DEVELOPMENT OF AN INSTRUCTIONAL MODEL BASED ON MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANCE CRITICAL THINKING ABILITIES FOR BUSINESS EDUCATION UNDERGRADUATE STUDENTS IN NIGERIA

AUGUSTINE AGBI

A Thesis Submitted to the Graduate School of Naresuan University
in Partial Fulfillment of the Requirements
for the Doctor of Philosophy in (Educational Technology and Communications - (Type 1.1))
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Title DEVELOPMENT OF AN INSTRUCTIONAL MODEL BASED ON MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANCE CRITICAL THINKING ABILITIES FOR BUSINESS EDUCATION UNDERGRADUATE STUDENTS IN NIGERIA

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ABSTRACT

An instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students is considered as an innovation in teaching and learning processes. This study adopted research and development (R&D) design method. the research objectives were (a) to identify the factors, components, and processes that are associated with inquiry-based mobile-blended learning, to enhance critical thinking abilities; (b) to develop an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for Business Education undergraduate students in Nigeria and; (c) to propose the instructional model to an institution of higher education that offers business education at the undergraduate level for implementation in Nigeria. The methodology of the research was divided into four phases as follows (1) to investigate the factors, components, and processes associated with the development of students' critical thinking abilities, with mobile-blended and inquiry-based learning approach; (2) to construct an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students; (3) to validate and tryout the instructional model and; (4) to propose the instructional model to an institution of higher education in Nigeria.

In phase 1, a sample of 120 business educators was used and the instrument was a questionnaire; in phase 2, the results of the analysis in phase 1 provided the materials for the construction of the instructional model. A sample of 11 experts was used for the validation while a sample of 70, that consisted of 3 business educators and their 67 students, were employed in phase 3 with a questionnaire for each of the groups as the instruments. In phase 4, a sample of 96, which consisted of 3 business education teachers and their 93 students, was used with the aid of a questionnaire as an instrument for both categories.

The findings of the study revealed that the instructional model has four factors as follows: (1) participation of teachers in the process of deciding on the innovation with a P-value of 0.012; (2) mobile-blended learning competency with a P-value of 0.006; (3) mobile instructional content with a P-value of <0.001; and (4) mobile-blended learning orientation with a P-value of 0.013. The findings also show that the instructional model has seven components, processes with five steps, as stated below (a) engagement; (b) exploration; (c) explanation; (d) elaboration and; (e) evaluation, with sixteen teacher's activities and fifteen students' activities. The experts for the validation were satisfied with the factors, components, processes, and steps, as well as, the teachers' and students' activities with an overall mean of 4.68 SD 0.47. Regarding the practicability and effectiveness of the instructional model, the satisfaction level of the Nigerian business educators used in the tryout was very high with a mean of 4.57 SD 0.48, and their students (4.58 SD 0.53). Results from the analysis of both the validation and the tryout of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students show that it was practicable and effective.

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CHAPTER I

INTRODUCTION

Background and rationale

The standards of education in Nigeria have continued to decline over several years, and business education is no exception. The decline negatively affects employability, which has led to a high level of unemployment throughout the country. there is a very low level of technology utilization by business education teachers in Nigeria (Okeke, Ezenwanfor, & Umoru 2012; Mafikuyomi, Ojewale, & Salami, 2016). The dearth of ICT resources utilization in most tertiary institutions in Nigeria, has led to many lecturers lacking adequate pedagogical knowledge and ability to effectively adopt ICT in their professional practice, which results in a discouraging level of technology integration within their teaching (Onasanya, Shehu, Oduware, & Shettu, 2010; Okolocha, & Nwadiani, 2015). This situation has resulted in a mismatch between the training received in school, and the knowledge/and skills expected by employers of business education graduates (Obiete, Nwazor, & Vin-Mbah, 2015).

Uddin, & Uddin (2013) asserted that an average Nigerian graduate lacks the skills required for gainful employment in the modern world of work, due to the falling standards of the educational system. In other studies, Echebiri (2005; O'Nwachukwu, 2017) confirmed that the causes of unemployment in Nigeria are the same with those of other developing countries, emphasizing that the standard of education has a significant relationship with unemployment. Longe (2017) posited that the quality of graduates and the unsuitable curricular in the country's educational system, which are not in tune with the modern needs of the industry are responsible for the high rate of unemployment.

Many studies have been carried out to ascertain whether standards of education are actually falling in Nigeria. Sadly, they all found that standards have declined at all levels of education, with the higher education most affected, followed by the secondary and primary levels (Tanuti, 2008; Duze, 2011; Ajoku, 2012; Oyedeji, 2015; Longe, 2017). The effect of poor standards in Nigerian higher education, is so grievous that the graduates are finding it increasingly difficult to secure employment even when jobs are advertised, due to the decay in the system (Hayward, 2006; Agbaire, 2015).

The falling standards in the Nigerian educational system has affected the performance of candidates in public examinations and the performance of the graduates who are ill-equipped for employment, has waned public confidence in the system (Ifedili, & Ochuba, 2009; Uwameiye, 2014; Ibrahim, Babalola, & Awaisu, 2017).

The declining standards in the Nigerian educational system, can be challenged by the integration of technology into the system to enrich both the teachers and students (Penga, Sua, Choua, & Tsaib, 2009; Kenney, 2011; Nassuora, 2013; Callum, Jeffrey, & Kinshuk, 2014). Mobile devices are considered because they have become rife among both teachers and students alike, and the nature of technology associated with them. With the advances in mobile technology, innovative forms of communication and collaboration have emerged. The digitalization and globalization that accompanied this development has led to a change in higher education, particularly, the shift from traditional face-to-face teaching to adaptive and self-regulated learning (Kuhnel, Seiler, Honal, & Ifenthaler, 2018). Following the evolution of mobile technology and the pervasiveness of the devices, several authors (Pelgrum, 2001; Figueiredo, & Afonso, 2005; Montrieux, Vanderlinde, Schellens, & De Marez, 2015) have emphasized the need to shift from the traditional classroom context, where the learner is considered as a passive consumer of educational knowledge, to a setting where students are seen as active participants that gives preference to collaboration and the sharing of information in a resource-rich environment.

There is an increasing rate of mobile device ownership with penetration rates in several countries now higher than 100%, which is due to people owning more than one (Chase, Julius, Chandan, Powell, Hall, Phillips, Burnett, Gill, & Fernando, 2018; Wishart, 2018; Uther, 2019). In relation to available mobile broadband in developing countries, ITU (2016) reported that in developed countries, more than 90 (90.3%) in every 100 inhabitants has access to mobile broadband falling to a significant 40.9 per 100 inhabitants in the developing countries. Mojaye (2015) stressed that there has been a monumental rise in the use of mobile devices by tertiary education students and teachers in recent years, and this development has equally spread to both secondary and primary schools. Nigeria has 169,104, 830 active mobile lines as of November 2018 and with a tele density of 120.79 (Nigerian Communications Commission, 2018).

Bhutia, & Tariang (2016) stated that adolescents are the leading users of mobile phones due to their curiosity to understand the trending improvements of communication technology, and their desire to be constantly in touch with their friends. Mathews (2004) observed that adolescents not only use mobile phones to make calls but also network socially with friends and conveniently carry out and manage their daily life. As a result, Kenney (2011) emphasized that since mobile technology has characterized the daily lives of adolescents, a learning context where such technology is integrated will become more attractive to them. Studies have shown that learners appreciate the internet, particularly social media platforms for the purpose of studying, as it supplements and increases the quality of their acquisition of knowledge due to its user-friendly features and potential of enhancing their participation (Brady, Holcomb, & Smith, 2010; Veletsianos, & Navarrete, 2012; Balakrishnan, & Lay, 2015). Albert, & Assad (2017) further stated that when mobile technology is utilized in education, learners' motivation increases, resulting in greater participation and faster acquisition of concepts and skills. As the standard of education in Nigeria is on the decline, and the educational focus is shifting from teacher-centered to students-centered, integration of mobile technology in the system becomes necessary, because it, among other educational benefits, guarantees students-centered learning.

Researchers have emphasized that mobile technology has significant potential to improve teaching and learning in all aspects of education, by inculcating in the learners critical thinking, creativity and problem-solving abilities (Chen, & Kinshuk, 2005; Olaitan, & Olusegun, 2017). Halder, Halder, & Guha (2015); Olaitan, & Olusegun (2017) concluded that the use of mobile devices in education, particularly in institutions of higher learning is necessary.

The integration of mobile instruction into business education in Nigeria will assist both the teachers and students to have facilitated access to up-to-date educational materials, exposure to recent trends in the field of education. This will create greater interactivity and collaboration, which will culminate in the development of the students' critical thinking abilities. It is against this background that this study focused on determining the factors and processes that influence the enhancement of critical thinking skills, using mobile-blended and inquiry-based learning, with a view to developing a mobile instructional model to enhance critical thinking abilities for business education undergraduate students, in Nigeria.

Presently, there are little or no ICT resources in most institutions of higher learning in Nigeria, which has resulted in the inability of the teachers to possess the required pedagogical competencies to effectively adopt ICT in their chosen profession (Onasanya, Shehu, Oduware, & Shettu, 2010; Okolocha, & Nwadiani, 2015). In addition, institutions of higher learning in Nigeria that offer business education courses, do not adequately equip the students with the required ICT skills, which are necessary for them to effectively participate in modern day society, that is technologically driven (Ololube, Ubogu, & Egbezor, 2006; Jude, & Dankoro, 2012; Longe, 2017; Moses, Mohammed, Agbu, & Gainaka, 2018). This is because the teaching and learning activities are still based on traditional approaches (Ramakrishnan, & Yasin, 2011; Ssebuwufu, Ludwick, & Beland 2012; Longe, 2017).

While developed countries benefit from investing in ICT to enhance their educational systems, developing countries could equally benefit from ICT mediated education, by using it to address the challenges of the poor distribution of facilities and reduced access to the latest educational materials (Nwosu, John, & Akorede, 2018). However, both teachers and students cannot access the great potential of the ICT tools in Nigerian institutions of higher education, particularly for business, because of its non-integration and in the few schools where it exists, it is either obsolete or the teachers and students lack the skills to manipulate the technology effectively to improve the teaching and learning processes (Ameen, Abdullahi, & Jubril, 2017; Bolarinwa, & Ajisafe, 2018; Babalola, 2018).

Statement of the problem

Research has revealed that the standards of education, including business education, in Nigeria are falling (Tanuti, 2008; Duze, 2011; Ajoku, 2012; Oyedeji, 2015; Longe, 2017). The decline in standards is blamed on, among other factors, the persisted use of traditional approaches to teaching and learning, absence or low technology integration and poor educational resource (Uddin, & Uddin, 2013; Uwameiye, 2014; Longe, 2017; Moyo, & Hadebe, 2018; Barnes, Boyle, Zuilkowski, & Bello, 2019). The absence of ICT resources in most institutions of higher learning in Nigeria has resulted in the inability of the teachers to possess the required pedagogical knowledge and ability to effectively adopt ICT in their professional practice (Onasanya, Shehu, Oduware, & Shettu, 2010; Okolocha, & Nwadiani, 2015). This situation has led to a mismatch between the training received in schools and the knowledge/skills expected by the modern employers of business graduates (Obiete, Nwazor, & Vin-Mbah, 2015). This mismatch between the training offered in schools and the knowledge/skills expectation of employers is increasingly disturbing, as most graduates find it difficult to secure employment even when such jobs are available (Hayward, 2006; Agbaire, 2015). In addition, institutions of higher learning in Nigeria that offer business education courses do not adequately equip their students with the required skills necessary for them to effectively participate in modern society, that is ICT driven (Ololube, Ubogu, & Egbezor, 2006; Jude, & Dankoro, 2012; Longe, 2017; Moses, Mohammed, Agbu, & Gainaka, 2018). The teaching and learning activities are still based on traditional approaches, therefore, the graduates produced from these educational institutions do not possess the practical skills to satisfy the needs of the labour market (Ramakrishnan, & Yasin, 2011; Ssebuwufu, Ludwick, & Beland 2012; Longe, 2017).

This is because memorization of knowledge does not result in the ability to use such knowledge to solve-problems (Kang, & Howren, 2004; Snyder, & Snyder, 2008). Despite the emphases on teaching critical thinking skills, most classrooms globally are still characterized by approaches that focus on lower order thinking, which does not support the application of knowledge to solve problems (Osborne, 2013; Zohar, & Cohen, 2016). Thomas, & Thorne (2009) stressed that critical thinking is a level that is beyond memorization of information or quoting facts back to an individual in exactly the same manner as they were previously expressed. It is the use of critical and creative thought that enables an individual to solve complex problems through analysis, synthesis and the evaluation of knowledge (Yeung 2012; Lee, & Lai, 2017). Critical thinking is observed when an individual receives and stores new knowledge, while interrelating and applying such information to address unfamiliar situations (Apino, & Retnawati, 2017).

Critical thinking abilities are required for survival in the ever-changing technological world (Partnership for 21st century skills. 2009; Brierton, Wilson, Kistler, Flowers, & David, 2016). This is because modern jobs are increasingly requiring employees whose tasks will involve critical thinking, analysis, creativity and problem-solving tendencies (Ananiadou, & Claro, 2009; Rimini, & Spiezia, 2016). Since these abilities can be developed through collaborative inquiry-based learning (Abosalem, 2016; Hwang, Lai, Liang, Chu, & Tsai, 2017; Mattar, 2018), there is the need to integrate mobile technology in the higher educational contexts to facilitate student's interactivity and collaboration that will culminate in the building and development of their critical thinking abilities (Chang, Chen, & Hsu, 2011; Hwang, Lai, Liang, Chu, & Tsai, 2017). The deployment of mobile technology into teaching and learning activities not only offers valuable tools that supplement or replace aspects of face-to-face traditional lectures while offering sufficient time for the engagement of students' cognitive processes during classroom activities, but also improves learners' digital skills, collaborative skills, communication skills, etc., which are survival skills in the modern world.

New educational approaches bring to the fore the necessity of interaction and collaboration in the teaching and learning processes. The purpose is to make educational activities learner-centered both in and out of the classroom, with the aim of creating an effective learning environment that will empower students to become analytical and creative critical thinkers, who are able to apply their knowledge to solve problems (Chu, Hwang, Tsai, & Tseng, 2010; Kearney, Schuck, Burden, & Aubusson, 2012; Marzouki, Idrissi, & Bennani, 2017). Collaboration is an effective strategy that enables students to interact and exchange their views with their colleagues, in order to effectively accomplish learning objectives (Morrison, Morrison, & Lowther, 2009; Osman, Duffy, Chang, & Lee, 2011; Hwang, Lai, Liang, Chu, & Tsai, 2017). Furthermore, mobile tools enable teachers to deliver instructional materia ls to their students prior to class. This will allow the students to access the instructional materials at their convenience, and seek clarification on confusing concepts via the internet, or from their teachers with the aid of their mobile devices, thereby allowing class time to be used for problem solving tasks that foster their critical thinking abilities (Herreid, & Schiller 2013; Couch, 2014; Clark, 2015; Lee, & Lai, 2017).

Europe, the United States of America and other developed nations have continued to witness integration of digital and technology networks in classrooms, leading to a rampant utilization of interactive whiteboards, educational computer games, virtual learning context, more reliance on internet integration for both classroom and individual study (Sheard, & Ahmed, 2007; BECTA, 2009a, b; Livingstone, 2012; Albert, & Assad, 2017).

However, as standards of the Nigerian educational system continues to witness decline, many educational institutions in the country are yet to fully appreciate the potential of ICT, particularly, mobile technology in education, and how to effectively integrate it in the teaching and learning processes (Imhonopi, & Urim, 2010; Edewor, Imhonopi, & Urim, 2014; Imhonopi, Urim, Onwumah, & Kasumu, 2017). This study finds its relevance by investigating the factors and processes that influence the use of mobile-blended and inquiry-based learning, with a view to develop a mobile instructional model that will enhance the critical thinking abilities of business education undergraduate students, in Nigeria, as well as to equip them with teamwork and lifelong learning skills.

Research questions

1. What are the factors that influence the use of mobile-blended and inquiry-based learning to enhance critical thinking abilities?

2. What are the components and processes that influence the use of mobile-blended and inquiry-based learning to enhance critical thinking abilities?

3. What are the opinions of the lead users of the validated mobile instructional model to enhance critical thinking abilities for undergraduate students studying business education in Nigeria?

Research objectives

1. To identify the factors, components and processes that are associated with the use of mobile-blended and Inquiry-based learning, to enhance critical thinking abilities in Business Education undergraduate students in Nigeria.

2. To develop an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for Business Education undergraduate students in Nigeria.

3. To propose the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for Business Education undergraduate students in Nigeria.

Research Hypotheses

The below hypothesis was formulated for the purpose of the study:

The instructional model based on mobile-blended and inquiry-based learning will significantly influence the enhancement of critical thinking abilities of business education undergraduate students in Nigeria.

Research variables

The dependent variable is an instructional model based on mobile-blended and inquiry-based learning to enhance the critical thinking abilities of business education undergraduate students in Nigeria, while the independent variables are the factors, components, and processes that facilitate the usage of mobile-blended and inquiry-based learning to enhance critical thinking abilities of business education undergraduate students in Nigeria.

Significance of the research

This study will provide a framework that will enable business education teachers in Nigeria to facilitate the development of the critical thinking skills of their students by providing them with the instructional model based on mobile-blended and inquiry-based learning to enhance these skills.

In addition, the mobile instruction model can also be adapted to other academic disciplines in Nigeria, with little or no modification.

Related studies

Despite the fact that mobile technologies in education is an emerging sub-field, researchers have conducted studies on mobile learning in Nigeria. Shaibu, Mike, Solomon, & Jarkko (2016) undertook a study to discover students mobile learning experiences in higher education in Nigeria, found that the technology improved the academic achievement of the students. Imhonopi, Urim, Onwumah, & Kasumu (2017) appraised ICTs as new media tools for language teaching and learning in tertiary institutions in Nigeria, and indicated positive outcomes. Olaitan, & Olusegun (2017) also analyzed the attitude of college students towards mobile phone usage in Nigeria, and found that they had a positive disposition towards the use of the technology. However, a mobile instructional model to enhance higher order thinking abilities for business education undergraduates in Nigeria has been studied.

Research scope

The study was restricted to universities and colleges that offer business education as an academic discipline, in three states in Nigeria.

The study centered on 120 teachers, who teach business education to undergraduate students. They were randomly selected from three states in the federal republic of Nigeria during the first phase of the study to identify the factors, sub-factors, and processes that promote the development of critical thinking skills, using mobile-blended and inquiry-based learning. However, at the validation stage, eleven experts, which consisted of eight Thai and three Nigerian experts, participated in the exercise. The eight Thai experts were randomly selected among the business teachers in Phitsanulok Vocational College, Thailand, and Phitsanulok Commercial College, Thailand through simple random sampling. The three Nigerian business teachers who participated in this validation were also selected through simple random sampling and were contacted via email and/or Whatsapp. This was due to the researcher not being able to travel to Nigeria, because of the industrial strike by the teachers that led to the closure of the institutions, and the second wave of Covid 19. Three teachers and students of Phitsanulok Vocational College participated in the tryout of the validated model. After the ease of the international travel restrictions and the suspension of the strike, when the tryout was later conducted in Nigeria. a sample of 96, which consisted of 3 business education teachers and their 93 students was used.

Operational definitions

The key words in this study are briefly explain below in line with their meanings as far as this study is concerned.

1. **Instructional model** means a teaching and learning approach based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria.

2. **Mobile-blended learning** refers to a teaching strategy that employs a mix of the traditional face-to-face instruction and asynchronous/synchronous online learning via mobile devices.

3. **Inquiry-based learning** means a learning approach that involves asking questions, finding information and new ideas in order to solve problems, while encouraging the development of cognitive processes.

