efforts to associate some of these theories of learning with mobile learning. This has assisted the 21st century educators to gain insight into the interaction that occur between learners and any technological device they interact with for learning purpose.

The main target of any of the theories of learning is to explain the relationship between any organism (learner) and the environment it relates with that results to learning as a result of the organism previous or present experience [19]. While defining learning [20] opined that learning is any activity that involves cognitive, emotional as well as environmental occurrences that results to the acquisition, enhancement, production or making of changes in the acquired knowledge, skills, values and the world views. Relating this with mobile learning application, this occurs when the mobile learning application is presented on a mobile device; the learner gives response and was followed with appropriate feedback as reinforcement to the learners [17]. The reinforcement that the learners receive enables them to become active rather than passive participants in the learning process [21].

Sequel to the cognitivists theory of learning was that of the behaviourists theory that founded its basis on classical conditioning as propounded and initiated by Ivan Pavlov. Thereafter, B.F. Skinner carried out further experiment in order to explain the previous work of the Pavlov. One of the major assumptions of behaviourists is that learners have no control over what they learn. They further argued and submitted that before any activity can result to learning it must involve observable action which is to be exhibited by the learners.

The proponents of this theory opined that objective should be the driving force that should predict what is to be learnt by the learners. They equally concluded that information is usually transmitted from teachers to the learners during learning [22]. However, researchers have criticised the submission of the behaviourists theory that it only encourages learners to only memorise and repeat facts only but does not encourage learners to become active participants in the learning activities [21].

In furtherance of the previous theories, constructivism emerged between the years 1960s and 1970s. The proponents of these theory included Piaget, Bruner and Papert among others [23]. Constructivists were of the view that while learning is going on, the learners change progressively from passive of information receivers to active constructors of knowledge. The assumption of constructivists is that learners are active creators of new ideas based on their previous and present experiences [24]. Based on this proposition, the role of a teacher is that of a facilitator while learners are allowed to work independently, learn better as well as discover facts by themselves rather than being fed with facts. As observed by [25]., learners have the opportunity to experiment with what to learn in a real life situation and this assists them to retain the content of the learning material(s) for a long period of time. In a nutshell, the proponents of this theory of learning submitted that learners are constructors of what they learn and pace by which they learn.

However, none of these theories of learning is mutually exclusive from others but are all used for theoretical explanation for the understanding of how learning takes place. Based on the submissions of these theorists, both cognivisists and behaviourists asserted that objective should be the driving force for what the learners are to learn. On the other hand, the constructivists opined that learners are supposed to be the constructors of what they learn. Hence, this study subscribes to the submission of ideas of the constructivists believing that students in Colleges of Education (learners) have mobile devices that they used for communication and other uses (previous experience) and the mobile learning application (present experience) that could be employed to learn periodicity (learning content). It is assumed that what is left to be done is the creation of an enabling environment that will assist students to construct learning by themselves. Therefore, the students who are the learners will be able to utilise their mobile devices (previous experience) to access the content of the mobile learning application (present experience) that contain content of periodicity (learning material) that will be learnt faster and retained for a long period of time.

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There is a current focus on research on the intersection of human-computer interaction (HCI), e-learning environments to determine how to engage learners and motivate them to interact with these systems. Usability is a key issue in HCI since it is the aspect that usually predicts the quality of the user interface. The International Standards Organisation (ISO) defined usability as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context. Usability of e-learning applications significantly affects learning since learners' interactions with e-learning interfaces is expected to result to true learning rather than to only successful completion of tasks [26].

Mobile learning implies adapting and building upon the latest advances in mobile technology, redefining the responsibilities of teachers and students and blurring the lines between formal and informal learning. It embodies and facilitates the understanding of what it means to be a life-long learning and what it takes to thrive in today's workplace [26]. It is very important to keep in mind that the use of technology in educational environments must be based on the dominant educational theories and approaches which is consequently applied to Mobile Learning as one form of technology used in education [27]. For instance, learning according to Behaviorism, takes place when a conditional correlation is established between a specific stimulus and a particular response, [17]. In Mobile Learning, applications of Behaviorism are limited to its main principle, which is stimuli and responses. That is, students via Mobile Learning are provided with the learning content which is the stimuli, while the attached assignments, short tests, and feedback are the students' responses that follow. Cognitive Approach on the other hand focuses on enabling the learner to reorganise his/her cognitive structures in a way that allows him to process and store newly acquired information that will be retained and recalled in future. Therefore, learners should be provided in advance with the learning materials and new knowledge [27].

The literature has been reviewed to find out the extent to which researchers have gone in the use of ICT for teaching and learning of Chemistry concepts. The theoretical base for this study originated from the work of [28]. on cognitive theory of multimedia that was built on the rationale that people learn from instruction that has to do with words and picture than making use of words only. This means that for effective learning to take place there is the need for instruction to be presented in both words and picture rather than making use of words alone especially for Chemistry concepts that are been perceived as difficult and abstract [28].

[29]. observed that scientific concepts generally and that of Chemistry in particular exist in multiple forms of representation [10]. The representations are: (1) macro: which are phenomena that are observable making use of the sense organs. For example, the reaction between sodium metal and water can be observed in the laboratory. (2) submicro: this has to do with description of reactions using atoms, molecules, ions, that is, how to describe the reaction between the sodium and water using the particulate matter.(3) symbolic: this has to do with representation of the reaction with symbols such as chemical symbols, mathematical symbols etc. [29]. submitted that students found it difficult to comprehend the three forms of representation especially the submicro representation which is not observable making use of the naked eyes. In order to have conceptual understanding of Chemistry concepts this particular aspect of the representation needs to be comprehended by the students. The comprehension of the submicro level of representation could be more effective with the aid of visualisation tools such as mobile learning app and it is as a result of this that researchers such as [14]. have laid so much emphasis on teaching and learning of Chemistry concepts using mobile app.

Evaluation of Mobile Learning App

Evaluation is an important part of the overall design process, which ideally consists of iterative cycles of designing, prototyping, and evaluating. It allows assessing whether the product under evaluation is efficient enough (are the users able to carry out their tasks while expending reasonable resources such as time, cognitive or physical demand?), effective enough (can the user complete the tasks they are supposed to perform with the tool?, is their performance complete and accurate?) and sufficiently satisfactory for the users (what is the users' attitude towards the system? do they experience discomfort?) [30]. Evaluation can be carried out at any stage of the design, development or deployment. If it is carried out earlier in the design or development stages, it will afford the developers the opportunity to revise and redesign as the case may be. If it is done after the device or the system has been released or deployed,

it will help the developer make the necessary adjustment for the subsequent versions. Mobile Learning can be defined as any type of education or learning that occurs when the learner is not in a predetermined or fixed place, or when the individual takes advantage of learning opportunities offered by mobile technologies, thus combining the concepts of technology and mobility [31]. The use of M-learning applications allows individuals to be more productive when they consume, create or interact with information through mobile and portable devices, because these devices accompanying the individual on a regular way from the start to finish of their daily tasks. According to [32]., M-learning can be defined as the method of using handheld devices to access learning resources. With the evolution of technology and digital inclusion, it is clear that M-learning is important for contemporary educational needs. The benefits offered by M-learning are beyond accessibility, convenience and communication. Through mobile devices, learners can use specific learning environments, collaboration tools, social networks, e-books, didactic content, among others [33]. Although several evaluation studies have been conducted in the field of technology and engineering, the field of education has not recorded many especially as it concerns tablets technology and other mobile learning platforms.

[34]. conducted a research titled, "A Comparison of the Usability of a Laptop, Communicator and Handheld Computer in Finland". Their main interest was to find out how user-friendly and economically correct the devices under study were. The study involved 25 subjects who had five minutes each to perform typing or calculation tests with each device. The researchers reported that based on the subjects' experiences, the handheld computer and laptop had better ergonomic characteristics than the communicator. It was concluded that subjects felt the highest amounts of stress in their neck while working with the laptop, felt stress on their backs while working with the communicator and felt stress in their eyes while working with the handheld computer. It was however observed that the subjects performed the typing tasks best using the laptop. The researchers suggested that companies developing mobile devices should consider ergonomic issues and the ergonomic differences between different types of mobile devices to further improve users' satisfaction. [35]. conducted a research titled, the Effects of Touch Screen Technology on the Usability of E-reading Devices. Twelve university students were involved in the experiment with their mean age reported as 20-26. Three different types of devices were compared: two e-readers with e-ink display (the Sony PRS 600 with a touch screen and the Sony PRS 505 without a touch screen) and one tablets PC with a backlit LCD (Apple iPad with a multi-touch screen). Participants completed different use case scenarios for each device and then completed a questionnaire that asked them to rate the usability of the navigation, design, handiness, and handling of each device. The results show that e-reading devices with touch screens correlate with better navigation ratings. Participants rated the navigation significantly better for the devices with a touch screen compared to a device without a touch screen. Overall results suggested that a touch screen allowed for an easier and more intuitive interaction. Nonetheless, participants were not able to solve all tasks without problems, and significant differences were found between the devices. Bye and large, previous researchers concluded that any devices that are evaluated needed to be improved upon as regards their usability level.