4. **Critical thinking ability** means a cognitive process that goes beyond comprehension of concepts. It involves the ability to analyze, evaluate, and synthesize information in order to find solutions to problems.

5. **Business education** refers to the aspect of educational training that empowers individuals to be competent, skillful and dynamic business teachers, office administrators and business entrepreneurs who can compete globally.

6. **Undergraduate students** means the students that undergo their bachelor degrees and Nigeria Certificate in Education (N C E) programmes in the universities and colleges of education in Nigeria, respectively.

Keywords: Instructional model, Mobile-blended learning, Inquiry-based learning, Critical thinking abilities.

CHAPTER II

LITERATURE REVIEW

This chapter presents a review of recent literature in Information and Communication technology (ICT), blended and mobile learning, as well as the development of critical thinking skills. It also presents a general overview of how ICT tools can be integrated in education to achieved desired goals of institutions. The wide search of relevant literature from research journals, books, theories, models, etc., provides useful information as presented below.

Information and Communication technology (ICT)

1. The meaning of ICT
2. ICT and education
3. Benefits of ICT in education
4. Factors that influence teachers' use of ICT in education

Mobile learning

1. The meaning of mobile learning
2. The fundamental elements of mobile learning
3. Characteristics of mobile learning

Blended learning

1. Blended learning
2. Mobile-blended and critical thinking enhancement
3. Links between Mobile-blended with collaborative inquiry-based learning approach and critical thinking enhancement

Constructivist theory

1, Constructivist theory and knowledge creation

2. Piaget's Stages of Cognitive Development

3. Constructivist theory and critical thinking skills

Inquiry-based learning

1. The meaning of inquiry-based learning
2. Teacher's roles in inquiry-based learning

Critical thinking abilities

1. The meaning of critical thinking abilities
2. The need to develop critical thinking tendencies in students
3. Strategies for developing critical thinking abilities in students
4. Bloom's taxonomy of thinking

Models for introducing innovation into teaching practices

1. Offering an instructional technology course model
2. Kortecamp and Croninger model
3. Systematic design model
4. Three-phase model

Business education

1. A brief background of the Nigerian higher education system
2. Business education
3. Objectives of business education
4. Challenges of higher education in Nigeria
5. Nigerian policy for information technology and education

Conceptual framework

1. Major and sub-elements of the concept
2. Characteristics of the mobile tool
3. Mobile activities
4. Classroom activities
5. Collaboration

Information and Communication Technology (ICT)

Information and Communication technology (ICT) is becoming increasingly more powerful and relevant in human activities, as it is spreading and dominating many aspects of people's lives. It has permeated into almost all facets of human activities including tourism, health, commerce, agriculture, education, etc. ICT can be extensively harnessed and deployed to improve the pace and level of development in both the teaching and learning processes in higher education (Sarkar, 2012; Twining, & Henry, 2014; Olafare, Adeyanju ., & Fakorede, 2017). The integration of ICT to improve instruction, especially its importance in supporting learner-centered education has been widely discussed (American Psychological Association, 1997; Buabeng-Andoh, 2012; Commission of the European Communities, 2008; Drent, & Meelissen, 2008; Phungsuk, Viriyavejakul, & Ratanaolarn, 2017). While most developed countries have integrated ICT in their educational activities, developing ones are struggling to achieve its integration in their teaching and learning processes (Simeo, Michael, & Said, 2015).

The meaning of ICT

The term Information and Communication Technologies (ICT) is used to refer to the diverse collection of technologies and resources which are utilized for communication, generation, processing, storage, retrieval and dissemination of information. The information could be in the form of text, voice, audio, video or a combination of any of them. It is a broad term for information and telecommunications, which encompasses the user's solutions, middleware and networks solutions (Lemke, & Coughlin, 1998; Brakel, & Chisenga, 2003; Yusuf, 2005; Folstad, 2008). ICTs are made up of hardware, software, networks and media for gathering, storing, processing, sending and presenting information, including associated services (Adeyinka, 1999; Tusubira, & Kyeyune, 2001; Aluko, 2004; Nwagwu, 2006; Sarkar, 2012; Imhonopi, Urim, Onwumah, & Kasumu, 2017).

ICT and education

ICT is increasingly becoming important in our daily lives, which includes teaching and learning activities. It has long been established that ICT has the potential to empower both teachers and learners, as well as the entire learning environment beyond traditional contexts due to its flexibility (Khirwadkar, 2007; Simeo, Michael, & Said, 2015; Imhonopi, Urim, Onwumah, & Kasumu, 2017). ICT promotes teaching and learning via its interactive, dynamic nature, engaging content, by enhancing the learner's understanding of meaningful constructs and providing concrete opportunities to individualized instruction in the learning process (Entwhistle, & Ramsden, 1983; Yusuf, & Onasanya, 2004; Simeo, Michael, & Said, 2015).

Students with ICT skills master learning content quicker and are better problem-solvers, more self-motivated, and attain greater control over their learning processes (American Association of School Librarians, & Association for Educational Communications and Technology, 1998; Katz, & Macklin, 2007; Twiss-Brooks, Andrade, Bass, Kern, Peterson, & Werner, 2017; Law, Thome, Lindeman, Jackson, & Lidor, 2018). To maximize the benefits of ICT in education, teachers need to depart from their traditional way of imparting knowledge and skills, by embracing innovation and changes (Al-Ansari, 2006; Evoh, 2007; Md Yunus, & Suliman, 2014).

UNESCO (2003) emphasized that teachers' use of ICT is focused primarily on more effective learning. ICT in education is considered as a necessary and important instrument to support new ways of teaching and learning to help develop students' skills for searching and accessing information, cooperation, problem solving and lifelong learning which are important for the preparation of children for the knowledge society (Plomp, ten Brummelhis, & Rapmund, 1996; Voogt, 2003; Drent, & Meelissen, 2007; Mojgan, Kamariah, Wong, Bahaman, & Foo, 2009; Torres, Infante, & Torres, 2015; Peter, Adelaiye, & Bijik, 2018). This is the reason nations, via their governments, have continued to invest in ICT, so as to take advantage of its enormous benefits in education to develop their citizens and societies (Adomi, & Anie, 2006; Johnson, Calvert, & Raggert 2009; Nut, 2010; Buabeng-Andoh, 2012; Vrasidas, 2015; Li, Yamaguchi, & Takada, 2018).

Benefits of ICT in education

Research indicated that there are immense benefits associated with the integration of ICT in education, when used with the proper framework (Noor-Ul-Amin, 2013; Tan, & Eze, 2008; Al-Shboul, Al-Saideh, & Al-Labadi, 2017). ICT in education has the potential of helping learners to accomplish their own individual needs, and promote equality of educational opportunities by offering high quality learning materials and promoting student independence, as well as fostering teachers' professional development (Bolarinwa, & Ajisafe, 2018). For instance, mobile learning offers the opportunity to study across many contexts via their mobile devices (Sampson, Isaias, Ifenthaler, & Spector, 2013; Delcker, Honal, & Ifenthaler, 2018; Kuhnel, Seiler, Honal, & Ifenthaler, 2018). The students not only acquire an in-depth knowledge of their various academic disciplines, but also understand that they can generate new knowledge by using ICT (Ameen, Abdullahi, & Jubril, 2017).

ICT facilitates the development, delivery and sharing of educational materials. These advantages offer learners the opportunity of accessing educational resources that are not obtainable in their immediate environment, providing administrative support in schools and at the same time enriching research activities (Rabah, 2015; Buttar, 2016).

ICT also offers a platform for the creation of digital content and libraries that learners, teachers and other stakeholders can access for the purpose of educational course development, and other activities such as research resources without time and location barriers (Bhattacharya, & Sharma, 2007; Buttar, 2016).

ICT has revolutionized distance education through electronic learning, by eliminating the challenges of time, travel and attendance associated with the traditional context of education through the delivery of materials and feedback including dialogue over the internet; it promotes greater participation and interaction among students, as well as challenges the approach of face-to-face methods of teaching and learning (Concannon, Flynn, & Campbell, 2005; Bhattacharya, & Sharma, 2007; Neeru, 2009). According to Livingstone (2012) the components of e-learning which include e-portfolios, cyber infrastructures, digital libraries and online learning object repositories, create a digital identity for the learners and link all other stakeholders in education. The best practice and expertise in various educational fields, can be accessed through e-learning (UNESCO, 2002). ICT fosters the demonstration of learning situations that are difficult or impossible to illustrate practically in a traditional classroom setting (Livingstone, 2012), by explaining both complex and abstract concepts to learners through simulation.

Blended learning is another innovation through which ICT has enhanced teaching and learning activities, where varied teaching methods are combined to deliver particular courses. This form of learning is the combination of face-to-face and any or multiple online approaches for both teaching and learning.

ICT has through its characteristics of flexibility and self-paced learning, extended education to those who would normally not have had time to study, due to their daily engagements or dispositions. Self-paced learning could be practiced in different ways like accessing educational materials via the internet or CD-based course material; participating in education through prerecorded classroom activities or accessing specific courseware online, as directed by the teacher or searching for materials for assignments, projects, teleconferencing, and research.

These technological tools enrich education via online collaborative learning (Rabah, 2015; Debra, & Qua-Enoo, 2018). This collaboration refers to the interaction among learners and between them and their teachers via the internet, which could either be asynchronous or synchronous. It is asynchronous when learners interact with their peers or teachers by either SMS or e-mail, while synchronous interactions include chat rooms, virtual classrooms and/or videoconferencing as well as instant messaging platforms like Whatsapp, Facebook messenger, Line, Flock, etc.

ICT in education fosters the building and development of digital skills for life-long learning that has increasingly become necessary in the competitive knowledge society for both the teachers and the learners (Evans-Greenwood, O'Leary, & Williams, 2015; Grand-Clement, Devaux, Belanger, & Manville, 2017; Brown, 2017). These skills not only help to develop the learners and the teachers, but also sustain and advance the contemporary competitive knowledge society (Livingstone, 2012). ICT, specifically mobile learning, enables learners to interact with their learning environment while on the move (Wong, 2012); provides learning communities among individuals who are mobile, and offers support that promotes a lifelong acquisition of knowledge (Sharples, 2007; Abdulrrahman, Beer, & Crowther, 2015).

There is a paradigm shift in the traditional approach to teaching and learning, which is a result of globalization that has made knowledge and information critical in contemporary society. This development has changed the aim of education to be on curricula and approaches that facilitate skills and productivity that necessitate access to a vast variety of information and authentic context, where the teacher becomes a facilitator rather than a knowledge expert (Neeru, 2009; Livingstone, 2012). This new focus is adequately supported by the prevailing technologies and the emerging ones, as they play a greater role in the professional development of teachers and the dissemination of new and better practices to outside communities (Baylor, & Ritchie, 2002; Debra, & Qua-Enoo, 2018).

O'Donoghue, Singh, & Green (2004); Al-Shboul, Al-Saideh, & Al-Labadi (2017) stated the main benefits of ICT in education are as follows: (a) learners are encouraged to decide where they want to study; (b) ICT also offers them the opportunity to choose their own time of study, thereby affording them the possibility to schedule and organize their own individual learning timelines. This eliminates students having to wait for specific times and locations in order to study; and (c) learners are able to determine their own pace of study, without being delayed by slower ones or vice-versa.

Albugami (2016) emphasized many benefits of ICT in education such as (a) greater access and more open systems of education: ICT expands the educational system by simplifying access to a vast variety of resources and information, while eliminating geographical boundaries; (b) it offers better educational management and control as well as diverse materials for research practice and development; (c) it improves students' capabilities by developing their skills to access, retrieve, use, organize and provide information. This makes them better equipped to solve problems, share perspectives on learning issues, while allowing them to construct meanings and demonstrate the use and choice of ICT tools; (d) adequate preparation of students for the labour market, the clamour for ICT integration in education, especially in higher education, is to better prepare them for the modern world of work that is characterized with the use of ICT facilities; and (e) ICT-oriented education enhances communication between both learners and teachers, by taking such interactions beyond the classroom.

Factors that influence educators' use of ICT in education

Factors in this context refer to those elements that promote or hinder the effective integration of ICT in teaching and learning contexts. Studies have shown that despite government investment in ICT for education and the increasing demand for its integration in institutions to equip students with the knowledge and skills required for adequate participation in modern society, the target stakeholders found it difficult to apply it to their instructional and learning processes (Tomei, 2005; Gulbahar, 2007; Kwache, 2007; Nut, 2010; Buabeng-Andoh, 2012; Vrasidas, 2015; Li, Yamaguchi, & Takada, 2018). The effective integration of ICT into education depends largely on the attitudes of the stakeholders. The factors that influence the effective utilization of technology in the classroom include: the teachers, students, school management, government, competencies of the users, the technology itself and the availability of technical support.

The teacher

The teacher's attitude has been identified as a major determinant that influences the use of technology in the instructional process (Lawton, & Gerschner, 1982; Kluever, Lam, Hoffman, Green, & Swearinges, 1994; Almusalam, 2001; Mojgan, Kamariah, Wong, Bahaman, & Foo, 2009; Vrasidas, 2015; Li, Yamaguchi, & Takada, 2018). When the teachers' attitude towards ICT is positive, there is a probability that they will strive to utilize it in their classroom activities, otherwise they will do everything possible to avoid using it. Teachers are a major factor that influences ICT integration in the classroom. They are the enabling/disenabling factor in its utilization, so there is the need to identify and address the factors that may militate against their utilization of technology in teaching and learning activities. This will help in the development of teachers' positive attitude towards ICT as a critical factor not only promotes its integration, but also to prevent their refusal to utilize it (Woodrow, 1992; Abas, 1995; Watson, 1998; Isleem, 2003). The factors that may impede the teachers' use of technology in the classroom include: competence, government policies, culture of educational institutions, technical support, nature of the technology itself, etc. (Woodrow, 1992; Watson, 1998; Kersaint, Horton, Stohl, & Garofalo, 2003; Bullock, 2004; Osinaike, & Adekunmisi, 2012; Shaibu, & Mike, 2014; Vrasidas, 2015; Li, Yamaguchi, & Takada, 2018).

Technology competence

Many studies have shown that, whether beginner or experienced teachers, ICT competence is a major factor that determines their level of technology use within the classroom (Bauer, & Kenton, 2005; Franklin, 2007; Wozney, Venkatesh, & Abrami, 2006). Pelgrum (2001); The British Educational Communications and Technology Agency (BECTA) 2004); Bingimlas, (2008); Li, & Yamaguchi, (2015); Li, Yamaguchi, & Takada, (2018) found effective educational innovation depends greatly on the knowledge and skills of teachers, and observed in their studies that the absence of basic knowledge and skills was the second most militating barrier to the utilization of technology in education. Cox, Preston, & Cox (1999) stated that a lot of ICT training for teachers focuses on the technical aspect, rather than on how it can be incorporated in their teaching activities, which results in the teachers still not knowing how to utilize these technologies in classroom activities. Knezek, & Christensen (2002) also affirmed that teachers with a high level knowledge of tools and skills, will display a greater level of technology integration in their teaching. In addition, Berner (2003) found that the level of ICT competence in a faculty determines the use of technology in its instructional processes. Teachers' attitude towards ICT, has a direct relationship with their level of Knowledge and skills. Al-Oteawi (2002) observed that most educators who have negative or neutral attitudes toward the use of ICT in classroom activities, do not possess the required knowledge and skills that would enable them to arrive at the decision to utilize it in their classrooms. For mobile instruction, teachers need to possess the following skills to enable effectiveness: student-centered instruction (Queiroz, & Mustaro, 2003; McQuiggan, 2007; Makoe, 2012); content development for online delivery (Denis, Watland, Pirotte, & Verday, 2004; McQuiggan, 2007; Smith, 2005); collaborative and team work skills (Aragon, & Johnson, 2002; Smith, 2005); feedback skills (McQuiggan, 2007; Smith, 2005; Dooley, & Lindner, 2002); and education technological skills (van Koller, 2003; Denis, Watland, Pirotte, & Verday, 2004; Aragon, & Johnson, 2002; Smith, 2005; Egan, & Akdere, 2005).

Culture of educational institutions

School culture according to Maslowski (2001) refers to the common fundamental beliefs, norms and values, and cultural artifacts that are shared by members of a school. Martinez (1999) opined that one of the main barriers facing developing countries to embrace technology as an essential part of their lives is their culture. Mojgan, Kamariah, Wong, Bahaman, & Foo (2009) stated that the effective integration of new technology in institutions can be obstructed by prevailing cultures. Before technology can be successfully introduced into the classroom, the teachers who are expected to use it must be part of the decision-making process to adopt the innovation (Bitner, & Bitner, 2002).

Where the teachers are not involved in the process of making the decision to adopt innovative initiatives, particularly when the school administrators are not committed to ICT integration and do not offer the required training, they will likely continue with their traditional methods and approaches in their classroom activities (Fullan, 1991; Vannatta, & Fordham, 2004). School administrators offer little or no support for the use of technology in the classroom in the sub-Saharan Africa (Hennessy, Harrison, & Wamakote, 2010; Kaliisa, & Picard, 2017). This attitude does not encourage the use of the ICT tools that would benefit both teachers and students.

Government policies

The poor ICT legislative frameworks make it difficult for teachers to explore ICT tools in their teaching activities, thereby constraining them to continue to use traditional approaches in their work (Cole, 1996; Saljo, 1999; Crook, 2001; Watson, 2001; Sutherland, 2004). Among other inhibiting factors against the use of ICT in the classroom stated by the teachers that participated in the 1998-1999 survey that assessed the World Links schools programme in developing countries, was the absence of a national policy regarding the use of computers in classrooms (Kozma, McGhee, Quellmalz, & Zalles, 2004).

Yusuf (2005); Agbetuyi, & Oluwatayo (2012) also argued that despite the objectives and strategies in the Nigerian Policy for Information Technology, it was not detailed enough to adequately address the needs of the Nigerian educational system in relation to ICT. Therefore, Aduwa-Ogiegbaen, & Iyamu (2005); Adomi, & Kpangban (2010); Oye, Salleh, & Iahad (2011) concluded that computers are not part of classrooms in over 90% of the public schools in Nigeria, as a result of the governments unrealistic policy.

Technical support

Where there is absence of on-site support or limited technical support in schools, teachers avoid utilizing computers in the classrooms (Cuban, Kirkpatrick, & Peck, 2001; Snoeyink, & Ertmer, 2002; Li, Yamaguchi, & Takada, 2018). The absence of technical support in schools and the lack of competence are prominent obstacles against teachers' readiness and confidence in using ICT tools in the classrooms in Nigeria (Tella, Tella, Toyobo, Adika, & Adeyinka, 2007). Ajadi, Salawu, & Adeoye (2008) revealed that the lack of technical support impedes the use of ICT in the National Open University of Nigeria. In addition, (Aduke, 2008) identified the absence or limited trained personnel to offer technical support to the ICT users as a factor limiting its utilization in many Nigerian schools.

Funding

Technology integration requires funds for procurement and implementation, as well as continuous maintenance and development of the staff for proper utilization, but where there is inadequate funding, integration into schools is hampered. Adequate financial and staff support is important if teachers are expected to adopt technology appropriately to promote learning for all students (Mojgan, Kamariah, Wong, Bahaman, & Foo, 2009). This is another critical challenge that is negatively affecting the utilization of technology in the Nigerian educational system. Odia, & Omofonmwan (2007) found that underfunding has led to falling standards of the system as classrooms, laboratories and libraries are all in a bad state. Oye, Salleh, & Iahad (2011) identified poor financial support as a major challenge of the National Open University of Nigeria (NOUN) to build the necessary infrastructure to adequately provide its students with learning materials online. To achieve successful ICT implementation in classrooms, the variables that negatively influence teachers' attitude requires addressing.

Internet connectivity

Allied with the above-mentioned factors is Internet connectivity. Access to the internet in Nigeria is very expensive and most students cannot afford it along with the other educational costs they are burdened with. The high cost of internet connectivity in developing countries makes it difficult for both teachers and students to access the opportunity and benefits that ICTs offer (Odongo, 2010; Brown, & Mbati, 2015; Albert, & Asaad, 2017).

Mobile learning

As ICT evolves, the devices become smaller and more mobile, from desktop computers to laptops and other mobile devices such as Personal Digital Assistants (PDAs), iPads and smartphones. The portability and mobility of the devices over the last few decades have increased their technological capabilities, resulting in the emergence of mobile learning that has given rise to new studying dynamics in different settings (Pachler, Pimmer, & Seipold, 2011; Liaw, & Huang, 2012; Giousmpasoglou, & Marinakou, 2013; Kljunić, & Vukovac, 2015; Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018).

Initially, the original function of a mobile device was to make it possible for users to interact through voice call anytime and anywhere, however through development, the functions of these devices have been extended to replicate a resourceful computer. This development has given rise to what educators now refer to as mobile learning, which is a direct result of the improved capabilities of modern mobile devices. The advent of mobile learning has extended the capabilities of e-learning, which encompasses mobile computing, e-learning, and personalized learning anytime and anywhere (Quinn, 2001; Motiwalla, 2007; Torres, Infante, & Torres, 2015). Unlike learning via a desktop computer, mobile instruction offers additional opportunities for students to access content anywhere and anytime, as well as being more adaptive to their individual requirements. Mobile technology embraces various applications and tools that permit learning to be more dynamic and accessible, so that students are no longer restricted to their classrooms when it comes to interacting with learning processes (Callum, Jeffrey, & Kinshuk, 2014; Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018). The mobility and ubiquity of mobile devices prevent instruction and learning from being restricted to a specific time and location (Wang, Wu, & Wang 2009; Osman, El-Hussein, & Cronje, 2010; So, 2016).

There is no single acceptable definition of mobile learning, because the field is evolving rapidly. Researchers are struggling to provide a specific definition of mobile learning that is educationally relevant and sufficiently different from e-learning (Farley, Murphy, & Rees, 2013; Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018). Mobile learning is an educational platform that majorly utilizes smartphones, personal digital assistants (PDAs) and tablets (Park, Nam, & Cha, 2012; Alsaadat, 2009; Sarrab, Al Shibli, & Badursha, 2016). By broadly examining the field of mobile learning, it can be seen as the deployment of pervasive handheld devices to enhance, support, and expand the access to teaching and learning activities (Aduke, 2008; Oye, Salleh, & Iahad 2011; Sarrab, Al Shibli, & Badursha, 2016; Chang, Lai, & Hwang, 2017). Mobile learning can take place in any location, at any time, including conventional classrooms, the workplace, at home, and while on the move.

Mobile technology actually offers the appropriate educational environment to facilitate instructional activities both inside and outside of the classroom (Yousuf, 2007). Mobile learning takes teaching beyond conventional classroom boarders, and supports both formal and informal instructional contexts (Kljunić, & Vukovac, 2015; Mehdipour, & Zerehkafi, 2013; Sarrab, Al Shibli, & Badursha, 2016). The use of mobile devices and wireless transmissions for instructional activities is mobile instruction (Hoppe, Joiner, Milrad, & Sharples, 2003; Chang, Sheu, & Chan, 2003; Penga, Sua, Choua, & Tsaib, 2009). The major difference between e-learning and mobile learning is the mobility that allows teachers and learners to utilize their free time for teaching and learning activities through mobile devices (Hummel, Hlavacs, & Weissenböck, 2002; Kynäslahti, 2003; Seppälä, & Alamäki, 2003).

It is a veritable tool that allows instruction and learning outside the conventional education setting. Geddes (2004) stated that, mobile instruction and learning happens when the content and the attendant acquisition of knowledge and skills are mediated by mobile technology, anywhere, anytime, that leads to an alteration of behaviour. Yousuf (2007) further posited that unlike the limitations of working and learning only in the classroom or in the laboratory, mobile technology offers access to learning material regardless of location and time. Mobile instruction involves the application of mobile devices in a manner that allows delivery of learning materials with harmonized approaches that enable learners to gain knowledge from anywhere at any time (Ally, 2004; Sampson, Isaias, Ifenthaler, & Spector, 2013; Kuhnel, Seiler, Honal, & Ifenthaler, 2018).

Mobile instruction utilizes mobile applications for the delivery of learning content, offering learners the opportunity to gain high level education in locations where schools and teachers are not accessible (Heflin, Shewmaker, & Nguyen, 2017; Li, 2017). Harris (2001) claimed that mobile instruction offers learners the possibility to participate in an educational moment from a mobile device or a personal digital assistant.

With a mobile device, the interaction between it and its owner becomes one-to-one, always on, always there, location aware, and individualized (Homan, & Wood, 2003; Motiwalla, 2007).

Owing to the portability, increasing proliferation of these devices and the availability of the Internet has made mobile instruction and learning the current trend in higher education worldwide, as they permit users to access various services and platforms, including educational materials, anytime and anywhere (Lepp, Barkley, & Karpinski, 2014; Shorfuzzaman, & Alhussein, 2016).

The affordability, sophistication, and pervasiveness of mobile devices have encouraged education providers to consider utilizing them as a new medium of instruction and learning because they are becoming increasingly more capable of performing all the functions that are necessary in the teaching and learning processes (Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018). While mobile devices assist teachers to make instructional content available to students anytime and anywhere, they also offer the students the opportunity to access online educational materials, review and share them, collaborate with others and develop a rich media content that can be helpful in solving problems (Davies, 2014; Torres, Infante, & Torres, 2015; Peter, Adelaiye, & Bijik,2018). Mobile instruction presents learners with the experiences that are not obtainable in their immediate environment, while at the same time equipping them with the necessary ICT consciousness and skills that are essential to actively participate in the modern world (Oye, Salleh, & Iahad, 2011; Hayati, Jalilifar, & Marshadi, 2013 Lauricella, & Kay, 2013). With mobile devices the compulsory requirement for teachers and students to be physically present in a particular location at a specific time is eliminated because students can access instructional materials, interact with their teachers and/or other students as well as anyone else to meet their quest for knowledge (Winter, Cotton, Gavin, & Yorke, 2010; Koper, 2014; Ferreira, Moreira, Pereira, & Durão, 2015). According to them, the use of this technology in education leads to a more intimate relationship between both teacher and student, resulting in a more participatory learning experience.

The integration of these devices and their associated technologies has significantly enhanced teaching and learning (Efaw, 2005; Valtonen, Kukkonen, Kontkanen, Sormunen, Dillon, & Sointu, 2015; Holland, & Piper, 2016). The portability of the mobile devices offers learners the option to use their free time for studying, rather than having to learn in predetermined locations (Ifinedo, 2013; Clarke, 2013; Wishart, 2018). ICT via social interaction on mobile devices, helps learners to construct and share knowledge, and cooperate and collaborate (Pence, 2007; Nelson, Christopher, & Mims, 2009; Barhoumi, & Rossi, 2013; Barhoumi, 2015).

The individualization and the extended functions of the mobile devices, have the potential to encourage learners to interact among themselves (Motiwalla, 2007). The use of mobile devices in education have been found to be beneficial to both teachers and learners (Dawabi, Wessner, & Neuhold, 2003; Mahdizadeh, Biemans, & mulder, 2008; Ferreira, Moreira, Pereira, & Durão, 2015). According to Rau, Gao, & Wu (2008) mobile technology is used to eliminate the distance between teachers and learners which results in enhanced motivation, interaction and reduced pressure. Mobile instruction provides the connection between formal and informal contexts which offers the opportunity to relate and apply what has been learnt from one context to another (Looi, Seow, Zhang, So, Chen, & Wong, 2010; Wishart, & Ekanayake, 2014; Nordmark, & Milrad, 2015). Teaching and learning activities only in the classroom are no longer sufficient to prepare students for the modern world (Ozdamli, & Cavus, 2011), and should be supported with additional learning outside the classroom (Uzunboylu, & Ozdamli, 2011). This offers enhanced interaction with other learners by helping them to construct meaning of their classroom learning experiences.

However, mobile learning has some challenges that are associated with the devices that include internet connectivity, screen size, limited memory capacity, short battery life, limited computation ability, and complex input capabilities (Thomas, Singh, & Gaffar, 2013; Tabor, 2016; Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018). To ensure a successful implementation of mobile teaching and learning, it is necessary to investigate the readiness of the potential users in order to provide suitable mobile instructional services (Liu, 2008; Shorfuzzaman, & Alhussein, 2016; Sarrab, Al Shibli, & Badursha, 2016). The key success factors with regard to mobile instruction and learning critically lies with the teachers and students' desire and intellectual engagement in this style of learning activities. Therefore, in order to effectively adopt mobile instruction in higher education, several factors must be addressed, particularly the driving factors that will encourage teachers and students' acceptance and usage of mobile devices (Callum, 2010; Thomas, Singh, & Gaffar, 2013; Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018).

The fundamental elements of mobile learning

The following are the basic elements of mobile learning and must be adequately harnessed in order to effectively achieve the benefits associated with it.

The learner: The learners are the focus of all elements involved in the teaching and learning activities. Mobile instruction helps to address the interests and experiences as well as the needs of the learners. They are at the center of the process (Makoe, 2010), and play active roles in identifying the learning objectives (Ozdamli, & Cavus, 2011). According to them, the learner's roles include:

1. access information when needed;
2. responsible for their own learning;
3. learning at their own pace;
4. identify and use their own learning styles;
5. develop and share their own learning construct;
6. learn with peers collaboratively;
7. evaluate themselves and others.

These are the major roles of students involved in a mobile learning environment.

The teacher: The teachers transfer instructional material to their students with the aid of mobile devices. In addition, the teachers are able to use this technology to access their students' progress. Halis (2002) stated that this creates a new feature unlike the traditional role regarding the searching and usage of information by the students. The roles of teachers include being presenters, facilitators, moderators and consultants in their own fields. The teachers should be

1. qualified enough to utilize the appropriate mobile tools and technologies
2. determine the strengths and weaknesses of applied methods, and study them to address any limitations associated with these approaches
3. a facilitator -guides the learners through the process
4. plays an advisory role
5. be self-confident in all relevant subject areas

6. learn with students
7. able to eliminate barriers from the process
8. enhance students' motivation
9. able to initiate and arrange activities to support interactions between collaborative groups
10. arrange activities for evaluating the results of the process. (Ghaln, 2011 as cited in Ozdamli, & Cavus, 2011)

Content: Content should be determined in consultation with the learners, and the required information should be easy to obtain quickly. Mobile instruction should be enhanced with graphics, videos, games, presentations and other multimedia elements. Educational content for mobile devices can be divided into three categories: HTML, video and audio content (ICT-AAC. Matematički vrtuljak, 2014; Taleb, & Sohrabi, 2012). Siragusa, Dixon, & Dixon (2007) stated that the detail and scope of the content provided to the learners may vary depending on their needs.

Environment: Environment here means the platform where the learners access instructional materials, interact among themselves and with their teachers, and should be designed properly to facilitate the desired learning experiences. The learners studying online must have access to all the unit content including the objectives, assignment requirements and relevant resources (Ozdamli, & Cavus, 2011; Makoe, 2010; Kljunić, & Vukovac, 2015). In a face-to-face setting, students can receive content and extra material online via their mobile devices (Siragusa, Dixon, & Dixon, 2007). Learners should be able to access material while on the move and outside the traditional learning setting. The environment must encourage interaction among learners and between their teachers. Social media or blog platforms can facilitate the required interactions, therefore, should be designed for mobile devices to eliminate geographical boarders.

Evaluation: This is very important in any learning context. Mobile technologies can enable the teacher to access records and monitor learner's performance. The evaluation of the learners should be carried out via database logs or other software packages, and would allow students to access themselves, as well as their peers. Mobile technology provides the necessary requirements to accurately evaluate a learner's knowledge, ability and creativity. Sharples, Taylor, & Vavoula

(2005) emphasized that evaluation is matched to the ability of the learners, providing diagnosis and formative guidance that builds on success. The evaluation should assist in addressing the learner's doubts in relation to the course and their progress (Behera, 2011). A properly designed course offers the learners immediate feedback that enables them to be aware of their progress, and encourages them to continue their studies (Sharples, Taylor, & Vavoula, 2005; Ozdamli, & Cavus, 2011; Kljunić, & Vukovac, 2015).

Characteristics of mobile learning

Below include the characteristics of mobile learning

Place: With mobile learning, students are able to learn in various contexts, such as in the classroom, on the field, in their dormitory, and/or even while on the move (bus, train, canteen) (Mehdipour, & Zerehkafi, 2013; Kljunić, & Vukovac, 2015). With mobile devices learners do not need to defer learning until they are in the classroom, laboratory or library.

Ubiquity: Learning opportunities are offered to students wherever they find themselves without constrains, anytime and anywhere (Sampson, Isaias, Ifenthaler, & Spector 2013; Mehdipour, & Zerehkafi, 2013; Delcker, Honal, & Ifenthaler, 2018; Kuhnel, Seiler, Honal, & Ifenthaler 2018).

Portability: Mobile devices are compact and lightweight, which enables students to always take them wherever they go, and allows them to have unrestricted access to this type of learning offered by the technology (Ozdamli, & Cavus, 2011; Kljunić, & Vukovac, 2015).

Instant access to learning materials: Teachers and learners are able to access required materials in their own time. Real time and immediate access to educational materials and feedback from teachers on assessments and other guidance can be accessed synchronously or asynchronously (Cavus, & Ibrahim, 2009; Eteokleous, & Ktoridou, 2009; Cohen, 2010; Chang, Lai, & Hwang, 2017; Durek, Kadoic, & Redep, 2018).

Privacy: Mobile learning enables each learner to work on their own activity without interference from others, while at the same time offering them the opportunity to collaborate whenever it becomes necessary (Chidi, 2002; Zhang, 2003; BenMoussa 2003; Ozdamli, & Cavus, 2011).

Pedagogical change: Mobile learning changes methods of teaching and learning which result in more voice instructions, graphical elements, video and animations, and also changes the roles of both teachers and learners (Ozdamli, & Cavus, 2011; Mehdipour, & Zerehkafi, 2013; Kljunić, & Vukovac, 2015).

Blended learning: Mobile tools can be utilized to support classroom learning, writing assignments, doing projects or research, and in addition, learners may receive content outside of the classroom on their mobile devices (Siragusa, Dixon, & Dixon, 2007; Oye, Salleh, & Iahand, 2011; Hayati, Jalilifar, & Marshadi, 2013; Lauricella, & Kay, 2013). The teacher may find it necessary to conduct evaluations online and/or send additional information to their students via mobile devices.

Improved communication and interactivity: As the teachers actively engage their students in learning via mobile devices, communication and interaction between them become facilitated. Moreover, the students improve their collaborative skills by sharing perspectives relating to their learning activities (Mahdizadeh, Biemans, & Mulder, 2008; Davies, 2014; Koper, 2014; de Witt, & Gloerfeld 2018). Communication between students and teachers is enhanced through unrestricted synchronous and asynchronous communication. In addition, student to student communication becomes more robust and flexible through instant text messages, video and audio teleconferences.

Collaboration: Unrestricted communication and interaction as well as community-centered educational content, leads to robust active collaboration between learners and teachers as well as each other (Winter, Cotton, Gavin, & Yorke, 2010; Ferreira, Moreira, Pereira, & Durão, 2015; Peter, Adelaiye, & Bijik, 2018).

Evaluation and feedback: Feedback to students can be one-to-one, and is available both synchronously and asynchronously (Ozdamli, & Cavus, 2011; Mehdipour, & Zerehkafi, 2013). Assignments and quizzes can be conducted online at anytime and anywhere that the internet can be accessed. In addition, the tests can be personalized, and adapted to the learner's specific needs, with the scores and/or feedback obtained instantly (Sharples, Taylor, & Vavoula, 2005; Behera, 2011; Mehdipour, & Zerehkafi, 2013).

Location Aware: Presentations, exams and assignments can be monitored by the teachers remotely, while learners who are taking part in assignments or participating in learning at any time or place, can be tracked (Homan, & Wood, 2003; Motiwalla, 2007; Ozdamli, & Cavus, 2011; Mehdipour, & Zerehkafi, 2013; Kljunić, & Vukovac, 2015).

Digital technology skills development: As both teachers and students engage in their relevant activities via mobile devices, they become conversant with the technology, thereby developing the required digital skills for lifelong learning (Laurillard, 2010; Timmis, 2012; Hyati, Jalilifar, & Marshadi, 2013).

Blended learning

A close observation revealed that educational settings that once only supported face-to-face learning are evolving rapidly into environments that are now accommodating technology mediated learning. This is because in the 21st century, the emphasis is increasingly on the facilitation of human interaction and collaboration (Graham, 2004; Cocquyt, Diep, Zhu, De Greef, & Vanwing, 2018). In the past, distance learning was designed as a one-way communication between an expert (teacher) and a passive-receptor (learner) based on the cognitive-behaviourist's theory (Anderson, & Dron, 2011), but as technology develops, distance learning is being used to facilitate interactive and constructivist (collaborative) learning by taking advantage of online communication technology, leading to the practice of studying anywhere in the world (Cocquyt, Diep, Zhu,De Greef, & Vanwing, 2018).

Blended learning is a combination of two generational models of teaching and learning, which is an instructional approach that incorporates both the traditional face-to-face classroom system and an online learning platform (Graham, 2004; Liu, Peng, Zhang, Hu, Li, & Yan, 2016; Han, & Ellis, 2019), that employs a mix of asynchronous and synchronous interactions (Wu, Tennyson, & Hsia, 2010).

Online experiences offer valuable tools that supplement or replace aspects of the face-to-face traditional lecture and textbook-based approach to teaching and learning (Glazer, 2012). Participating in lectures usually involves memorizing and recalling information, which are lower levels of Bloom's taxonomy of learning (Bloom, 1956), while on the other hand, engaging in solving real life problems during class enables students to synthesize and apply knowledge through reflection and reconceptualization of ideas (Cottrell, & Robison, 2003; Graham, 2004; Amador, Miles, & Peters, 2006). Research has revealed that a course design embedded with in-class problem solving, improves learners' performance and reduces the achievement gap between students (Stockwell, Stockwell, Cennamo, & Jang, 2015).

The rampart utilization and the availability of digital learning facilities, has led to increased levels of deployment of ICT-mediated instructional elements into the conventional learning environment. This practice provides educators with the opportunity to help students acquire the information and terms associated with the course before class starts, which allows the usual face to face teaching time for problem-solving tasks that engages the students' cognitive processes (Couch, 2014; Clark, 2015; Lee, & Lai, 2017).

In any e-learning scenario such as blended learning, students are expected to exercise self-efficacy and regulative skills (Collis, 2003; Laffey, Lin, & Lin, 2006; Liaw, 2008), while the teachers being experts in their subject field and teaching methods, should be responsive to the interactions of learners on the platform and be able to utilize the learning tools to achieve the desired objectives (Hassanzadeh, Kanaani, & Elahi, 2012; Diep, Zhu, Struyven, & Blieck, 2017).

Blended learning affords teachers adequate class time for collaborative problem-solving activities, demonstrations, question and answer sessions and other engaging tasks that lead the students to a greater depth of knowledge (Saitta, Morrison, Waldrop, & Bowdon, 2016). It is a pedagogical approach that provides teachers with the opportunity to invert the classroom and homework activities (Du, Fu, & Wang, 2014; Obari, & Lambacher, 2015) which permits them more time to tutor their students (Wallace, 2014; Alsowat, 2016).