[36]. conducted a Literature review of usability evaluation of e-learning system titled A Peek at the Position of Pedagogical Aspects in Usability Evaluation of E-learning System from 2000-2010. It was submitted that many studies have been conducted on usability evaluation methods in many specific areas, but much has not been carried out on E-learning systems. The paper compared all the studies reviewed to see how the pedagogical aspects or criteria has been treated when performing such evaluations as well as present a summary of all the usability evaluation methods (UEMs) that have been used in the studies. York method was used for the literature review. A total of 27 papers were analysed with a focus on four important pedagogical usability factors namely; learning content design, assessment, motivation to learn and learning/authoring supportive tools. However, it was however discovered that one third of the studies were not fully aware of the importance of pedagogical aspects in usability, in conclusion, usability evaluators were urged to be aware of the pedagogy usability when performing usability evaluation in future.

[37]. worked on Development and Evaluation of Educational Android Application. In the study, a mobile application was developed for

courses at undergraduate level. The application after development was used practically for 8 weeks; the findings were based on a practical experience rather than a theoretical basis. The study aimed to determine the opinions of students who participated in the development and application process of an Android application named NEU-CEIT about the mobile learning environment, educational and sharing structure of the developed application. A total of 27 students participated and asked to upload the developed application and examine the content. Following the application, students were administered an environment evaluation questionnaire. Data of the research were collected with survey method. Data obtained in the research were analysed through the views of experts. The result revealed that outcomes related with the usage structure of the developed application were positive, educational structure of the application was appropriate to follow the curriculum, it was rich in terms of materials and it might be one of the applications that students can use for communication. The result also showed that mobile applications would support education, increase motivation and improve academic achievement.

[38]. worked on Mobile Learning to Development of Students' Self-concept of Chemistry by developing mobile learning App in electrolyte solution and oxidation-reduction reaction. The results of the research were obtained from four types of findings that are percentage of Chemistry self-concept instruments, observation sheets, reflective journals, student interviews and the results focus on four indicators of Chemistry self-concept. The result of the study indicated that students' self-concept of Chemistry on the use of mobile learning media can be analysed from four indicators, namely Chemistry Self-Concept Indicator, which is due to group learning that makes the discussion process run well so that the existence of students learning groups that have low Self-Concept Chemistry was increasing because of joining a friend who had a high Chemistry Self-Concept.

Mobile learning media can minimize learning difficulties in Chemistry because the material in mobile learning is concise, easy to understand, and flexible (does not have to carry books) which makes students' enthusiasm to learn Chemistry high so students can learn Chemistry better. As for the indicators of learning convenience, the existence of mobile learning media makes students interested in learning Chemistry because of the appearance, images, and music found in mobile learning. Academic capability self-concept indicators develop after the use of mobile learning media due to a test simulation that is useful to train students' understanding of non-electrolyte and Redox electrolyte solution material and test simulations contained in mobile learning can be used whenever and wherever making students practice frequently so that students' school grades, especially in Chemistry, can be better. The last indicator is an indicator of problem-solving self-concept ability, and students' skills in solving problems develop after the use of mobile learning media, especially regarding practical videos that help students to solve chemical problems when practicum activities other than the consequences of mobile learning [38].

Using Mobile Devices for Improving Learning Outcomes and Teachers' Professionalisation was a study carried out by [39]. The study adopted an inclusion and exclusion criteria in the Web of Science and Scopus databases selecting 16 articles to argue why Mobile learning has become a modern innovative approach. Improvement in students' learning through M-learning, factors that encourage the use of mobile devices in universities have been identified and effective mobile applications in improving teaching and learning processes have been presented. The inclusion of this methodology requires a new role for teachers, whose characterisation is also specified. The results found in the systematic review, as a result of the 16 selected studies, can be clustered into benefits and factors that encourage the use of M-learning in higher education, identification of mobile applications for educational purposes and new roles of students and teachers to assume new conceptions about instructional processes. One of the factors identified as important for establishing M-learning in higher education is the increase in teacher-student interactions and the improvement of communication in the classroom. Asserting that the main thing that people make use of mobile devices for is indeed communication.

[40]. carried out a study on Mobile Learning via Educational Apps: An Interpretative Study, the rationale behind the utilisation of mobile learning technologies was explained in the study using a qualitative study among children to better understand their opinions and perceptions toward the use of educational applications (apps) that are available on their mobile devices (smartphones and

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tablets). The researchers organised semi-structured, face-to-face interview sessions with primary school students who were using mobile technologies at their institution. The students reported that their engagement with the educational apps has improved their competencies. Relational and communicative skills were acquired as they collaborated together in teams. On the other hand, there were a few students who did not perceive the usefulness and the ease of use of the educational apps on their mobile device. This study revealed that the research participants had different skill-sets as they exhibited different learning abilities. In a related study conducted by [41]. the researchers worked on developing an Android-Based Game for Chemistry Learners and its Usability Assessment. It was reported in the study that Smartphones were not only used for communication purposes but also for gaming and studying. The gamification of Chemistry concepts, therefore, becomes very interesting and promising to enhance students' intention of learning and promoting ICT literacy among university students. The study conducted a need analysis assessment to acquire responses from students about smart phone usage and attitude of students in using mobile applications in learning activities. The study revealed that smart phone was responsible for students' academic performance decline all over the world, but it was believed that controlling the smart phone use with a proper app like a specific subject matter game (learning App for Chemistry concept of colloids) could encourage students to learn better and independently. This was indicated by the usability scores of the app (72%), students' interest (70%), and demand of the game (59%). A quality model consists of a set of characteristics that relate to each other and which provides the basis for specifying quality requirements and quality evaluation [42]. Hence, the quality of a software product can be evaluated from the perspective of the development process, which relates to activities performed during the stages of the life cycle, and from the perspective of the product, which refers to the product characteristics after its development [42]. There are models proposed by International Organisation for Standardisation (ISO) and International Electro technical Commission (IEC), which also aim at establishing ways to ensure the quality of a software product. The series of standards by ISO/IEC defined a quality model in which product quality characteristics is presented [43]. This is also called Software Product Quality Requirements and Evaluation (SQuaRE) model. The evaluation of mobile learning applications was made by adapting the quality evaluation process for M-learning environments. According to [44]., evaluation of mobile learning App involves the following: Pedagogical; Functionality; Communication; Performance; Usability; Security; Portability and Support.

Periodicity as a Concept in Chemistry

Periodicity can be described as Chemistry concept that deals with arrangement of elements in a regular pattern based on their atomic number. [13]. defined it as regular repeated variations in properties of elements as a result of increament in atomic number. It was explained further that periodicity has enormous role to play in prediction of both chemical and physical properties of elements as well as features and behaviour of heavy elements by scientist. It was also reported that periodicity cannot be over looked in the conceptual understanding of Chemistry concepts such as ionisation energy, electronegativity, atomic radius, electron affinity etc. Hence, effective understanding of periodicity will play a huge role in understanding of the chemistry concepts related to it, and as a result the teaching and learning should not be handled with levity

Chemistry has been recognised as a science subject that is full of abstract concepts and also difficult to learn by students [45]. and one of the abstract concepts found in Chemistry is periodicity [46][47]. It is as a result of this that researchers have made it point of priority that for better teaching and learning of chemistry concepts such as periodicity there is the need for proper investigation of the concept such as [47]. who investigated the misconceptions about periodicity in secondary chemistry education making use of the case study of Kazakhstan. The study was carried out to identify the misconceptions present in periodicity so as to improve students' learning of periodicity, the instrument for data collection for the study was Periodicity Conceptual Test (PCT) which consisted of multiple-choice questions as well as true or false format and open-ended test items. The reliability coefficient of 0.76 was gotten by using Cronbach alpha. One hundred and sixteen secondary school students in year 9 and 8 took part in the study. The data was analysed using frequency counts and percentage and the misconceptions were grouped into six which were: meaning of periodicity, determinative factors of periodic properties, relation between periodic properties and number of subatomic properties,

periodic properties and periodic table. In which the erroneous ideas were attributed to poor teaching method that majorly laid emphasis on Mendeleev's short form periodic table without exercises on periodic properties and meaning of periodicity.

[45] also investigated Undergraduate Chemistry teacher trainees' understanding of chemical phenomena, in which interpretive studies were used to identify misconceptions students' possessed in explaining chemical phenomena that has to do with periodic trend and suggested method to find solution to the problem. Twenty-six first year undergraduate chemistry students were involved in the study. The instrument for the study was open-ended diagnostic test known as chemical phenomena diagnostic test (CPDT). Finding from the study revealed that 50% of the students from Ghana tertiary teacher education had misconceptions about periodicity especially chemical phenomena. The major misconception by the respondents was on electro negativities in a group, in relation to the way they change and also polarity.