Studies have shown that students are able to watch, pause and repeat the online learning materials, which allows them to gain understanding of the content before class *(*Hamdan, McKnight, McKnight, & Arfstrom, 2013; Herreid, & Schiller 2013; Lee, & Lai, 2017), and this affords the teachers sufficient time to engage them in collaborative problem-solving tasks that promotes their critical thinking skills. Nederveld, & Berge (2015) stated that in blended learning, teachers are able to concentrate on the application of knowledge of higher-order learning, instead of lower-level thinking activities, which offers the opportunity to identify mistakes and reinforce critical and creative thinking, as well as effective communication.

When students are sent learning materials to study before class, it ensures a more collaborative and engaging environment in the classroom (Baker, 2000; Strayer, 2007; Clark, 2015), enabling them to reconceptualize and evaluate the content for problem solving in real life contexts (Bretzmann, 2013; Bergmann, & Sams, 2012, 2014; Sung, 2015). In higher learning institutions, students appreciate the opportunities of flexibility and improved access to learning materials offered by mobile technology, which results in greater academic achievements due to the improved interaction and collaboration with their lecturers (Talley, & Scherer, 2013; Vaughan, 2014; Alsowat, 2016).

The information technology department in a school where the blended learning framework is being adopted has a role to play by facilitating access to videos, websites, both on and offline platforms, as well as offering technical support to both teachers and students (Bharali, 2014; Bergmann, & Sams, 2014; Mathews, 2015).

Mobile-blended and critical thinking enhancement

The advancement of the 21st century is characterized by the application of ICT in many human endeavours, including teaching and learning. Participating in lectures usually involves memorizing and the recalling of information, which are lower levels of Bloom's taxonomy of learning (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956), while on the other hand, engaging in solving real-time problems during class, enables students to synthesize and apply knowledge through reflection and reconceptualization of ideas (Graham, 2004; Amador, Miles., & Peters, 2006).

Mobile-blended with collaborative inquiry-based learning is a purposeful strategy that involves an appropriate blend of mobile and face-to-face contexts to achieve specific learning objectives by taking advantage of the two environments. The practice allows teachers to leverage the stunning potential of mobile technology, to equip their learners with the information and terms associated with a course before class starts, which provides them adequate time to engage the students with real-life collaborative inquiry-based learning tasks during a face-to-face meeting, that facilitate the enhancement of their critical thinking abilities (Lee, & Lai, 2017).

As teacher delivers mobile instructional materials in an appropriate format (video, text, image, or a combination of formats) with a user-friendly platform for students to study and offers them clarifications on the complex concept of the content via mobile technology (Jantakoon, & Piriyasurawong, 2018), adequate time becomes available to them during the face-to-face session to apply the knowledge gained from the content to inquiry activities collaboratively.

As students endeavour to resolve the problem through sharing of perspectives and reflection, as well as analysing, evaluating and reorganising the knowledge gained from the mobile content, they acquire deeper insight resulting from enhanced critical thinking skills. The aim of delivering instructional content to students to study before class time is to allow adequate time for collaborative inquiry activities during classroom encounter,

Mobile blended learning is an approach that encourages students to maximize the face-to-face context with the knowledge gained from the online content (Dwiyogo, 2018). This practice has a positive result on the enhancement of problem-solving abilities, and it is more effective compared to the traditional approach (Yu, Lin, Ho, Wang, 2015; Tsai, & Tang, 2017; Hasanah., & Malik, 2020).

Research has shown that blended learning promotes the acquisition of employability skills of learners, these skills are connected with the abilities to think creatively, acquire digital skills, work under different circumstances and communicate effectively because modern jobs require flexibility, initiative, and skills to approach assorted tasks (Lane, 2016; Hart, 2019; Blau, Shamir-Inbal, & Avdiel, 2020).

Links between Mobile-blended with collaborative inquiry-based learning approach and critical thinking enhancement

When mobile-blended learning is effectively implemented, teachers acquire a greater amount of class time to engage students in collaborative inquiry-based learning (Fu and Hwang, 2018; Jantakoon, & Piriyasurawong, 2018). As students work collectively and share ideas on their inquiry activities, such a collaborative and interactive context facilitates the development of their creative thinking which better equips them for effective participation in their later life engagements.

The aim of education in this digital era is to expose students to more active learning, which facilitates their collaborative problem-solving abilities, culminating in equipping them with the realities of the world of work. When students are engaged in real-time inquiry tasks during class, it encourages them to analyse, synthesize, and apply knowledge through reflection and reconceptualization of ideas. Critical thinking ability is a level that is beyond the memorization of information or quoting facts back to an individual in the same manner as they were previously expressed (Thomas, & Thorne, 2009). It is the use of critical and creative thought that enables an individual to solve complex problems through analysis, evaluation, and synthesis of knowledge (Lee, & Lai, 2017). The constructivist theory emphasized that learners are required to be exposed to learning experiences that inspire and empower them to construct their knowledge, leading to the facilitation of their thinking abilities.

In an environment where education is student-centered, learning is considered as knowledge constructing activities where learners collaboratively obtain, reorganize, and use the information acquired for analyzing and solving the problem. Interaction and collaboration are important in the process of developing students' critical thinking (Slavin, 2014). They need interaction and reflection on what they were previously exposed to, and what they are currently experiencing.

Engaging in social interaction with peers in real-world contexts has the potential of facilitating learners' ability to reflect on previous exposure and views. Such social interactions promote the development of students' critical thinking abilities that enables them to effectively transfer their knowledge across courses and apply it to unfamiliar situations. Collaboration enables students to interact among themselves by exchanging views and ideas to effectively discover new knowledge to accomplish their objectives. It allows them the opportunity to work as a team with interdependence, and assist others to accomplish specific targets (Fu, & Hwang, 2018). Interactive and collaborative environments empower learners to exercise their minds to find solutions to problems and develop higher-order tendencies, as they respond to their peer's questions and remarks.

Constructivist theory and knowledge creation

Globally, the constructivist learning theory is commonly recognized in teaching and learning processes, particularly when the focus is on cognitive development. It is a great theory for explaining how human beings learn about their environment and how new knowledge is created (Gordon, 2008; Felder, 2012). It is a learning theory that assists students to attain a higher level of understanding through collaboration and interactive activities (Xu & Shi, 2018), and it emphasizes that learning experiences are greatly strengthened when students actively participate in the process (Fernando & Marikar, 2017). Naylor & Keogh (1999) described constructivism in the following statements "learners can only make sense of new situations in terms of their existing understanding. Learning involves an active process in which learners construct meaning by linking new ideas with their existing knowledge" (p. 93).

Flynn, Mesibov, Vermette & Smith (2004) stated that constructivism theory is focused on "facilitating the learner to go beyond simple recall (memorization) toward understanding, application, and competence" (p. 113). Also, according to Brooks & Brooks (1993) "constructivism is not a theory of teaching, it is a theory about knowledge and learning (…) the theory defines knowledge as temporary, developmental, socially and culturally mediated" (p. vii).

Fox (2001, p. 24), identify the major elements of constructivism theory to further clarify its meaning as follows:

1. Learning is an active process.
2. Knowledge is constructed rather than innate or passively absorbed.
3. Knowledge is invented not discovered.
4. All knowledge is personal and idiosyncratic.

5. All knowledge is socially constructed.
6. Learning is essentially a process of making sense of the world.
7. Effective learning requires meaningful, open-ended, challenging problems for the learner to solve.

Kouicem (2020) stressed that constructivism theory emphasizes that knowledge is actively developed by students in response to interactions with their present knowledge and environment, and that teacher does not transfer knowledge to their students but offers them the opportunities and incentives to construct it.

Piaget's Stages of Cognitive Development

Jean Piaget, a Swiss psychologist, is among the first theorists in constructivism. He divided the stages of cognitive development into four as shown below:

Sensory Motor Stage: according to him this stage is from birth to two years of age. The infants' schemes are simple and action-based; they simply use their senses with physical actions to create their schemes (Pressley & McCormick, 2007). Intelligence at this stage does not depend on the mind, but on the activities carried out by the infant, who constructs his understanding of the world through his or her environment (Kouicem, 2020).

Preoperational Stage: Pressley & McCormick (2007) this is the pre-school age, children begin to develop cognitive structures called 'symbolic schemes'; they can represent ideas and objects by symbols like language, mental images, and gestures. This stage is generally termed the preoperational stage because they are unable to engage in operational thinking, and cannot internalize complex concepts.

Concrete Operational Stage: this stage in Piaget's theory is the elementary-grade years. An important characteristic of this stage is that they can sufficiently use their cognitive processes to solve problems relating to concrete objects (Pressley & McCormick, 2007).

Formal Operational Stage: generally, this stage begins from early adolescence; they can engage in abstract thinking at this stage (Pressley & McCormick, 2007; Kouicem, 2020).

Constructivist theory and critical thinking skills

Contemporary educational theory emphasized learning as a learner-centered activity. Social constructivism, a component of constructivism theory, strongly emphasizes self-learning where learners are provided with adequate guidance and the necessary tools to uncover knowledge, gain understanding, and find solutions to problems (Ertmer, & Newby, 1993). Constructivism is the construction of new knowledge by learners and social constructivism is learning as a consequence of collaboration where new meanings are collectively constructed (Brown, 2006; Brown, & Mbati, 2015; Chung, Hwang, & Lai, 2018). Social constructivist approach appears to be the most compactible with the implementation of mobile learning, because it facilitates learner-centered approach, interaction, collaboration, and construction of personal understanding. This culminates in interpretive learning process instead of memorization of concepts or facts, and the knowledge gained is as a result of learning experience (Brickell, & Herrington, 2004; Dyson, Litchfield, Lawrence, Raban, & Leijdekkers, 2009; Marzouki, Idrissi, & Bennani, 2017; Chung, Hwang, & Lai, 2018).

Dewey (1916); Gagne (1965) stated that learning is a basic cognitive process of mental and social change throughout an entire lifetime. Leung, & Chan (2003) claimed that learning can be achieved through social interaction, such as the collaborative approach offered by mobile learning devices. Working collaboratively (sharing meaning of content) enables students to construct knowledge (Dunlap, & Grabinger, 1996). From the social constructivism point of view, knowledge is derived as a human product, and is socially and culturally constructed (Ernest, 1999; Gredler, 1997; Prawat, & Floden, 1994). In other words, the formation of knowledge is established as a result of interaction between learners and their environments.

Social constructivism sees learning as a collaborative process, not passive, that encourages students to be engaged in effective collaborative activities that will enable them to construct meaning (Kim, 2001). Vygotsky (1978) emphasized that individuals construct knowledge from within and not conveyed to them from the outside, and Al Hamdani (2014) claimed that knowledge gained as a result of social interaction is the best. Through collaborative, contextual, and constructivist learning environments, the benefits of mobile learning can be achieved by institutions and their students (Patten, Arnedillo, & Tangney, 2005; Al Hamdani, 2014). Jonassen, (2000) maintained that construction of knowledge is best promoted through constructivist learning environments that provide assorted portrayals of reality; target construction of knowledge; empower learners' reflective approaches; and support collaboration. The application of social constructivist theory in a technology-based learning environment, facilitates the actualization of the full benefits of using technology in education (Campbell, 2004).

Brown, Collins, & Duguid (1989) stated that learning is not a process of acquiring knowledge but a social activity for constructing knowledge to solve problems. Furthermore, construction of content requires the students to collectively work actively with the tools and construct their own knowledge (Frohberg, Göth, & Schwabe, 2009; Huang, Liao, Huang, & Chen, 2014; Chung, Hwang, & Lai, 2018). Social interaction facilitated by mobile devices offers such a "content construction" tool (Elfeky, & Masadeh, 2016). An example is Sung, Hwang, Liu, & Chiu, (2014) who designed a mobile learning activity without learning content, the students were only given adequate guidance to generate their own content.

As the learning environment in a constructivist approach enables students to take part in studying with suitable tools and adequate guidance, they uncover knowledge themselves (Crompton, Burke, & Gregory, 2017). Teachers, as facilitators, have to provide leaners with collaborative learning environments that will enable them to ruminate on the learning process in order to construct new outlooks (Chung, Hwang, & Lai, 2018).

Inquiry-based learning

Inquiry-based learning is an approach that involves asking questions, gleaning information and new ideas in order to solve problems (Duran, & Dokme, 2016). Inquiry-based learning helps students to exercise their analytical skills (define similarities and differences in content) and critical thinking abilities -defines the cause of change in a variable and the effect of it on another (Duran, & Dokme, 2016).

Mobile inquiry-based learning integrates and exposes students to real-world contexts that trigger their critical thinking process (Hwang, Kuo, Yin, & Chuang, 2010; Shih, Chu, Hwang, & Kinshuk, 2011; Hwang, Wu, Zhuang, & Huang, 2013; O'Connor, Jeanes, & Alfrey, 2014). Teachers play the role of guide/facilitator in scaffolding learning through timely questioning (Weinberger, Stegmann, Fischer, & Mandl, 2006; Sharma, & Hannafin, 2007; Neeru, 2009; Livingstone, 2012; Duran, & Dokme, 2016; Zoha, & Cohen, 2016).

Inquiry-based learning focuses on active learning, engaging students to ask questions, formulate hypotheses, and to test the hypotheses through problem solving (Laru, Järvelä, & Clariana, 2012). Inquiry-based learning takes place when students learn both content and reasoning skills including practices within a discipline, via collaborative investigation suitable for real-world situations (Hmelo-Silver, Duncan, & Chinn 2007). Through interaction in inquiry-based learning, students exercise reflection and how to approach situations critically (DeBoer, 2000). It involves the ability of students to investigate and search for information, which allows them to formulate their own ideas through critical thinking (Seranica, Purwoko, & Aliefman, 2018). Authentic learning results from social constructivist's view, which emphasizes that learners are active researchers, and knowledge is generated by investigating and actively experiencing reality (Roelofs, & Jan 1999; O'Connor, Jeanes, & Alfrey, 2014).

To encourage productive interaction and promote critical thinking, sufficient scaffolding is necessary (Weinberger, Stegmann, Fischer, & Mandl, 2006; Sharma, & Hannafin, 2007) because it makes learning more manageable for students by presenting complex tasks in a manner that makes them accessible, feasible and within their grasp (Vygotsky, 1978).

Inquiry-based learning refers to a pedagogy approach that enables learners to experience the processes of knowledge creation (Spronken-Smith, 2012), emphasizing the potential for them to engage in the exploration and creation of new information (Damsa, & Nerland, 2016). The factors of inquiry-based learning include the structure and types of activities that are required by learners to gain increased knowledge (Levy, Aiyegbayo, & Little, 2009; Levy, & Petrulis, 2012; Prince, & Felder, 2006). The aims of inquiry involve the comprehension of existing knowledge to resolve problems and develop new abilities; the structure involves inquiring questions framed by teachers or students; and types of activities include problem solving, investigations of practical situations and the generation of greater understanding (Damsa, & Nerland, 2016).

Inquiry-based learning strategy exposes students to research experiences, as it engages them in exploring problems and knowledge (Brew, 2010; Spronken-Smith, 2012). Exposing students to real world situations in inquiry-based learning enables them to engage adequately with professional knowledge and practice within their disciplines (van Bommel, 2012; Levy, & Petrulis, 2012; Litzinger, & Lattuca, 2014; Damsa, & Nerland, 2016).

Modern mobile technologies can assist students in inquiry learning that leads to the exploration and discovery of new knowledge (Price, & Rogers, 2004; Looi, Wong, So, Seow, Toh, Chen, Zhang, Norris, & Soloway, 2009).

Teacher's roles in inquiry-based learning

The teacher's role in inquiry-based learning is to guide the learners to unfold knowledge themselves by playing the role of a facilitator rather than that of an information provider (Juskeviciene, Jasute, Kurilovas, & Mancenko, 2016). Zuckerman, Chudinova, & Khavkin, (1998) identified the following crucial factors associated with inquiry-based learning: the teacher must stimulate students' imagination by presenting them with situations that are within their grasp to recognize the new elements that relate to their existing knowledge, and should provide the opportunity to work collaboratively to resolve problems. The students must be encouraged to continually ask questions to assess their understanding and improve knowledge.

When teachers are actively involved in challenging students to think and solve problems in collaborative learning by using questions to guide their thought processes, Gillies, & Boyle (2006) claimed that students become more focused in their desire for knowledge. Effective implementation of inquiry instruction, requires teachers to appropriately scaffold tasks/activities that will enable their students to understand how to exercise their minds as they engage in tasks, acquire step-by-step knowledge on how to resolve situations, how to collaborate with peers and how to deeply reflect on their learning (Harris, & Rooks, 2010; Hmelo-Silver, Duncan, & Chinn, 2007; Gillies, & Nichols, 2015).

Critical thinking

Resnick (1987) stated that critical thinking is non-algorithmic, but a complex mode of thinking that usually generates multiple solutions, involves uncertainty, the application of diverse criteria, reflection, and self-regulation. Cognitive processes such as analysis, synthesis and evaluation in Bloom's taxonomy are critical thinking abilities that extend beyond comprehension; while knowledge, understanding and application are lower order thinking abilities (Bergmann, & Sams, 2014; Alsowot, 2016; Apino, & Retnawati, 2017). Learning experiences that emphasize analysis, synthesis and evaluation help to develop skills with problem solving through interpretation, creativity and generalization. These learning experiences promote reproductive thinking, rather than productive reasoning. Thomas, & Thorne (2009) stressed that critical thinking is a level that is beyond memorization of information or quoting facts back to an individual in exactly the same manner as they were previously expressed. It is the use of critical and creative thought that enables an individual to solve complex problems through analysis, synthesis and the evaluation of knowledge (Yeung 2012; Lee, & Lai, 2017).

Critical thinking is observed when an individual receives and stores new knowledge, while interrelating and applying such information to address unfamiliar situations. It is the ability of individuals to achieve a complex and logical thinking process that allows them to interpret, evaluate and manipulate previous experiences, in order to confront present life challenges. Resnick (1987) further identified the following as characteristics of critical thinking:

1. non-algorithmic, that is, steps cannot be adequately determined at the beginning
2. complexity, meaning that steps are not predictable from a certain perspective
3. product of multiple solutions instead of a single solution
4. it involves disagreement and different interpretative meanings
5. it involves integration of multiple criteria, which maybe in disagreement
6. usually involve uncertainty
7. it involves self-regulation in the process of thinking
8. involves imposition of meaning

9. it requires adequate effort.

Critical thinking requires complex and logical thinking in dealing with life situations and solving problems (Apino, & Retnawati, 2017).

Elements of critical thinking are the ability to think creatively leading to alternative perspectives and reflect on one's own thinking and its quality (Flores, Matkin, Burbach, Quinn, & Harding, 2012; Niu, Behar-Horenstein, & Garvan, 2013); the ability to analyze and evaluate knowledge and make informed judgments (Wass, Harland, & Mercer, 2011; Flores, Matkin, Burbach, Quinn, & Harding, 2012); and the ability to generalize knowledge to solve problems from various perspectives (Utriainen, Marttunen, Kallio, & Tynjälä, 2017; Arya Wulandari, Sa'dijah, As'ari, & Rahardjo, 2018).

The need to develop critical thinking tendencies in students

Despite the emphases on teaching critical thinking, most classrooms globally are still characterized by approaches that still focus on lower order thinking (Osborne, 2013; Zohar, & Cohen, 2016). The development and promotion of critical thinking has been a major educational goal for many years, this is because it equips students with the ability to work and address challenges they may face in their lives (Association of American Colleges and Universities, 2010). Research has shown that memorization of knowledge does not result in the ability to use such knowledge to solve-problems (Kang, & Howren, 2004; Snyder, & Snyder, 2008). All levels of education aim to produce students who are critical thinkers, analytical and problem solvers by seeking to turn out individuals who are not only able to acquire knowledge, but also able to synthesize, evaluate and use their gained knowledge to resolve problems (Brierton, Wilson, Kistler, Flowers, & David, 2016; Hwang, Lai, Liang, Chu, & Tsai, 2017).