Another study was carried out by [46] on reflections of teaching periodic table concepts citing the case study of selected schools in South Africa. The study explored the teaching of periodic table in five secondary schools in South Africa. The data for the study was gathered by using qualitative method which required the use of interview and document analysis from the respondents that were purposively selected for the study. The major research question answered in the study was "what practice inform physical sciences teachers when teaching periodic table of elements". Finding from the study revealed that participants were able to describe particular teaching-learning difficulties, for instance relationship between substances properties and constituent particles characteristics. Finding also laid emphasis on the use of atomic and molecular models to promote conceptual understanding.

Based on the submission of researchers such as [47][45][46]. who identified that the teaching method employed by Chemistry teachers in teaching periodicity results to misconceptions encountered in the learning of periodicity. Therefore, there is need to make use of instructional methods that will improve the learning of periodicity by the students one of such method identified by researchers is the use of Mobile Learning App.

Gender Influence on Evaluation of Mobile Learning App

Researchers have documented that gender difference existed among students in science and non-science related fields. A number of investigations have documented differences in male versus female use of mobile technology in a range of national and cross cultural contexts. Some of these researchers were of the views that male students achieved better than their female counterparts, some believed that females were better off when it comes to the use of mobile technology. For example, a study conducted by [48]. examined the moderating role of gender in the relationship between personality traits and Smartphone addiction. A multi-group SEM analysis was employed to investigate the relationship between five factor personality traits (Big Five) and Smartphone addiction among men and women. Big-Five-Inventory (BFI) and Smartphone Addiction Inventory (SPAI) were used to collect data from 320 undergraduate students. The results revealed a positively significant relationship between neuroticism (emotional imbalance) and Smartphone addiction for women only. Whereas, conscientiousness was negatively related with Smartphone addiction for women. Further, there was a negatively significant relationship between agreeableness and Smartphone addiction for both genders. The findings suggested that gender had a moderating role in the relationship between neuroticism and Smartphone addiction.

In a study conducted by [49]. on evaluating pre-service teachers' acceptance of mobile devices with regards to their age and gender in Greece, the study examined teachers' background variables, such as age and gender, with respect to whether and to what extent they influence the use of mobile devices in class. The Technology Acceptance Model (TAM) was used as the core framework for analysis while additional constructs were added in order to find and understand teacher acceptance of smart mobile devices better. Data were collected from 125 pre-service teachers who were studying in a one-year programme of pedagogical training in Greece. The study was conducted as a survey research study. Quantitative data collection tools were used for data collection. Descriptive and inferential statistics were used to analyse the data. Results revealed that pre-service teachers had positive opinions about mobile devices. However, there was no gender and age difference regarding the purpose for using smart mobile devices.

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On the other hand, [50]. conducted a study in Kuwait. The study examined instructor perceptions of m-learning and social media learning tools, as well as investigated instructor gender and age differences to better understand social and cultural issues that affect the implementation of m-learning in Kuwait. A questionnaire was administered to 132 instructors from different higher education institutions. The results revealed that instructors had moderately positive opinions about m-learning. The findings also confirmed significant gender and age differences and reports social and cultural influence that may act as barriers to the implementation of m-learning. Understanding these issues provides insight as to how these technologies were adopted, and allows us to develop better strategies and systems to assist individual instructors better integrate mobile technology into teaching and learning.

[51]. examined Gender Influence on Undergraduates Students' Acceptance of Mobile Learning Instruction using Technology Acceptance Model (TAM). A total number of 216 undergraduate students of the University of Ibadan, Nigeria were exposed to mobile learning platform using the Technology Acceptance Model (TAM Model). The model contained the following variables: perceived usefulness, perceived ease of use, attitude, and peer-influence, behavioural intention to use, interest, technology self-efficacy and acceptance. The study discussed gender influence on these variables and the results revealed that there was no significant difference between male and female undergraduate students' attitude to mobile learning after their exposure to mobile learning platform. The finding of the study showed that both male and female undergraduate students had positive attitudes towards mobile learning.

In a study carried out by [52]. that investigated the impact of instructors' age, experience, and gender on the integration of ICT into language learning. The sample of the study was 46 in-service teachers working at Najran University, Saudi Arabia. The results indicated a significant difference between male and female instructors in using ICT in language teaching.