Newmann (1988) maintained that while critical thinking means challenging and a broader use of the mind, lower order thinking occurs in a routine or mechanistic manner that limits the potential of the mind. Challenging and broader use of the mind is accomplished through clarifying, analyzing and manipulating information to resolve problems. Therefore, the ability to adequately comprehend the context of a problem is very critical, because it helps to understand, clarify and apply the appropriate knowledge to the situation.

Critical thinking abilities are required for survival in an ever-changing technology-based knowledge society (Partnership for 21st century skills. 2009; Brierton, Wilson, Kistler, Flowers, & David, 2016) which can be developed through collaborative inquiry-based learning. This necessitates the need to integrate mobile technology in the educational contexts to facilitate student's interactivity and collaboration that will culminate in the building and development of their critical thinking abilities (Chang, Chen, & Hsu, 2011; Hwang, Lai, Liang, Chu, & Tsai, 2017).

Students who utilize ICT facilities in their studies gain a deeper understanding of complex concepts and develop critical thinking abilities as well as being able to apply what they have learnt to solve real life problems (Apple Computer, 2002; Boyce, Mishra, Halverson, & Thomas, 2014; Wong, Chai, Aw, & King, 2015).

An information-driven society workforce requires a generation of people who can think individually and make effective decisions to solve problems. The development of critical thinking skills in students cannot be over emphasized in order to promote the conversion of their knowledge and skills into a reproductive activity in the workplace (BenChaim, Ron, & Zoller, 2000; Zoller, 2001).

Strategies for developing critical thinking abilities in students

The effectiveness of interactivity and collaboration in building and developing critical thinking, analytical, creative, problem-solving abilities in students is well established in various studies (Chuang, Chiang, Yang, & Tsai, 2012; Lan, Tsai, Yang, & Hung, 2012; Hwang, Hung, Chen, & Liu, 2014; Yang, Gamble, Hung, & Lin, 2014; Chen, & Chiu, 2016). When the educational process is teacher-centered, there is too much control over the learners, and this restricts their learning to only facts instead of deep concepts, therefore, this approach cannot proceed beyond the three lowest stages of Bloom's taxonomy (Koch, 2016; Alsowat, 2016). Since higher order thinking does not spontaneously occur in most individuals, it needs to be taught through student-centered learning process that would encourage them to exercise their cognitive abilities (Williams, 2015). To achieve this, there is the necessity to develop students' abilities to analyze unfamiliar situations and make decisions to resolve such situations in a way that is based on critical thinking strategies (Miri, David, & Uri, 2007) and this requires teachers to imbibe approaches that foster students' application of higher order thinking in their learning activities (Biggs, 2011; Oliver, & Utermohlen, 1995).

Interactivity (communication) is defined as the ability to coherently present thoughts and ideas effectively by utilizing oral, written and nonverbal interactivity skills in a range of forms and settings (Frazier, & Reynolds 2012). Problem solving is the capacity to identify problems, obtain and analyze appropriate information, suggest feasible solutions and take the most effective actions to overcome the problems (Wiley 1998; Wang, & Chiew 2010). Critical thinking is the cognitive strategy that learners adopt to determine their procedures and opinions in a reflective manner (Kozma, & Voogt 2003; OECD 2008). Dewey (1933) emphasized that thinking is progression of chaining incidents that begins from reflection to inquiry and into critical processes that result in substantive decisions that are beyond personal beliefs and appearances. Reflection can "straighten out entanglements, clear obscurities, resolve confusion, unify disparities, answer questions, define problems, solve problems, reach goals, guide inferences, shape predictions, form judgments, support decisions, and end controversies" (King, Goodson, & Rohani, 1998, p. 5). Dewey (1933) further stated that thinking does not happen naturally, rather it must be triggered by questions and problems and Cañas, Reiska, & Möllits (2017) concluded that systematic and prolonged inquiry is an essential component in the development of higher order thinking abilities.

Newmann (1988) maintained that while higher-order thinking means challenging and broadening the use of the mind, lower order thinking occurs in a routine or mechanistic manner that limits the potential of individuals. He claimed that critical thinking is accomplished by clarifying, analyzing and manipulating information to resolve problems, and that the mechanistic utilization of previously acquired knowledge lacks what it takes to solve problems. King, Goodson, & Rohani (1998) emphasized the importance of the ability to understand the context of a problem because it helps to know or remember, clarify and apply appropriate knowledge to situations.

The transfer of knowledge is the ability associated with higher order skills, which enables an individual to use gained knowledge in unfamiliar contexts as well as across other domains (Barak, David, & Uri, 2007; Zohar, & Dori, 2003). The two main objectives of education are to equip learners with the tendencies of knowledge retention and transfer; while retention demands that students recall the knowledge they have gained, transfer demands that they are not only able to recall, but also to make informed decisions by applying learnt knowledge (Anderson, & Krathwohl, 2001).

Critical thinking is targeted at what is deemed to be suitable for a given situation (Norris, & Ennis, 1989), furthermore, it is reflective in promoting learner's abilities to establish obvious and sequential links between facts and conclusions, through evaluation of one's cognitive process with self-disciplined and guidance (Ivie, 2001). Critical thinking skills are essential because they enable individuals to solve problems effectively (Shakirova, 2007; Snyder, & Snyder, 2008). This is a process that requires learners to examine their thinking and improve on it, which also requires them to utilize their creative skills rather than just memorize or readily accept what they read or what they are told, without subjecting it to a cognitive process critically (Scriven, & Paul, 2008; Schafersman, 1991; Templeaar, 2006). Some scholars stated that critical thinking, as a higher order ability, is focused on argumentation (Kurfiss, 1988; Yeh, 2001; Geertsen, 2003; Barak, & Dori, 2009).

Creativity is the ability to evolve innovative ideas or products through elaboration, clarification, analysis and assessment of existing options (Yang, & Cheng 2010; Zeng, Proctor, & Salvendy, 2011; Jarvis, Dickie, & Brown, 2013).

King, Goodson, & Rohani (1998) stated that creative and critical thinking abilities come to life when a learner is confronted with unfamiliar situations, which requires the process of assessing the evidence obtained to address the situations (Lewis, & Smith, 1993; Crowl, Kaminsky, & Podell, 1997; Cañas, Reiska, & Möllits, 2017).

Analytical skills involve reviewing a variety of information, understanding their meaning, deciding on the appropriate information for the situation and the processing of such information to resolve problems (Subramanian, 2017). Analytical competence is the foundation of students' higher order thinking skills and it refers to special cognitive activities aimed at the identification, assessment and generalization of knowledge as well as its application to new situations (Toporovsky, 2011; Arya Wulandari, Sa'dijah, As'ari, & Rahardjo, 2018).

Collaborative learning experience refers to the instructional method that offers learners the opportunity to learn as a team with positive interdependence, group accountability and interactions as well as assist others to accomplish specific learning targets (Johnson, & Johnson, 1975; Slavin, 2014; Fu, & Hwang, 2018).

The interactive and collaborative learning environments encourage students to respond to their peer's questions in a more complex and knowledgeable way, by enhancing their critical thinking abilities as they exercise their minds in finding feasible solutions to problems (Davis, 1993; Hunkins, 1995; Arends, 2004).

Collaborative learning is an effective strategy that enables students to interact by exchanging their views and ideas in order to effectively accomplish specific learning objectives (Morrison, Morrison, & Lowther, 2009; Osman, Duffy, Chang, & Lee, 2011; Hwang, Lai, Liang, Chu, & Tsai, 2017). Interactive and collaborative learning develop students' thinking ability as they express and share knowledge with other students in the same group, and apply it to other contexts (Fogarty, & McTighe, 1993; Jones, & Safrit, 1994; Abosalem, 2016). Such educational environments offer learners the opportunity to reflect on their past and present learning dispositions which leads to a deeper understanding as a result of their cognitive processes (Ellis, & Goodyear, 2010; Mattar, 2018). A problem-based learning facilitates students' thinking skills and their discovery of new knowledge (Gurses, Acikyildiz, Dogar, & Sozbilir, 2007; Kumar, & Natarajan, 2007).

Social constructivism is when learners work collaboratively to create or construct meaning or knowledge through interactivity (Scardamalia, & Bereiter, 1996; Vrasidas, 2000). Construction of knowledge results from critical thinking. The major focus of social constructivism is to enable learners to attain in-depth meaning as a result of brainstorming via the collective construction of knowledge (Palinscar, 1998).

Social learning contexts enable interactivity and collaboration among learners on diverse topics in various perspectives that serve as a base for critical thinking to flourish. Constructivists' thinking focuses on the construction of knowledge from personal experiences which allows them to gather greater information, is the main hub of andragogy (Knowles, Holton, & Swanson, 2005). Knowledge construction requires learners to interact and reflect on what they were previously exposed to and what they are currently experiencing, and this happen in both external (social) and internal (reflective) contexts (Brierton, Wilson, Kistler, Flowers, & David, 2016). Piaget believed that reflection leads to higher order knowledge by permitting the resolution of elements of lower level knowledge (Bruner, 1996). Such resolution can be mediated by social constructivism through mobile interactivity and collaboration.

Mobile technologies offer better and wider educational applications greater than the conventional means of interaction and collaboration, because of their convenience, connectivity, personalization and interactivity (Sharples, 2000; Terras, & Ramsay, 2012; Fu, & Hwang, 2018). Mobile collaborative learning is the learning approach that utilizes mobile devices and wireless technology to accomplish specific targets in a group by permitting learning anywhere and anytime (Fu, & Hwang, 2018).

Engaging in social interaction with peers in real world contexts has the potential of facilitating learners' ability to reflect on their previous exposure and views through collaborative learning that results in them developing social experiences (Hwang, Shi, & Chu, 2011; Fu, & Hwang, 2018). Such collaboration promotes the development of higher order thinking abilities that enable students to effectively transfer their knowledge across courses and apply it to unfamiliar situations (Perkins, & Salomon, 1992; Bransford, Donovan, & Pellegrino**,** 2004; Toledo, & Dubas, 2016).

Due to the development in Information and Communication Technology (ICT), there is a paradigm shift in the mode of education which has made it student-centered rather than teacher centered (Al-Samarraie, Teo, & Abbas, 2013; Hwang, Lai, Liang, Chu, & Tsai, 2017). Appropriate wireless technological learning devices and interface, including collaboration and flexible learning content are the fundamental ingredients of students' mobile learning activities (Hwang, Tsai, &

Yang, 2008; Al-Samarraie, Teo, & Abbas, 2013). To effectively adopt the emerging mobile technologies in modifying the conventional technology-enhanced instruction, educators are required to reassess the structure and strategies of learning processes and take students' interests into consideration (Ruchter, Klar, & Geiger, 2010; Kamarainen, Metcalf, Grotzer, Browne, Mazzuca, Tutwiler, et al. 2013; Hwang, Lai, Liang, Chu, & Tsai, 2017).

When online interactivity and collaboration are on a synchronous basis, the learners will be able to relate with each other in real time and this will intensify interaction and strengthen collaborative knowledge construction; and if interactivity and collaboration is asynchronous, more useful time is given that enables learners to ruminate, process and reflect on the content and this is critical in developing higher order thinking skills (Arends, 2004; Wilen, 2004; Brierton, Wilson, Kistler, Flowers, & David, 2016). Furthermore, while synchronous interactivity and collaboration offer learners the platform to examine content in real time and each learner can respond instantly, this possibility enables them to make remarks that can modify their thoughts and perceptions; asynchronous platform enable learners to present a more detailed response (giving room for more social constructivism) as they are not under pressure to respond instantly (Wilen, 2004; Brierton, Wilson, Kistler, Flowers, & David, 2016).

Brierton, Wilson, Kistler, Flowers, & David (2016) stated that mobile collaboration should be an appropriate platform for learners to cooperatively work to develop their higher order thinking abilities, to corroborate Palinscar (1998) who emphasized that there is extensive cognitive processing when an individual explains his thinking to another on the same content. Wireless and personalized devices have enhanced learners' interactivity and collaboration in learning tasks (Toh, So, Seow, Chen, & Looi, 2013) and the provision of appropriate content through mobile devices, can spur students to apply their learnt knowledge to real-world situations, thereby developing their higher order thinking abilities (Boyce, Mishra, Halverson, & Thomas, 2014; Looi, & Wong, 2014). Other studies have examined the development of students' abilities such as collaborative, critical thinking and problem-solving through engagement in mobile learning (Wang, & Wu, 2008; Vogel, Kurti, Milrad, Johansson, & Muller, 2014) and revealed that a robust mobile technology integration in students' learning activities, fosters their higher order thinking.

The adoption of mobile technology in instruction and learning with a well-prepared pedagogical approach, facilitates the development of students' information literacy competency, critical thinking skills, creativity and problem-solving tendencies (Kong, 2014; Lai, & Hwang, 2014; Kim, Lee, & Kim, 2014; Wong, Chai, Aw, & King, 2015). Tsai, Tsai, & Hwang (2012) developed a context-aware ubiquitous learning environment survey (CULES) to ascertain the factors that promote students' acceptance and learning results of a mobile technology-powered learning environment. The study revealed that real-context information, effective guidance and a collaborative environment are connected with the cultivation of students' higher order thinking capabilities.

Critical thinking refers to a creative thought process that enables an individual to solve complex problems (Yeung 2012; Lee, & Lai, 2017). Studies have shown that critical thinking can be facilitated using blended learning, because students can pause the videos to meditate about the instructional content (Hamdan, McKnight, McKnight, & Arfstrom, 2013; Herreid, & Schiller 2013; Lee, & Lai, 2017). The term blended learning has to do with a recent student-centered teaching and learning approach that empowers teachers to reallocate classes and homework time, where students are required to study instructional resources online that may be in the form of videos, images, text or any other format that enables them to understand the subject content before classroom activities (Bergmann, & Sams 2012; Johnson, Adams, Estrada, & Freeman, 2014; Lee, & Lai, 2017). Nederveld, & Berge (2015) stated that in blended learning, teachers are able to utilize classroom time on application and critical thinking tasks instead of teaching lower-level thinking activities and this approach offers teachers the opportunity to identify misconceptions, thereby, reinforcing critical and creative thinking as well as effective communication. Zainuddin, & Halili (2016) emphasized that classroom approach like group discussions in blended learning enables students to spend more time on higher order level learning.

In an environment where learning is student-centered, learning is considered as a knowledge constructing activity where learners obtain, reorganize and use knowledge for analyzing and solving problems (Gonza´lez-Marcos, Alba-Elı´as, Navaridas-Nalda, & Ordieres-Mere, 2016). The advancement and pervasiveness of mobile technology has spurred researchers to emphasize the capability of mobile devices, by empowering learners to connect their learning experiences with real-world contexts and adopting mobile technology to support classroom instruction, is an effective approach for promoting a learner-centered environment (Chang, Chen, & Hsu, 2011). The potential of mobile technology in education offers more room and flexibility for students to become self-directed and engage in collaborative learning activities (Song 2014; Swallow, 2015; Zydney, & Warner 2016).

Many studies have highlighted the positive effects of using mobile instruction to support classroom instruction to develop students' critical thinking abilities for problem solving (Kong, & Song, 2014; Kim, Suh, & Song, 2015; Hwang, Lai, Liang, Chu, & Tsai, 2017). Toh, So, Seow, Chen, & Looi (2013); Boyce, Mishra, Halverson, & Thomas (2014); Kim, Lee, & Kim (2014) maintained that from their various studies the utilization of mobile technology to access extra learning materials, not only enhances students' abilities to apply the knowledge gained to challenges in real-world contexts, but also facilitate the development of their critical thinking abilities.

Bloom's taxonomy and critical thinking

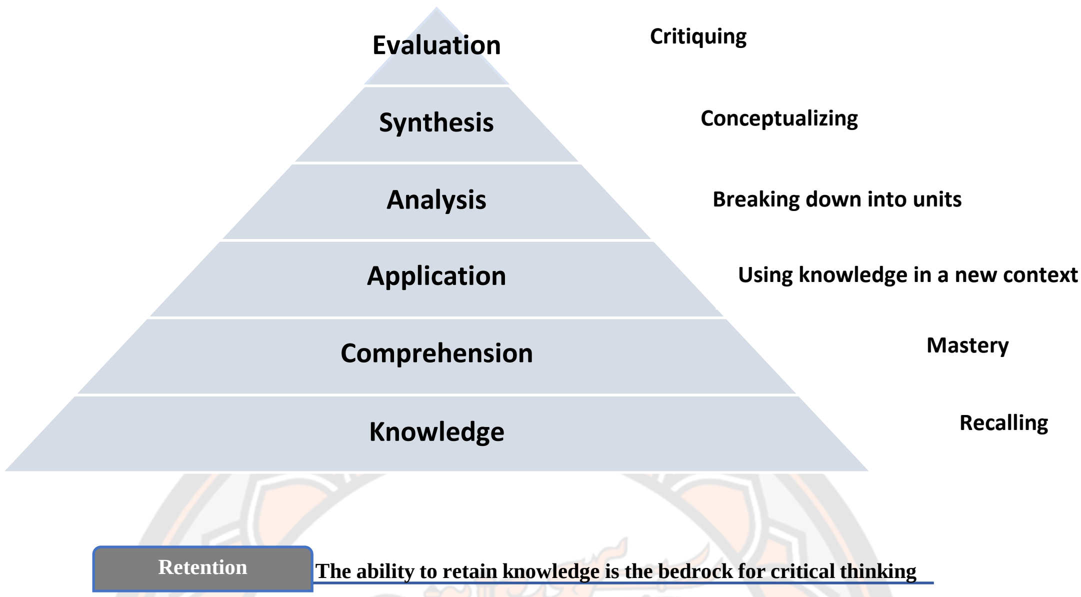

Figure 1 Bloom's taxonomy of cognitive process

Bloom's Taxonomy (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) is a framework that can be applied to distinguish the various levels of cognitive abilities in students (Hamdan, McKnight, McKnight, & Arfstrom, 2013; Fowler, 2014; Lee, & Lai, 2017). It has been used widely in educational research (De Wever, Zhu, & Creed, 2009; Apino, & Retnawati, 2017; Crompton, Burke, & Lin, 2018). In addition, it has been used more recently as a framework in studies that relate to online technology in education (Odhabi, 2007; Hixon, Buckenmeyer, & Zamojski, 2011; Sylvia, 2014; Diacopoulous, 2015; Ekren, & Keskin, 2017). As a result, Bloom's Taxonomy is proposed as a framework for this study to effectively ascertain students' cognitive levels during mobile learning activities.

Cognitive process such as analysis, synthesis and evaluation in Bloom's taxonomy are higher order thinking abilities and knowledge, understanding and application are lower order thinking skills (Fisher, 2010; Apino, & Retnawati, 2017).

Knowledge: This is the easiest to implement through online mobile instruction, because it is easy to provide learners with basic concepts of a course, and with the aid of their mobile devices they can acquire knowledge through self-learning online.

Comprehension: Comprehension refers to understanding the concepts and other associated information relating to comprehending the concept. In applying this to mobile learning, the focus is to make sure the learners have understood the information sent to them via their mobile devices, and this level is the bedrock for learning advanced concepts.

Application: At this level the learners relate with the mobile instruction through feasible or practical exercises in other similar situations. The teacher using the tool must expose the learners to real life scenarios that they are familiar with, to enable them to apply their knowledge, information and techniques.

Analysis: At this cognitive level, learners will begin to develop adequate understanding of the content, they should be able to distinguish, integrate and deconstruct information and concepts relating to the content. An informal online interactive platform, where learners are able to interact with each other can serve as a good approach for developing analytical skills.

Synthesis: This involves the ability to establish relationships among concepts in a course as a result of adequate knowledge. Learners that attain this level of cognitive process can make real productive change and become mentors to others.

Evaluation: At this level learners will be able to exercise their own judgement, make recommendations and offer criticism. This is the final and highest level of Bloom's taxonomy. At this level, learners are able to generate, plan and produce original work from the concepts they have learnt. It is also the level where they demonstrate their knowledge about the online instruction they have received (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, 2001; Pradhan, 2018).

Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, (2001) revised Bloom's taxonomy by changing the titles of the levels from nouns to verbs for a clearer understanding of the cognitive processes in learning. In addition, they replaced *'synthesis'* in Bloom's taxonomy with *'evaluate'* and replaced *'evaluation'* with *'create'* (Apino, & Retnawati, 2017; Crompton, Burke, & Lin, 2018; Pradhan, 2018).

They revised Bloom's Taxonomy in the following order, from lower to higher order thinking skills:

1. remembering, (ability to recall information such as venues and dates of events, places, define concepts, theories and formulas);

2. understanding, (ability to know the meaning of the information, explain it in personalized words and/or give examples);

3. applying, (ability to apply knowledge or skills to different situations, utilize information and knowledge to resolve problems, answer questions, and/or carry out other activities);

4. analyzing, (ability to break down knowledge into fragments or units and demonstrate and express the relationships among them);

5. evaluating, (ability to exercise judgement or examine the value of material and approaches for specific purposes); and

6. creating (ability to arrange together pieces of knowledge and information to build a different project and develop relationships for different contexts) (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, 2001)

Table 1 Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, & Wittrock, 2001 revised classification of Bloom's taxonomy Lower thinking order skills higher thinking order skills

Lower thinking order skills → **higher thinking order skills**

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Recognizing *(identifying)* Recalling *(retrieving)*	Interpreting *(clarifying, paraphrasing, representing, translating)* Exemplifying *(Illustrating instantiating)* Clarifying (categorizing, subsuming) Summarizing *(abstracting, generalizing)* Inferring *(concluding, extrapolating, interpolating, Predicting)* Comparing *(contrasting, mapping, matching)* Explaining *(constructing models)*	Executing *(carrying out)* Implementing *(using)*	differentiating, *(discriminating, focusing, selecting, distinguishing*) Organizing *(finding, coherence, integrating, outlining, parsing, structuring*) Attributing *(deconstructing)*	Checking *(coordinating, detecting, monitoring,* testing) Critiquing *(judging)*	Generating *(hypothesi-zing)* Planning *(designing)* Producing *(construc-ting)*

Models for introducing innovation into teaching practices

Researchers have continued to develop models to facilitate teachers' adoption of technology in their professional activities. The following are some of such models.

Offering an instructional technology course

Schmidt (1998) emphasized the need to offer instructional training for teachers to prepare them for effective integration of technology in their profession. This approach has been criticized because these classes usually focused on teaching about using technology instead of proper demonstration of the practical ways of using it in classroom activities (Parker, 1997). In addition, findings from the International Society for Technology in Education (ISTE), a survey commissioned by the Milken Exchange Family Foundation (1999) revealed that exposing teachers to a single instructional technology course is not adequate enough to equip them with the necessary knowledge and skills that will enable them to utilize technology in the classroom. In preparing teachers to use technology in their teaching activities, they need to understand in practical terms what technology can do, and how students can use it, including the processes of using it in both teaching and learning (Brownell, 1997).

Effective technology integration in teachers' activities, requires a comprehensive well-thought-out plan with a sequence of activities and experiences that will lead to the understanding and application of technology in the teaching and learning processes (ISTE, 2000). Successful integration of technology in education requires its infusion into the teaching and learning activities.

Kortecamp and Croninger model

Kortecamp, & Croninger (1996) proposed a model that was effectively implemented in a teacher education program at the New England University (Mojgan, Kamariah, Wong, Bahaman, & Foo, 2009). This model involves five interconnected stages which are familiarization with hardware and software, partnering with mentors, developing personal projects, becoming mentors and keeping current.

After teachers have familiarized themselves with both the hardware and software, they are exposed to detailed professional training that will equip them with the knowledge and skills required to use the technology. In the second phase, partnering with mentors, teachers are encouraged to collaborate with other faculty members who have experience using technology. This is to expose them to methods of using it in their teaching activities and to offer them continuous support since they are less familiar with the technology. During the third stage, teachers are expected to design projects that assist their students to utilize the technology in meaningful ways. For example, teachers initiate projects to model technology use in their teaching activities, and place students in technology-driven field practices. In the final stage, becoming a mentor and maintaining the trend, they become facilitators and guide their students in using the technology in a correct manner (Mojgan, Kamariah, Wong, Bahaman, & Foo 2009).

Systematic design model

Gagne, Briggs, & Wager (1992) designed this model and Mckenzie, Kirby, & Mims, (1996) conceptualized it to develop a technology training course for staff development at West Georgia College, to place the teachers on the front line of activities in northwest Georgia.

This model identifies gaps in the knowledge, skills and abilities possessed by the teachers through needs assessment tools; formulate a technology plan and develop training activities to address the specific areas of weakness identified.

Technology planning experts identify the school's current state of technology use and the teachers' areas of weakness through needs assessment to enable them determine necessary areas for professional development in accordance with the target technology. This enables them to obtain information to establish training goals for technology utilization in both the teaching and learning processes.

This is followed by the teachers being exposed to staff development sessions where an evaluation is carried out by both the participants and designers to review each meeting, and future ones are revised and planned in accordance with the training results obtained.

The training sessions are taught by a number of technology specialists from both within and outside the institution. Each session consists of two sub-sessions with the first focusing on instruction and information about the target technology, and the other is hands-on practice for the participants.

This illustrates a better teacher's development training that promotes their use of technology in the classroom, because it is based on a plan that is designed to address their weaknesses in its utilization. The plan provides a road-map for the required areas of development as it identifies what needs to be taught and how to do it, as well as which technology should be explored in such training.

In addition, the Gagne, Briggs, & Wager, (1992) systematic design model is evaluation driven in all the phases, which makes it possible to identify areas of reinforcement during the training process. Successful professional development utilizes evaluation to ensure that at every phase, the participants' needs are accomplished by providing them with new learning experiences. Guskey (1998, & 2003) stressed that there are three stages of evaluation -pre-formative evaluation, formative evaluation and summative evaluation. The pre-formative evaluation identifies the teachers' needs in the planning phase, at this stage, the desired goals are identified and established with strategies for gathering data in order to achieve them (Guskey, 1998). The formative evaluation is carried out during the training exercise, and this provides feedback on how well the teachers are progressing and also helps to review their professional development in making it more effective and valuable to them. The summative evaluation that is carried out at the final stage offers the teachers the opportunity to assess the general worth of the training and provides the decision makers with information for future plans (Guskey, 1998, & 2003). The successful application of this model can be effective in assisting teachers to adopt technology in their classroom activities due to the procedures associated with it.

Three-phase model

Efaw (2005) constructed a three-phase model that consisted of learning, practice, feedback, and continued development. He effectively implemented this model to introduce new faculty members to the use of technology in the classroom in the United States military academy at West Point.

Learning phase: This first phase involves training on available technology, classroom modeling of the technology, learning how to encourage students' participation and initial feedback from experienced instructors. The first step is to develop the faculty's comfort level with the technology, because the negative attitude of some teachers is a major barrier towards the adoption of technology in the classroom (Efaw, 2005; Lawton, & Gerschner, 1982; Kluever, Lam, Hoffman, Green, & Swearinges, 1994; Almusalam, 2001; Mojgan, Kamariah, Wong, Bahaman, & Foo, 2009). Faculties develop a more positive attitude toward technology after receiving introductory training on their uses and capabilities (Abbot, & Farris, 2000; Bullock, 2004; Vrasidas, 2015; Li, Yamaguchi, & Takada, 2018). It is critical to ensure that teachers are comfortable with the technology before attempting to adopt it into their teaching plans. The major factor of the success of this model in the United States military academy was that the development programme was faculty-based, and the core members who already possessed the skills and knowledge on how to use the technology in the classroom were involved (Efaw, 2005).

During the classroom modeling of technology, the teachers who already possessed the skills and knowledge of the technology usage in the classroom serve as resource persons to teach those with little or no skills and knowledge, including some technology experienced teachers. They do the modeling of technology in the same way they would do during normal classes with students. Different experienced teachers model different classes on methods to adopt available technology. This offers the participants the opportunity to observe different teaching styles and also serves as innovative approaches to adopting and utilizing the technology. They model typical challenges and questions that are common with the use of the technology in the classroom, and provide the participants with experience at the same time, while the participants play the role of learners. This role compels them to adequately engage with technology so as to complete the assignments and classroom activities. Willis, & Raines (2001) emphasized that observing other teachers as they use technology in fascinating ways in the classroom to complete assignments while actively participating in course activities, is an effective approach in adopting this model in schools. Seeing new techniques as they play the role of a learner, the participants are able to understand new instructional methods and try their effectiveness personally.

Feedback phase: At the end of each training session by an experienced teacher (resource person), the faculty member modeling the session explains the instructional strategy adopted and the problems encountered. The participants and experienced teachers provide feedback on what they observed as the strengths and weaknesses of the session, and both groups benefit from this discussion and feedback. Teachers need honest feedback on the strength and weaknesses when developing training that involves technology (Means, & Olson, 1995).

Practice phase: This second phase involves making provision in the training schedules for the participants to design and practice what they have been taught, mentoring by experienced faculty members, video recordings of the practice sessions and providing feedback. The mentoring is not on superior and subordinate basis but advisory, the mentors offer the participants additional resources, which includes talking and brainstorming with them. The mentors also assist the participants with lesson preparations, providing vision and feedback. The video recorded practice sessions may be viewed by the participants alone or with their mentors reflecting on their past experiences or upcoming ones. At the end of a practice session, the participants review the sessions explaining the teaching strategy, the strengths and weaknesses.

Continued development: At the end of the entire training, several avenues and programmes are put in place to ensure continued development towards effective technology integration in the classroom. This is in line with Cradler, & Cradler's (1995) finding that though one-time training helps teachers to integrate technology, but in reality, it demands a long-term programme for actual effectiveness because continued development, training, and mentorship are necessary. Clark, & Solomon (2001) noted that transfer of training experience is more likely to be successful when there is prolonged and continuous initiatives to ensure comprehensive application of newly developed skills and knowledge. Continuous professional development is linked with the school's curriculum goals, designed with built-in evaluation process which is sustained by adequate financial provision and staff support, if teachers are to adopt technology appropriately to promote learning in the classroom (Mojgan, Kamariah, Wong, Bahaman, & Foo, 2009). With the persistent evolution of technology, both those that provide professional development service and the teachers need training development in order to be proficient in the use of evolving technologies to enhance teaching and learning.

A Brief Background of the Nigerian higher education system

Nigeria currently has a population of above **200** million, representing 2.6% of the world population as of May 13, 2019 (United Nations Population Fund, 2019), with a land area of 910,770 Km2 (351,650 sq. miles), population density of 221 per Km^2 (571 people per mi^2) and about 274 ethnic groups. The provision of affordable and quality education for its citizenry has been challenging.

The provision of higher education was solely the responsibility of the government for many decades. The government resolve to take charge of higher education could only be guaranteed while the challenges of equity, access and imbalance continued unresolved (Nwadiani, 1997; Adeyemi, 2001; Okobiah, 2002; Olawore, & Ajayi, 2016).

The state and federal governments provided the higher education, but their failure to cope with admission upsurge became clearer from the 1990s. In 1990 over 250,000 candidates applied for admission, while less than 50,000 (20%) of them were admitted; and in 1992, almost 300,000 applied for admission and approximately 50,000 (17%) secured admission, while in 1994 out of the 400,000 that applied for admission, less than 50,000 (13%) were offered admission into different universities in Nigeria (Moja, 2000; Obasi, & Eboh, 2001; Iruonagbe, Imhonopi, & Egharevba, 2015).

The Nigerian Government, that had denied private ownership of universities, acknowledge the obvious reality on 10th May, 1999 when it granted certificates of registration to the first three private universities in the country. They were Babcock university, Ilisan-Remo, Ogun-State; Igbinedion university, Okada-Benin, Edo State; and Madonna university, Okija, Anambra State (Ajadi, 2010; Olawore, & Ajayi, 2016). Since this development there has been a tremendous increase in the number of private universities in Nigeria. Presently, there are 79 private universities which are already accredited and whose academic activities have begun (National University Commission, 2019). However, these private universities are mostly commercialized and not without challenges, which is due to them operating with limited numbers and poor quality of academic and non-academic staff in order to minimize costs, poor educational quality and facilities, exorbitant tuition fees (Fadipe, 1990; Robinson, & Nwaham, 2007; Abiodun-Oyebanji, 2011; Olawore, & Ajayi, 2016).

The first initiative that introduced a distance education component as part of higher education, was in 1974 when the correspondence and open studies unit, now referred to as distance learning institute, was created in the University of Lagos (Ifinedo, 2013). The University of Ibadan started its distance learning programme in 1979. An Act by the National Assembly created the National Open University of Nigeria (NOUN) in 1983 as the first higher education Open University in the country, to address the demands of the increasing populace for higher education.

The institution was closed down and the Act suspended owing to the instability in the country's government, but in 2002 it was reactivated due to the reality that led to its initial introduction became obvious. However, poor financial support has been the major challenge of the National Open University of Nigeria (NOUN) to build the necessary infrastructure to adequately provide its students with learning materials online (Oye, Salleh, & Iahad, 2011).

Currently, Nigeria has 418 tertiary institutions made up of 169 universities, 124 polytechnics (National Board for Technical Education, 2019), 89 colleges of education (National Commission for Colleges of Education, 2019) and 36 colleges of agriculture (National Board for Technical Education, 2018).

Business education

Business education is an academic discipline that is only offered in the universities and colleges of education in Nigeria, with options in office technology and management, and accounting. The two options are to enable students to gain the appropriate skills necessary for them to participate adequately as an employee or self-employed (Bolarinwa, & Ajisafe, 2018). It is also designed to prepare competent teachers who teach business related subjects in secondary schools and other educational institutions (Federal Republic of Nigeria, 2002, 2009 and 2012). Thus, Jimoh-Kadiri, & Bupo (2011) defined business education as the transfer of pedagogical and business competencies required for teaching business knowledge, concepts, skills and attitudes. Onyesom, & Umoeshiet (2013) described it as the aspect of educational training that empowers an individual with adequate knowledge, concepts, understanding, skills and attitudes in business activities for usage in careers as an administrator, teacher or manager in the business world. Similarly, Odunaike, & Amoda (2008); Okoli (2010); Amesi (2018) noted that business education is mainly to make learners competent, skillful and dynamic business teachers, office administrators and business individuals that will favourably compete in the world of work. Amoor, & Udoh (2008) stated that it is the focus to equip learners with knowledge and skills that will enable them to effectively train others, manipulate office technologies and information systems. Business education strictly emphasizes work ethics and the preparation of individuals for skilled jobs including critical thinking and problem-solving abilities (Snyder, & Snyder, 2008).

Idialu (2007) claimed that it is an aspect of vocational education that is focused on equipping individuals to be effectively productive in teaching, other employments and self-employment. It is an expression of vocational knowledge and skills required for employment and advancement in a wide range of business careers (Atakpa, 2011). Business education is a part of the total education that provides knowledge, skills, understanding and attitudes required by an individual to participate adequately in the world of business as a producer or consumer of the goods and services which business provides (Adukwu, 2008). It is an educational training programme that equips individuals with proper knowledge, skills, capabilities and competences that enables them to be self-reliant and contribute to sustainable economic growth, and poverty eradication in their society (Oduh, 2010).

Objectives of business education

According to Njoku (2006); Aliyu (2006); Onyesom, & Umoeshiet (2013) the objectives of business education include the following:

1. To provide the needed background for teaching business subjects
2. To develop a good understanding of the general nature of business
3. To equip learners with effective skills, knowledge and value to perform specific functions enabling them to become self-reliant
4. To help students appreciate the world around them and to contribute adequately to the socio-economic development of their society
5. To equip students with the necessary knowledge and skills that will assist them in making informed decisions in all spheres of life
6. To provide training in specialized phases of business activity
7. To lay a cultural and ethical foundation for the development of the fore-going objectives.

Nigerian Policy for Information Technology and Education

Information Communication Technology policy as stated by Hafkin (2002; Yusuf, 2005) should be vertical, infrastructural and horizontal in order to be comprehensive enough to address the desired changes. According to them ICT policy is vertical when it covers the various sectoral needs such as health, education, agriculture, commerce, etc. The idea of ICT policy to be infrastructural is related to telecommunication which is the foundation for its effectiveness. The horizontal aspect addresses the effect on society with regards to privacy, security, pricing, and freedom of information.

These three components are not sufficiently covered in the Nigerian IT policy as far as education is concerned (Yusuf, 2005). Though the policy stresses the importance of ICT in schools, it does not offer specific provisions for education, as issues that relates to teaching and learning are embedded as subheads under the sectoral provision for human resources development in the policy. The question now is ‘how did this policy address the education sector in relation to ICT? The mission statement of the policy emphasized the need to use ICT. Among the 31 general objectives of the Nigerian policy for IT in education, objective 3 subsections xv, xvi and xxiv highlighted that IT must be applied to: (xv) empower the youth with IT skills and prepare them for global competitiveness; (xvi) integrate IT into the mainstream of education and training; and xxiv) establish new multifaceted IT institutions to serve as centres of excellence to ensure the country’s competitiveness in international markets (Federal Republic of Nigeria, 2001).

One of the strategies to accomplish these objectives was stated thus “Restructuring the education system at all levels to respond effectively to the challenges and imagined impact of the information age, and in particular the allocation of a special IT development fund to education at all levels” (Federal Republic of Nigeria, 2001. p. vi). Under the sectoral provisions for human resources development, the first four objectives relate to education, which are: a) to develop a pool of IT engineers, scientists, technicians, and software developers; b) to increase the availability of trained personnel; c) to provide attractive career opportunities; and d) to develop requisite skills in various aspects of IT.

To achieve the objectives of human resources development, the following strategies were formulated: (i) making the use of ICT mandatory for all levels of educational institutions; (ii) development of ICT curricular for primary, secondary, and tertiary institutions; (iii) use of ICT in distance learning; (iv) ICT companies investment in education; (v) provision of study grants and scholarships for ICT; (vi) training the trainer scheme for National Youth Service Corp members (vii) ICT capacity development at zonal, state, and local levels; (vii) growth of the private and public sectors dedicated to ICT in the primary, secondary, and tertiary educational institutions; and (ix) working with international and domestic initiatives to enable the transfer of ICT knowledge.

Regardless of these objectives and strategies relating to ICT in education, the policy is not detailed enough to adequately address the needs of the Nigerian educational system in relation to ICT (Yusuf, 2005; Agbetuyi, & Oluwatayo, 2012). The claimed that beside the supply and assemblage of computers in the Federal Government Unity schools only, the project was not actually implemented. Computers are not part of classroom technology in over 90% of the public educational institutions in Nigeria (Aduwa-Ogiegbaen, & Iyamu, 2005; Adomi, & Kpangban, 2010; Oye, Salleh, & Iahad, 2011).

From observation, one can conveniently say that ICT is not in the Nigerian education system, because those that study academic courses such as computer science or computer engineering are rarely exposed to these facilities for in-depth training. Bolarinwa, & Ajisafe (2018) also observed that the instruction provided at some institutions of higher education in Nigeria does not attain the expected quality because resources required for effective and efficient delivery were either in short-supply or supplied but not suitable and/or in some cases, totally unavailable. Students spend less instructional time during school hours, because there are not enough teachers and other resources to fully engage them in their learning activities (Odden, Archibald, & Tychsen, 2009; Bolarinwa, & Ajisafe, 2018).