Another study was conducted by [53]. at a New Zealand tertiary institution using mobile phones to deliver supplementary learning material, assessment reminders, and study tips to tertiary students. The study investigated what sort of learning environment is created by the use of mobile tools, if the learning environment can be enhanced through the use of mobile technologies in order to enrich the student learning experience and if these experiences differ based on gender and age. The gender results showed that there were no differences in perceptions between males and females, with age results showing that the younger age group had a more positive attitude toward the use of technology.

III. METHODOLOGY

The study is a descriptive research of the survey method. Descriptive research reports situations the way they are and since this is what is expected of this study, the method is thought to be appropriate. The target population for the study was 5 lecturers in the field of Educational Technology and computer science education in tertiary institutions in Kwara State. Also, 100 chemistry education students were purposely selected from two Colleges of Education in Kwara State, Nigeria to participate in the study. MLA was developed by the researchers and it was given to the experts and Chemistry students for them to study for a week. The study employed the Heuristic Evaluation instrument adapted from [54]. to determine the usability of the mobile App. The instrument consists of Experts' Usability Evaluation Questionnaire (EUEQ) and Students' Usability Evaluation Questionnaire (SUEQ).

The instruments consist of two sections that have to do with the experts and students' perceptions about the efficiency, effectiveness, learn ability etc. of the MLA. Section A examines the respondents' bio data while section B has to do with the respondents' perception of usability of MLA which are four points likert scale of strongly Agree, Agree, Disagree and Strongly Disagree. The SUEQ was subjected to reliability by administering 20 copies to students that would not be taking part in the study. The data collected was analysed using Cronbach Alpha and reliability coefficient of 0.75 was obtained. The EUEQ was subjected to reliability and validation by 2 experts that did not take part in the study and the reliability was determined using inter rater reliability in which 0.81 was arrived at. Also, their suggestions were effected in the final draft of the instrument. The research questions were answered using descriptive statistics such as mean and standard deviation while the hypothesis was tested using t-test statistics for the SUEQ. This is because the variable in the study i.e. gender of the students is independent variable occurring at two levels that is,

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male and female students. The students' response to the questionnaire items which is the dependent variable was treated as score data. Then the EUEQ items were subjected to inter rater agreement in order to determine the extent of agreement of the 5 experts that were involved in the study to the usability of the MLA.

IV. RESULTS

Research question 1: What are Students' Impression about MLA as Learning Tool?
Students had positive impression about MLA as a learning tool.

Table 1: Descriptive Analysis of Students' Impression about MLA

s/n	Items	Mean	Std. Deviation
1	The MLA is difficult to use for learning of periodicity	2.02	.932
2	I wish I can take periodicity note on my MLA	3.01	.835
3	Using the MLA helps me a lot in learning periodicity	3.28	.842
4	I am willing to carry out more learning about periodicity on my MLA	3.15	.744
5	The MLA supports important aspects of my learning periodicity	3.12	.808
6	I cannot carry out my learning of periodicity without the MLA	3.01	.732

Table 1 show that the students had positive impression about MLA because majority of them agreed with the statements on their impression about MLA except item 1. The mean values greater than or equals to 2.5 means agreement with the statement and the mean values less than 2.5 means disagreement. Hence, all the statements are greater than 2.5 except that of item 1.

Research Question 2: Are students satisfied with MLA as learning tool?
Students were satisfied with MLA as learning tool

Table 2: Descriptive Analysis of Students' Satisfaction about MLA as Learning Tool

s/n	Statement	Mean	Std. Deviation
7	The MLA has all the features I need for the learning of periodicity	3.02	.921
8	The MLA provides suggestions I need towards the learning of periodicity	3.10	.674
9	The MLA is not rigid and flexible to interact with in learning periodicity	2.70	.882
10	I am satisfied with the functions offered by the MLA on learning periodicity	3.22	.675
11	The terminologies that have been used in the MLA are familiar to me	3.38	.632
12	The arrangement of topics on the MLA is perfect and should not be changed	3.25	.880

Table 2 reveal that the students were satisfied with MLA as a learning tool since all the statement presented to them were agreed upon by the students because their mean values are all greater than 2.5 it means they all agreed with the statements which translate to being satisfied with MLA as a learning tool.

Research Question 3: Does student find the MLA efficient as a learning tool?
Students found the MLA efficient as a learning tool

Table 3: Descriptive Analysis of MLA Efficiency as a Learning Tool

s/n	Statements	Mean	Std. Deviation
13	I find navigating around the periodicity MLA very easy	2.91	.842
14	It is easy to switch from one subtopics to the other on the MLA	3.08	.900

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15	I can effectively complete the learning of periodicity using the MLA	3.08	.804
16	It takes little time on learning periodicity MLA	3.04	.803
17	I can effectively complete the learning of periodicity using the MLA	2.87	.825
18	I can navigate within the MLA using available short codes	2.76	.866

As it can be observed from Table 3 the students agreed that the MLA was a efficient for learning periodicity. This is because the mean values of the statements presented to them were all greater than 2.5 which translate to agreement on the part of the students.

Research Question 4: Does student find MLA as a learning tool that retain retention

The students were of the opinion that MLA is a learning tool that retains retention

Table 4: Descriptive Analysis of Students' Opinion of MLA as a Learning Tool that Retain Retention

s/n	Statements	Mean	Std. Deviation
19	I don't need any expert's help to use the MLA the second time	2.94	.962
20	I can easily locate any topic on the MLA	3.12	.769
21	I can mention the basic subtopics of the MLA without seeing them	2.84	.992
22	Remembering how to navigate within the MLA is very simple	3.13	.774

It is evident on Table 4 that students were of the opinion that MLA is a leaning tool that retains retention since the mean values gotten from the analysis were all greater than 2.5. It means students believed that MLA is a learning tool that supports retention.

Research Question 5: Does student find MLA learnable as a learning tool?

Students found MLA learnable as a learning tool

Table 5: Descriptive Analysis of Students Opinion of MLA learnable as a Learning Tool

s/n	Statements	Mean	Std. Deviation
23	Opening the MLA is very easy	2.89	1.014
24	It is easy to navigate through contents of any sub-topics in the MLA	3.00	.804
25	Understanding the different sub-topics in the MLA is easy for me	3.22	.786
26	I can test while reading my MLA and still return to same chapter with ease	3.19	.662
27	While using the MLA, I can pause and continue later	3.30	.810

Table 5 show that students found MLA to be learnable as a learning tool because all the mean values gotten from the analysis were all greater than 2.5 which is the average mean value. This means that majority of the students agreed with the statements that MLA is learnable.

Research Question 6: Does MLA reduce error rate when used for learning?

MLA reduces error rate based on students' views.

Table 6: Descriptive Analysis of Students' Perceptions of MLA as a Learning Tool that Reduces Error Rate.

s/n	Statements	Mean	Std. Deviation
28	When using the MLA, I can reverse any error(s) I commit	2.93	.924
29	There is a user guide on the MLA, so I cannot make irreversible errors	2.94	.839

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30	When am using the MLA, I cannot commit any error	2.65	.833
31	Any error I commit while using the MLA is always reversible	3.03	.822
32	It is not possible to commit error while using the MLA	2.64	1.020
33	I cannot commit any error because all icons on the MLA are properly labeled and visible	3.18	.783

It could be inferred from Table 6 that students were of the opinion that MLA reduces error rate. This is because the mean values of the analysis carried out on the students' opinion were all greater than 2.5 which is the average mean value. Hence, the students agreed with all the statements presented to them.

Research Question 7: Do experts find the MLA conform to heuristic guidelines technically?

The experts found that the MLA conform with the heuristic guidelines technically

Table 7: Intraclass Correlation Coefficient on Experts Opinion on MLA Conformity with Heuristic Guidelines Technically

Intraclass Correlation Coefficient							
	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.395[a]	.202	.585	4.868	39	117	.000
Average Measures	.723	.503	.849	4.868	39	117	.000
Two-way random effects model where both people effects and measures effects are random.							
a. The estimator is the same, whether the interaction effect is present or not.							
b. Type A intraclass correlation coefficients using an absolute agreement definition.							

Table 7 reveals that the experts agreed that the MLA conform to the heuristic guidelines technically. This is because when the Inter Rater Reliability IRR was carried out using two-way random, absolute agreement Intraclass Correlation Coefficient ICC (2, 4) = 0.723. This is to determine the degree to which the raters agreed with the MLA as learning tool, that is, the experts' agreement as regard technical usability of the MLA. The resulting ICC which is 0.723 belongs to the moderate range according to [55]. This reveals that the raters have moderate degree of agreement.

Research Question 8: Do experts find the MLA pedagogically usable

Experts found the MLA pedagogically usable

Table 8: Intraclass Correlation Coefficient on Experts Opinions on Pedagogical Usability of MLA

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.621[a]	.414	.802	7.367	19	57	.000
Average Measures	.868	.739	.942	7.367	19	57	.000
Two-way random effects model where both people effects and measures effects are random.							
a. The estimator is the same, whether the interaction effect is present or not.							
b. Type A intraclass correlation coefficients using an absolute agreement definition.							