Challenges of higher education in Nigeria

Many challenges are facing higher education in Nigeria, the following includes some of them:

Uncertain job opportunities for higher education graduates

A significant number of graduates of higher education in Nigeria find it extremely difficult to secure jobs, this is because of the mismatch between the training received in schools and the knowledge/skills expected by employers (Uddin, & Uddin, 2013; Obiete, Nwazor, & Vin-Mbah, 2015). Echebiri (2005) and O'Nwachukwu, (2017) posited that the causes of unemployment in Nigeria are the same as those of other developing countries, emphasizing that the standard of education has a significant relationship with it. Longe (2017) stated that the quality of graduates and the unsuitable curricular in the country's higher educational sub-system that are not in tune with the modern needs of the industry, are responsible for the high rate of unemployment.

Industrial unrest

Academic activities in Nigerian institutions of higher learning are fraught with strikes, which usually results in the shutdown of the country's universities for weeks or even months. The most recent was the 2020 universities strike action that started in March and lasted until it was suspended in December 2020. These incessant strikes distort the academic calendar of higher education, and most of the causes are the inability of the government to adequately fund these institutions to carry out their functions properly.

Table 2 Nigerian universities strikes from 2010 -2020

Year	Duration
2010	5 months and 1 week
2011	3 months, lasted till 2012
2013	5 months and 3 weeks
2016	1 week
2017	1 month and 5 days
2018	3 months and 4 days, lasted till 2019
2020	Over 9 months

Besides the academic activities, these industrial unrests also have negative effects on the socio-economic lives of the stakeholders, universities' ratings, and ongoing research activities (Adepoju, & Okotoni, 2018).

Poor standard

The standard of higher education in Nigeria has been on the decline for many years and is negatively affecting the employability of its outputs which has led to a high level of unemployment in the country. Uddin, & Uddin (2013) asserted that an average Nigerian graduate lacks the skills required for gainful employment in a modern world of work due to the falling standards of the educational system. In other studies, Duze (2011) carried out a study to find out if educational standards were actually on a decline in Nigeria and at what level it was worse. It was found that standards have declined at all levels throughout the country, with the higher institutions of learning being the worst, followed by the secondary and primary levels.

Low utilization of technology

Lack of ICT competency and facilities as well as poor power supply have made the integration of technology into higher education almost non-existence. Poor computer literacy and the cost of internet connectivity are critical factors affecting the integration of technology in Nigerian higher education (Oye, Salleh, & Iahad, 2011; Quadri, & Abiodun, 2017). Ajadi, Salawu, & Adeoye (2008) claimed that poor power supply has been the bane of technological advancement in Nigeria, and that since most villages are not linked to the national grid, the students that live in such communities find it difficult to access the benefits offers by ICT.

Inadequate academic staff

The desire to expand enrolment and improve on quality is usually frustrated by the inadequate number of qualified academic staff available. Both the state and federal governments have not been stable in their annual budgetary allocation for education. For example, the federal government allocated 10.78% of its total budget to education in 2015, 7.92% in 2016; 7.40% in 2017; 7.04% in 2018. This practice grossly falls short of the 26% of the annual budget recommended by UNESCO for education. The poor funding manifest in dilapidated educational facilities, inability to hire more academic staff, irregular payment of staff's salaries, absence or rare in-service training for existing staff, etc.

The proliferation of private universities

The establishment of private universities started in Nigeria on May 10th 1999, when it granted certificates of registration to the first three private universities, Babcock University, Ilisan-Remo, Ogun-State; Igbinedion University, Okada-Benin, Edo State; and Madonna University, Okija, Anambra State (Olawore, & Ajayi, 2016). Since this development, there has been a tremendous increase in the growth of private universities in Nigeria. Presently, there are 79 of them which are already accredited and whose academic activities have begun (National University Commission, 2019). However, these private universities are not without challenges. This is due to fact that they are operating with a limited number and poor quality of academic and non-academic staff in order to minimize costs, poor educational facilities, exorbitant tuition fees, and a poor quality of education because of commercialization (Fadipe, 1990; Robinson, & Nwaham, 2007; Abiodun-Oyebanji, 2011; Olawore, & Ajayi, 2016).

Conclusion

From the review of the related literature, there is no doubt that the present teacher-centred modes of teaching in the Nigerian higher education system can no longer guarantee adequate preparation of the students for their future roles in the 21st-century. These types of methods only focus on equipping students with knowledge of concepts that do not sufficiently avail them with the required abilities to solve real-life problems in modern society. There is the need for the teachers to be sufficiently equipped with teaching approaches that will enable them to shift from their present passive mode of teaching to student-centred learning methods which will actively engage their students in their learning processes.

The integration of mobile technology into the country's higher education system will minimize the disturbing rising rate of unemployment among the graduates. This will awaken the consciousness of both the teachers and students to understand that the mobile devices which are prevalent among them can also be utilized as teaching and learning tools. The integration of these devices into the education system as educational tools will facilitate their ability to have greater access to vast and richer educational content that will better equip them for their various roles in teaching and learning processes. The deployment of mobile technology into higher education promotes the acquisition of digital and lifelong learning skills.

One of the effective methods to integrate this technology into the higher education system is through inquiry-based mobile-blended learning. This is because the approach allows the teachers to leverage the stunning potential of the technology, to equip their learners with the information and terms associated with a course before class starts, thereby providing them with adequate time to effectively engage their students with real-life collaborative inquiry-based learning tasks during a face-to-face meeting, that facilitate the enhancement of their critical thinking abilities.

Conceptual framework

Mobile tool

Teacher send instructional material and questions to students (Ozdamli, & Cavus, 2011 Bergmann & Sam, 2012; Hayati, Jalilifar & Marshadi, 2013).
Students interact with teacher for clarification of concept and with each other to share and generate ideas to create personalized knowledge (Koper, 2014; Davies, 2014; de Witt & Gloerfeld, 2018).

Blended learning

The aim of sending students learning materials to study before class time is to ensure more time during class meeting for collaborative inquiry-based learning that fosters students' critical thinking that results in their abilities to analyze, evaluate and reconceptualize information to solve au **critical thinking abilities** *thentic problems (Baker, 2000; Strayer, 2007; Bergmann & Sam, 2012; Hamdan, McKnight, McKnight, & Arfstrom, 2013; Herreid & Schiller 2013; Couch, 2014;*

Inquiry-based learning

Inquiry-based learning integrates and exposes students to real-world contexts that trigger their critical thinking process to solve real life problems (Hwang, Kuo, Yin & Chuang, 2010; Shih, Chu, Hwang & Kinshuk, 2011; Hwang, Wu, Zhuang & Huang, 2013; O'Connor, Jeanes & Alfrey, 2014).
Teacher as a guide/facilitator in scaffolding learning (Weinberger, Stegmann, Fischer, & Mandl, 2006; Sharma & Hannafin, 2007; Neeru, 2009; Livingstone, 2012; Duran & Dokme, 2016; Zoha & Cohen, 2016).

Collaboration

Students engage in self-directed and collaborative learning activities as they find feasible solutions to problems (Arends, 2004; Song 2014; Swallow, 2015; Zydney & Warner 2016).
Students engage in collaborative inquiry-based learning (in groups) through reflection, generating and sharing ideas to solve real-life problems (Cavus & Uzunboylu, 2009; Rabah, 2015; Fu & Hwang, 2018).

Mobile instructional model to enhance students' critical thinking abilities

Critical thinking abilities

1. ability to analyze information
2. ability to evaluate information
3. ability to infer, that is, ability to relate previous knowledge to present context in order to solve a problem (Laru, Järvelä, & Clariana, 2012; Duran & Dokme,2016; Apino & Retnawati, 2017)

Figure 2 Conceptual framework

Major and sub-elements of the conceptual framework

The follow are the major and sub-elements of the above conceptual framework

Students

1. Engage in self-directed learning
2. Study online resources
3. Interact with teacher and peers synchronously and asynchronously
4. Engage in collaborative learning with peers synchronously and asynchronously
5. Search for information on topics online

Technology

1. Must be mobile and able to access the internet
2. Should be portable and always remain with the teachers and the students
3. Must support collaboration among users
4. Should be able to deliver learning contents

Teacher

1. Design instructional contents for mobile delivery
2. Deliver instructional materials to students using mobile technology
3. Provide online scaffolding of students' knowledge with questions
4. Plays the role of e-moderator, facilitator and guide
5. Always be available via instant messaging, telephone, and email
6. Provide content clarification online when necessary
7. Assess learners

Content

1. Must be related to the learning objective
2. Must be related to the learners' needs
3. Available to students both online and offline
4. Available synchronously and asynchronously
5. Should be short and in appropriate formats (audio, video, text, graphics)

Institution

1. Provide ICT facilities and services such as Wi-Fi in schools for teachers and students to access the internet.

2. Provide regular training for teachers on how to use ICT to enhance teaching and learning

3. Provide academic support by helping learners to develop time management skills

4. Provide technical support (improving knowledge of the tool and proficient usage) for both the teachers and the students

Characteristics of the mobile tool

The mobile tools must possess the following attributes:

1. Must be portable and always with the learners (Ozdamli, & Cavus, 2011; Kljunić, & Vukovac, 2015)

2. Must be connected to the internet for unrestricted information accessibility (Ozdamli, & Cavus, 2011; Mehdipour, & Zerehkafi, 2013; Jantakoon, & Piriyasurawong, 2018)

3. Must be able to deliver instructional materials to students anywhere anytime (Du, Fu, & Wang, 2014; Obari, & Lambacher, 2015; Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018)

4. Must facilitate students' exchange of ideas (social media) (Barhoumi, 2015; So, 2016; Al-Rahmi, & Zeki, 2017; Peter, Adelaiye, & Bijik, 2018)

Mobile activities (Before meeting in class)

1. Designing and delivering mobile instructional materials in an appropriate format (video, text, image or a combination of formats) to students before class (Bergmann, & Sams, 2012; Abeysekera, & Dawson, 2015; Lo, & Hew, 2017)

2. Students study mobile learning material at home/dormitory, classroom and even while on the move (Mehdipour, & Zerehkafi, 2013; Kljunić, & Vukovac, 2015; Hwang, Lai, & Wang, 2015)

3. Students can communicate with teachers anytime anywhere for clarification on confusing concepts (Ozdamli, & Cavus, 2011; Koper, 2014; de Witt, & Gloerfeld, 2018)

4. Students exchange ideas on the same content through interaction – social constructivism (Wilen, 2004; Arends, 2014; Brierton, Wilson, Kistler, Flowers, & David, 2016)

5. Students search for related information on concepts online, and write down relevent questions that may arise which they present to their teachers either via mobile devices or during class (Francl, 2014; Gilboy, Heinerichs, & Pazzaglia, 2015)

6. Teachers send personalized quizzes to their students, which are returned after being completed for assessment and feedback via mobile technology (Sharples, Taylor, & Vavoula, 2005; Behera, 2011; Bishop, & Verleger, 2013; Szpunar, Jing, & Schacter, 2014; Hew, Huang, Chu, & Chiu, 2016; So, 2016).

Development of critical thinking activities (During class)

1. Teachers recap the mobile instructional material to refresh the students' memory and answer any questions they may have (Grypp, & Luebeck, 2015; Chao, Chen, & Chuang, 2015; Lai, & Hwang, 2016).

2. Identifying learning objectives (Savery, & Duffy, 2001; Hämäläinen, & Vähäsantanen 2011; Kaendler, Wiedmann, Rommel, & Spada, 2015)

3. Generating ill-structured problem-negotiating with the learners to develop an authentic problem in line with the learning objective for which they can take ownership (Jonassen, 2000; Savery, 2006; Jonassen, & Hung, 2008)

4. Allocating students to small heterogenous learning groups (Johnson, Johnson, & Smith, 2014; Retnowati, Ayres, & Sweller, 2018)

5. Assigning different roles to groups or group members (Dillenbourg, & Tchounikine 2007; Kaendler, Wiedmann, Rommel, & Spada, 2015)

6. Ensuring individual accountability and positive interdependence (Matsul, Kakuyama, & Onglatco, 1987; Kaendler, Wiedmann, Rommel, & Spada, 2015)

7. Ensuring elaborate students' discussions (O'Donnell, 2006; Kobbe, Weinberger, & Dillenbourg, 2007; Webb, 2009)

8. Facilitating students' learning without providing information by asking questions which probe learners' knowledge deeply (Barrows, 1992; Bannert 2003; Jantakoon, & Piriyasurawong, 2018).

Collaboration

In an environment where education is student-centered, learning is considered as knowledge constructing activities where learners collaboratively obtain, reorganize and use the information acquired for analyzing and problem solving (Gonza´lez-Marcos, Alba-Elı´as, Navaridas-Nalda, & Ordieres-Mere, 2016).

Collaborative learning refers to the instructional method that offers learners the opportunity to learn as a team with positive interdependence, group accountability and interactions as well as assist others to accomplish specific targets (Johnson, & Johnson, 1975; Slavin, 2014; Fu, & Hwang, 2018). The constructivist theory emphasized that students are required to be exposed to learning experiences that inspire and empower them to construct their own knowledge and promote their thinking skills (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Since the shift from traditional approaches of teaching and learning, most educational stakeholders believe that learners are not just holders but also builders of knowledge (Abosalem, 2016; Mattar, 2018).

The effectiveness of interactivity and collaboration in building and developing critical thinking that leads students to solve problems, is well documented in various studies (Chuang, Chiang, Yang, & Tsai, 2012; Lan, Tsai, Yang, & Hung, 2012; Hwang, Hung, Chen, & Liu, 2014; Yang, Gamble, Hung, & Lin, 2014; Chen, & Chiu, 2016). A collaborative learning environment is an effective strategy that enables students to interact by exchanging views and ideas in order to effectively accomplish their objectives (Morrison, Morrison, & Lowther, 2009; Osman, Duffy, Chang, & Lee, 2011; Hwang, Lai, Liang, Chu, & Tsai, 2017). Collaborative inquiry-based learning facilitates students' thinking skills and their discovery of new knowledge (Gurses, Acikyildiz, Dogar, & Sozbilir, 2007; Kumar, & Natarajan, 2007).

Learners need interaction and reflection on what they were previously exposed to, and what they are currently experiencing, which happens in both external (social) and internal (reflective) contexts in order to gain new knowledge (Brierton, Wilson, Kistler, Flowers, & David, 2016). Piaget believed that reflection leads to higher order knowledge by permitting the resolution of elements of lower level knowledge (Bruner, 1996).

Engaging in social interactions with peers in real world contexts has the potential of facilitating learners' ability to reflect on previous exposure, views and collaborative learning environments, are critical in developing their social experiences (Hwang, Shi, & Chu, 2011; Fu, & Hwang, 2018). Such social interactions promote the development of students' critical thinking abilities that enables them to effectively transfer their knowledge across courses and apply it to unfamiliar situations (Perkins, & Salomon, 1992; Bransford, Donovan, & Pellegrino, 2004; Toledo, & Dubas, 2016).

Interactive and collaborative environments empower learners to exercise their minds to find solutions to problems and develop critical thinking tendencies, as they respond to their peer's questions in more complex and confident ways (Davis, 1993; Hunkins, 1995; Arends, 2004).

CHAPTER III

RESEARCH METHODOLOGY

The Study Plan

This study is mixed-methods research design because the methodology used involved the collection, analysis, synthesis and integration of both quantitative and qualitative research methods to gain a comprehensive understanding and to achieve the objectives of the study. The study was divided into four phases according to the objectives. The first phase was focused on the investigation of the factors, components and processes associated with the development of students' critical thinking abilities, with mobile-blended and inquiry-based learning approach. Upon the identification of the factors, components and processes, an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria was constructed at the second phase of the study.

The third phase was the validation and tryout of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria, while the fourth and final phase is the proposition of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students to institutions of higher learning in Nigeria that offer business education at undergraduate level for implementation.

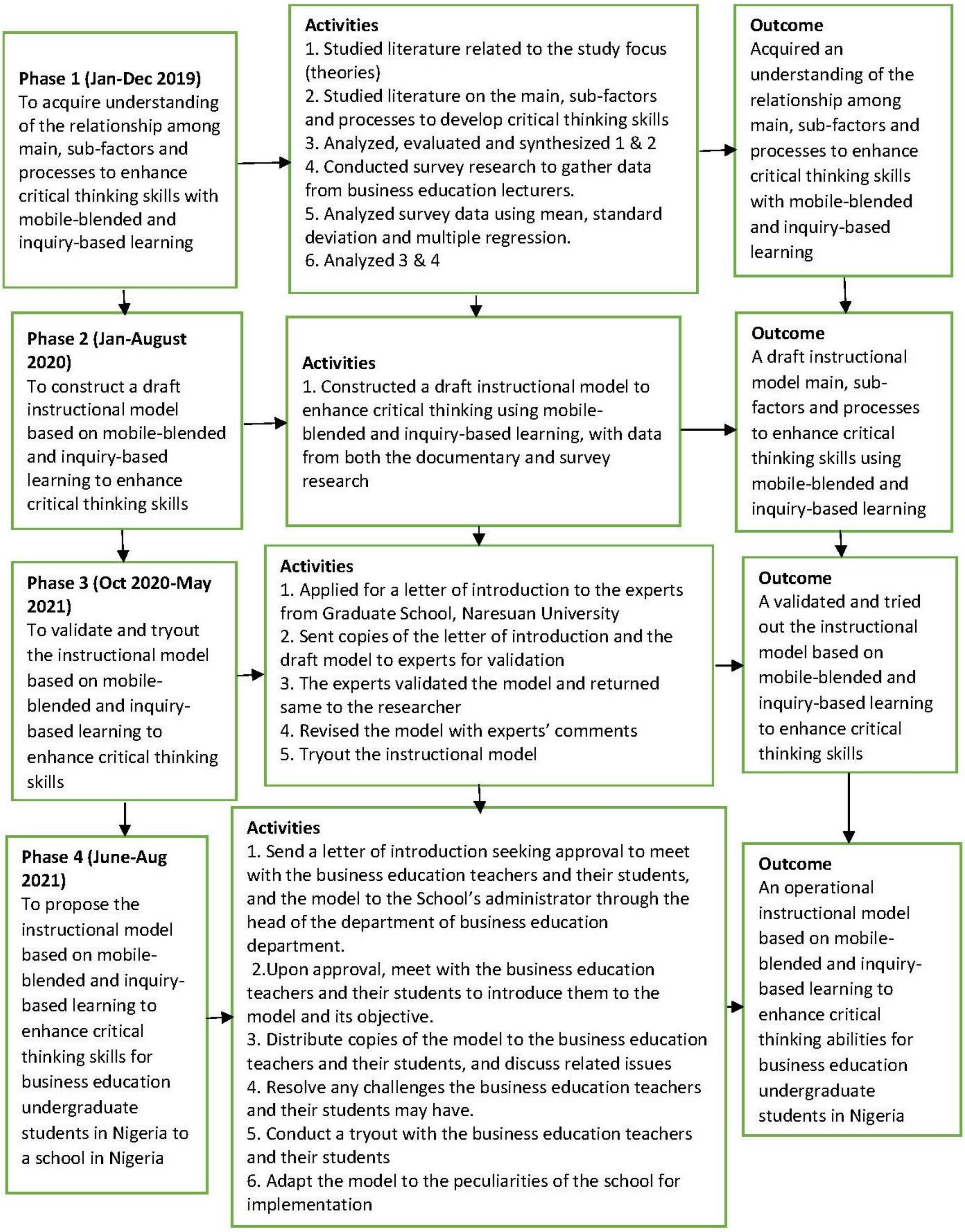

Figure 3 Flowchart of research objectives, activities and outcomes

Phase One: **Acquisition of the understanding of the relationship among the main, sub-factors and processes to enhance critical thinking skills with mobile-blended and inquiry-based learning.**

The methodology in this phase was be based on:

1. **Documentary research**

The researcher engaged in documentary research to study, analyze and synthesize literature related to the focus of the study, with a view to identifying the factors and processes that enhance the development of critical thinking abilities, using mobile-blended and Inquiry-based learning.