Table 8 shows that the experts found the MLA pedagogically usable. This is because when the Inter Rater Reliability IRR was carried out using two-way random, absolute agreement Intraclass Correlation Coefficient ICC (2, 4) = 0.868. This is to determine the degree to which the raters that is, the experts agreed on pedagogical usability of the MLA. The resulting ICC which is 0.868 is described as good according to [55]. This reveals that the raters have good degree of agreement as regard pedagogical usability of MLA.

Research Question 8: Do male and female students differ in their general perceptions of MLA

Male and female students did not differ in their general perceptions of MLA

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Hypothesis 1: There is no significant difference between male and female students as regard their general perceptions of MLA

Table 9: t-test Analysis of Gender Influence on Perceptions of Students on MLA

Gender	N	Mean	Std. Dev.	t	Df	p	Decision
Male	31	101.61	15.68	1.205	96	0.231	Not Significant
Female	67	98.21	11.59				

Table 9 shows that there was no significant difference in the general perceptions of male and female students as regard MLA. Male (Mean = 101.61, SD = 15.68), Female (Mean = 98.21, SD = 11.59) t(96) = 1.205, P =0.231. Since p-value is greater than 0.05 this means that there is no significant difference in the perceptions of male and female students and as a result of this, the null hypothesis formulated was not rejected.

V. DISCUSSION AND CONCLUSION

Generally findings from the study revealed that the students had positive views as regard the usability of the mobile learning App on periodicity. Six out of the heuristic evaluation guide lines were agreed upon by the students which are: impressions about MLA, user satisfaction, efficiency, retention, learn ability and errors. The finding agreed with that of [56]. study was carried out on evaluating usability of mobile learning App in the context of higher education. The finding showed that the application was user friendly, efficient, effective and the users were satisfied. The finding also agreed with that of [40]. who worked on mobile learning via educational App. The finding from the study revealed that the students' use of the educational App improved the competencies of majority of the students. The finding is also in line with that of [38]. that carried out study on mobile learning to development of students' self-concept of chemistry by developing mobile learning App in Electrolyte solution and oxidation-reduction reaction. Finding from the study showed that mobile learning media can minimize learning difficulties in Chemistry because the material in mobile is concise, easy to understand and flexible. The study of [41]. on developing on android-based game for Chemistry learners and its usability assessment is also in agreement with that of the present study. The study reported that when smart phone is combined with learning App, it encouraged students to learn better and individually.

Another finding from the study revealed that the experts agreed that the MLA conforms with the heuristic guidelines technically and they also found it pedagogically usable. The finding disagreed with that of [36]. who reviewed literature on usability evaluation of e-learning system titled A Peek at the Position of Pedagogical Aspects in Usability Evaluation of E-learning System from 2000-2010. Their finding revealed that one third of the 27 papers reviewed in their study were not fully aware of the importance of pedagogical aspects in usability which focused on learning content design, assessment, motivation to learn and learning supportive tools. But the finding is in agreement with that of [37]. whose the study was on development and evaluation of educational android application. The finding showed that mobile applications would support education, increase motivation and improve academic achievement.

Finding from the study also revealed that there is no significant difference in the general perceptions of male and female students as regard the MLA. The finding agreed with that of [51]. examined Gender Influence on Undergraduates Students' Acceptance of Mobile Learning Instruction using Technology Acceptance Model (TAM). And that of [49]. on evaluating pre-service teachers' acceptance of mobile devices with regards to their age and gender in Greece. Their studies revealed that gender did not influence acceptance of mobile learning. However, the study disagreed with that of [50]. who conducted a study in Kuwait. The study examined instructor perceptions of m-learning and social media learning tools, as well as gender and age differences to better understand social and cultural issues that affect the implementation of m-learning in Ku-wait. Finding from the study revealed that there was no significant difference in the perceptions of male and female instructors.

It can therefore be concluded that the NCE students had positive perceptions about the usability of the MLA, that the learning mobile App

for periodicity will be effective for learning. The experts also submitted that the mobile learning App will be effective for learning of periodicity. Both male and female students have the same perception as regard usability of the MLA.

VI. RECOMMENDATIONS

The following recommendations are thought to be appropriate for the study:

1. The students should be encouraged to use mobile learning App for learning of periodicity by their instructors for effective learning of the concept.
2. Experts in the field of Chemistry should encourage the students to make use of the mobile learning App
3. Gender should not be prioritised when encouraging students to use mobile learning App for learning of Chemistry concepts.

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