2. Survey design for primary data

In addition to the documentary research, the researcher surveyed primary data from teachers who teach business education undergraduate students in Nigeria, to identify and acquire better understanding of the factors and processes that promote critical thinking skills with mobile-blended and inquiry-based learning.

Population and sample

The population of this phase of the study comprised of all the lecturers, who teach business education undergraduate students, in the universities and colleges of education in Nigeria. However, since it was impossible to study the total population, the researcher settled for a significant sample of them for the purpose of achieving the objective of this phase of the study. Black, & Champion (1976) referred to a sample as a portion of the total population that fully represents its true characteristics.

In determining proper and adequate sample size for study, Roscoe (1975); Sekaran (2003) stated that sample sizes larger than 30 and less than 500 are proper and adequate for most researches. Consequently, the researcher randomly selected 120 lecturers from Edo, Delta and Kano states who taught business undergraduate students, both in universities and colleges of education in Nigeria. These respondents were randomly selected from a cross section of different years of appointment, academic qualifications, age group and gender.

Research instrument

In this phase, copies of a paper questionnaire was employed as the main instrument for data collection from the respondents.

Construction of the research instrument

1. Items in the questionnaire were derived from the study, analysis and synthesis of secondary data, such as, literature (journal articles, books, conference papers, etc.) relevant to the objectives of this study.

2. The questionnaire was divided into two sections, the first covered the demographic information of the respondents, while the second part focused on the study.

3. The questionnaire focused on enabling the researcher to identify the factors and processes that promote critical thinking abilities in students and their relationship with using mobile-blended and inquiry-based learning.

Validity and reliability of the research instrument

The following activities were carried out in order to ensure that the research instrument was valid and reliable:

1. The researcher used information synthesized from the documentary research as the basis for formulating the items in the questionnaire.

2. Thereafter, the instrument was presented to five experts in the Department of Educational Technology and Communications, Naresuan University, Phitsanulok, Thailand. They individually subjected the items in the instrument to thorough scrutiny with a view to ascertaining the representativeness of its contents, and the extent to which they relate to the objectives of the study. This enabled them to make useful suggestions to the researcher in order to improve on the validity and reliability of the research instrument.

3. All the suggestions made by the experts were reflected in the final version of the questionnaire to ensure face, content and construct validity.

Data collection

To ensure effective data collection the following activities were carried out:

1. Copies of the paper questionnaire were administered to the respondents personally by the researcher.

2. In each of the schools where the questionnaire was administered, the researcher first sought audience with the heads of the department to intimate him/her with the objectives of the study before proceeding to the departmental lecturers.

3. The lecturers were informed about the study through *the information sheet for research participants* and were given opportunity to ask questions, before the questionnaire was administered to them.

4. The respondents were assured that all information recorded in the questionnaire will be regarded and treated with utmost confidentiality and no name was required on the questionnaire so as to protect their identities.

5. Mobile phone numbers of those who were not able to complete the questionnaire immediately, on the day it was administered, due to one reason or another were collected in order to enable the researcher get back to them a few days after. This enabled the researcher to keep in touch with them to ensure the copies of the questionnaire administered were complete and retrieved. The researcher used six weeks for the data collection.

Data analysis

The responses from the survey were analyzed using statistical analysis software. Demographic variables were analyzed using frequencies. Multiple regression was used to identify the factors, while Mean, Standard Deviation and Percentage were used to analyse the processes associated with the promotion of critical thinking in students using mobile-blended and inquiry-based learning.

The results of the analysis of both the primary and secondary data enabled the researcher to identify and understand the relationship among main, sub-factors and processes to enhance critical thinking skills with mobile-blended and inquiry-based learning

Phase Two: **Construction of an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria.**

Sources of materials for the construction of an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria

The following sources provided the factors, components and processes that were used to construct an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria.

1. The collection, analysis and synthesis of both the quantitative and qualitative data in phase one above provided materials (the main, sub-factors, components and processes identified in phase one of the study) to construct the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for business education undergraduate students.

2. While the primary data was derived from the analysis and synthesis of the responses from the research respondents, the secondary (qualitative) data was generated from the information that results from the analysis and synthesis of literature (books, journals, conference paper, etc.) that relate to experts' opinions on the use of mobile-blended and inquiry-based learning to enhance critical thinking abilities.

3. The instructional model was constructed with the information generated from both the quantitative and qualitative research design methods. Data from both sources was integrated to construct the instructional model.

Phase Three: Validation and tryout of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for Business Education undergraduate students in Nigeria

As at the time for the model validation, the Academic Staff Union of Universities in Nigeria embarked on an indefinite strike, the same week the Federal Government imposed a lock to curb the spread of the COVID-19 pandemic. This situation could not allow the higher education teachers in Nigeria to participate in the validation in good numbers. In addition, the international travel restriction arising from the pandemic prevented the researcher from travelling from Thailand to Nigeria to meet the tertiary institution teachers one on one. The researcher was only able to access three experts from Nigeria for validation via email. These three Nigerian experts participated in the validation along with nine Thai experts.

Sample of experts involved in the instructional model validation

A total of eleven experts were used to validate the draft model. These experts consisted of the following:

1. five business education experts in Thailand
2. three educational technology experts in Thailand
3. three business educators in Nigeria.
4. Majority (95%) of the experts were Ph. D holders while others had master degrees as their highest academic qualifications.
5. The researcher applied for a letter of introduction to the experts from Graduate School, Naresuan University. The purpose of the letter was to introduce the researcher as a doctoral student of the University to the experts, and to avail him the necessary support for a successful validation of the draft instructional model.
6. The letter of introduction and the draft model were delivered to the experts in their schools by the researcher personally, while the others, particularly those in Nigeria, received theirs electronically via their email addresses.

Instrument

The researcher provided the experts with a column at the left corner in the document that contains the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria, to either indicate if they agree or disagree with factors, components, and processes of the instructional model.

The experts were asked to respond by ticking agree or disagree at the left corner of each of the factors, components, and processes, and make comments or suggestions where necessary.

Validity and reliability of the instrument

The document that contains the instructional model based on mobile-blended and inquiry-based learning to enhance critical abilities for business education undergraduate students in Nigeria and the column for validation, was given to five experts in the Department of Educational Technology and Communications, Naresuan University, Phitsanulok, Thailand. They individually subjected the items in the instrument to thorough scrutiny to ascertain their suitability and the extent to which they relate to the objectives of the study. This enabled them to make useful suggestions to the researcher to improve the validity and reliability of the validation instrument.

Data collection

The researcher personally administered copies of the document that contained the instructional model based on mobile-blended and inquiry-based learning to enhance critical abilities for business education undergraduate students in Nigeria and the column for validation to the experts, and the letters of introduction from graduate school, Naresuan University. The researcher had to travel to meet six of the Thai experts in their various schools and two others were contacted via their LINE App, thereafter the document for validation and the letters of introduction from graduate school, Naresuan University was sent to them electronically.

The Nigerian experts were contacted via their email addresses to seek their consent before the document for validation and the letters of introduction from graduate school, Naresuan University was sent to them electronically.

Telephone calls were used to track the Thai experts to know when the copies of the validated model were ready for collection, while their Nigerian counterparts were sent frequent email reminders for the return of the validated instructional model.

Upon confirmation of the validation from the Thai experts, the researcher travelled to collect copies of the validated model from them in their schools, while others returned theirs via LINE App. The Nigerian experts returned versions of the validated via the researcher's email address.

Data analysis

The experts' responses were analyzed using mean and standard deviation, to know the aggregate of the factors, components, and processes the experts agreed or disagreed with. The results of the analysis of the experts' responses and their comments, as well as suggestions were used to revised the instructional model based on mobile-blended and inquiry-based learning to enhance critical abilities for business education undergraduate students in Nigeria.

Tryout of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria

After the results of the analysis of the experts' responses and their comments, as well as suggestions were used to revised the instructional model based on mobile-blended and inquiry-based learning to enhance critical abilities for business education undergraduate students in Nigeria its tryout was conducted at the Phitsanulok Vocational College.

1. The tryout of the model was carried out by three business education teachers of the Phitsanulok Vocational College, Thailand with their students. This was because the researcher could not travel to Nigeria as the schools were shutdown owing to the outbreak of Covid-19 coupled with the nine months nationwide strike by the university teachers in Nigeria.

2. The researcher applied for a letter of introduction to the School's Director for the tryout from Graduate School, Naresuan University.

3. The researcher sent copies of the letter from Graduate school to the school's Director and the teachers for the try-out.

4. The researcher scheduled and held a meeting with the teachers for the tryout to discuss related issues.

5. In preparation for the tryout, the validated instructional model was translated into an instructional plan to guide the teachers.

6. The business education teachers tried out the validated model with their students with the aid of the instructional plan derived from the processes of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria.

7. At the end of the tryout period, the teachers evaluated their students' critical thinking skills with the assessment criteria provided for them by the researcher.

8. Anonymous questionnaires were designed and administered to the three teachers and students.

9. While the questionnaire administered to the teachers focused on the practicability of the model, the items in the one for the students were to elicit their responses regarding their satisfaction, motivation, learning gains, etc., about the innovation, as well as the teachers' attributes, the teamwork.

10. The items in the teachers' questionnaire were to seek their response on the practicability of the process, such as workload, allocation of time for both online and classroom contexts, and challenges associated with the tryout.

11. The teachers indicated that the allocation of time for mobile and classroom activities should be determined by the teachers to adequately cover the activities in their lesson plan.

12. The teachers revealed that the model is in many ways similar to the one that is being used in the school which allows them to equip the students with information and terms associated with their course before class time.

13. They also indicated that the model allowed them to dedicate the face-to-face contexts to the engagement of the students' problem-solving skills

14. Similarly, the students indicated that the online sections allowed them to acquire knowledge and terms related to their courses, while the face-to-face contexts were focused on using such knowledge to solve work-related problems.

15. They also noted that they were able to regularly communicate with their teachers to resolve any misunderstanding of the mobile content.

16. Their responses also show that they were satisfied with the processes in the model because they could study the mobile content in the comfort of their homes, and collaborate with their peers to analyze, evaluate and synthesize the content to solve problems in the classroom.

Phase Four: Proposition of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria to school in Nigeria for implementation

Activities associated with the proposition of the instructional model

To propose the model the following activities were carried out:

1. The instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities in Nigeria was presented to the management of one of the schools that offer business education at the undergraduate level because the instructional model was specifically designed for such schools.

2. The researcher applied for approval to have discussion sessions with business education teachers and their undergraduate students through a letter of introduction, with an attachment that contained the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities in

Nigeria, via the head of the department of business education from the administrator of the school.

3. Upon confirmation of approval, the researcher held discussion sessions with both the teachers that teach business education undergraduate students and their students in the university. This allowed the researcher to assess the lead users' opinions on the practicability of the instructional model. This was because the 4 weeks tryout of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities in Nigeria was done in Thailand. This was because of the nine months strike embarked by Nigeria's higher education teachers in 2020, allied with the Covid-19 pandemic which forced countries globally to initiate international travel restrictions as part of measures to curb its spread.

4. During the first meeting with the business education teachers and their students, copies of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria were distributed to them. This was to enable them to study the instructional model and express their opinion on it.

5. The researcher ensured that all issues raised during the discussion sessions, relating to the instructional model, were addressed in the model to ensure its effective implementation.

6. A tryout of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria was conducted in the school after exhaustive interactions between the researcher and the business education teachers/their students. This was to ensure issues of peculiarities were adequately resolved for a proper adaptation.

7. Thereafter, the adapted instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria was presented to the school for its implementation.

CHAPTER IV

RESEARCH RESULTS

This chapter presents the results of the activities in phases 1 to 4 of this research. The results are presented to show how the study achieved its three objectives.

Objective 1: To identify the factors, components and processes associated with the use of mobile-blended and inquiry-based learning to develop critical thinking abilities of business education undergraduate students in Nigeria

The activities in objective 1 were divided into two phases as shown below.

Phase 1: Acquisition of the understanding of the relationship among the main, sub-factors, and processes to enhance critical thinking skills with mobile-blended and inquiry-based learning.

The responses generated from business educators during the survey were analyzed as shown in Tables 4 and 5 in order to identify the factors, components and processes associated with the use of mobile-blended and inquiry-based learning to develop the critical thinking skills of business education undergraduate students in Nigeria.

More than 120 copies of the questionnaire were administered, to ensure that the duly filled and retrieved copies met the number (120) specified in the previous chapter (Chapter 3). The copies were administered to business education teachers, who teach undergraduate students, in Edo, Delta and Kano states, Nigeria. These respondents cut across universities and colleges of education that offer business education at undergraduate level. At the end of the data collection, 120 copies of the instrument were duly filled and returned.

Table 3 Socio-demographic characteristics of the respondents (n = 120)

Variables	N	Percentage
Gender		
Male	67	55.8
Female	53	44.2
Total	**120**	**100**
Highest qualification		
Bachelor	19	
Master	58	
Ph. D	43	
Total	**120**	**99.9***
Teaching experience		
<10 years	34	28.3
10-19 years	38	31.7
20-30 years	29	24.2
>30 years	19	15.8
Total	**120**	**100**

*One of the respondents did not indicate his present highest qualification in the questionnaire.

Out of the 120 respondents that duly completed and returned the copies of the questionnaire, 67 (55.8%) were male while 53 (44.2%) were female. 19 (15.8%) of them at the time of this study had bachelor degrees as their highest qualification, while 58 (48.3%) had masters degrees and 43 (35.8%) had doctoral degrees. In relation to the duration of their teaching career, 34 of them (28.3%) had spent less than 10 years in the profession, 38 (31.7%) have spent between 10 – 19 years, while 29 (24.2%) and 19 (15.8%) have spent between 20 -30 years and above 30 years, respectively.

Table 4 Multiple regression of factors associated with mobile-blended and inquiry-based learning to develop critical thinking skills (n = 120)

Variables	Beta	SE	P-value
Participation of teachers in the process of making decision on innovation	0.29	0.27	0.012
Mobile-blended learning competency	0.26	0.25	0.006
Mobile instructional content	0.45	0.25	< 0.001
Orientation	9.28	0.17	0.013

Teachers' participation in the process of making the decision to adopt innovation

Table 4 shows there was a significant relationship between teachers' participation in the decision-making process to adopt innovation and mobile-blended learning with inquiry-based approach, to enhance critical thinking in undergraduate students. For a unit change of teachers' participation in the process of making decision on the adoption of the innovation, there is a corresponding increase in the enhancement of critical thinking skills in business education undergraduate students, with a P-value of 0.012.

Mobile-blended learning competence

Mobile-blended learning competency, as shown in Table 4, was significantly associated with critical thinking skills enhancement, using the mobile-blended and inquiry-based learning approach. For a unit change of mobile-blended-learning competency, there is a corresponding increase in critical thinking abilities of undergraduate students of business education, resulting in a P-value of 0.006.

Mobile learning content

From Table 4, the online learning content was obviously linked with the development of critical thinking abilities, by using mobile-blended learning with inquiry-based approach. This is because there is a corresponding increase in critical thinking skills, which results from every unit change of the online content, with a P-value <0.001.

Orientation

Table 4 shows that the orientation was significantly associated with the development of critical thinking when using mobile-blended learning with the inquiry-based method. For a unit change of the orientation, there is a corresponding increase with a P-value of 0.013.

Hypothesis: As shown in table 4 above, the hypothesis was accepted because the various values of the factors associated with the use of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities of business education undergraduate students in Nigeria were less than 0.05. The participation of teachers in the process of deciding on innovation with a p-value of 0.012; mobile-blended learning competency with a p-value of 0.006**;** mobile instructional content was found to be most significant with a p-value of < 0.001; and mobile-blended learning orientation with a p-value of 0.013**.** Therefore, the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria is significantly effective.

Table 5 Participants Mean Score of Processes for the model utilization (n = 120)

Variables	Mean	Standard Deviation
Mobile-blended learning community	4.38	0.61
Teachers' support	4.31	0.52
Students' support	4.29	0.54
Mobile-blended learning innovation fund	4.34	0.52
Teachers' online activities	4.37	0.51
Teachers' classroom activities	4.30	0.43
Students' online activities	4.38	0.61
Students' classroom activities	4.35	0.50

As indicated in Table 5 above, the mean score of the mobile-blended learning community was 4.38 SD 0.61. The participants agreed that the mobile-blended learning community facilitates the effectiveness of this approach. They indicated that it fosters collaborative learning among the members, sustains their commitment while helping them not to feel isolated with online learning, as well as ensures they move progressively through the phases of critical inquiry. The mean score of teachers' support unit was 4.31 SD 0.52 (Table 5). The respondents indicated that the support department for the teachers would assist them in the following areas: online course design and development, media creation of course materials, exposure to blended learning prototypes that have been successful and boost their confidence, as well as afford experienced faculty members to serve as mentors to the beginners.

As shown in Table 5, students' support mean score was 4.29 SD 0.54. The majority of the research participants agreed that students' support unit helps them to achieve more in mobile-blended and inquiry-based learning. They admitted that the provision of such support will facilitate students' access to mobile-blended learning facilities and equip them with the knowledge and skills necessary to succeed, as well as helping them with issues relating to the functionality of their devices.

The mobile-blended learning innovation fund mean score was 4.34 SD 0.52 (Table 5), indicating that the majority of the respondents agreed that the creation of the fund as part of the implementation strategies, fosters the provision of the required facilities and incentives for the teachers, as well as ensure the sustenance and transformation of the project.

Teachers' online activities mean score was 4.37 SD 0.51, as shown in Table 5. The participants agreed that the activities such as the design of mobile instructional content to meet learners' needs, delivery of such mobile instructional materials in appropriate formats before class, provision of online clarification of confusing concepts, and sending online personalized quizzes to students to ascertain their understanding of the content, will adequately prepare them for the interactive face-to-face component of blended learning.

From Table 5 above, the mean score of teachers' classroom activities was 4.30 SD 0.43, showing a higher level of agreement that classroom activities such as, recapping of the mobile content to refresh the students' memory, question and answer sessions to consolidate their understanding/application of the content, generate real-life problems, divide them into smaller groups that will ensure discussion and scaffold their knowledge by asking logical questions that probe their minds to ignite critical thinking. The participants agreed that these activities enhance the development of critical skills with blended learning.

Students' online activities mean score, as shown in Table 5, was 4.38 SD 0.61. The majority of the participants agreed that the online activities, such as studying mobile instructional content at various locations, communicating with their teachers anytime anywhere for clarification on confusing concepts, exchanging ideas among their peers regarding the content via mobile interaction, searching for and studying related information online and attempting quizzes from their teachers, are part of the learning processes. They agreed that these activities help the students to sufficiently prepare for the interactive classroom that is dedicated to the development of their critical thinking.

As shown in Table 5, the mean score of students' classroom activities while using mobile-blended and inquiry-based learning to enhance critical thinking skills was 4.35 SD 0.50. The majority acknowledged that part of the students' activities such as, asking questions regarding concepts of the content they do not understand, and studying collaboratively to analyze, evaluate and reconceptualize their knowledge to solve problems, while enhancing their critical thinking skills.

Phase 2: Construction of a draft instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for business education undergraduate students in Nigeria.

The survey research findings in this chapter (Phase 1 above) and the synthesis of related literature revealed the factors and processes associated with the adoption of an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for business education undergraduate students in Nigeria. These provided materials for the construction of the draft instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for business education undergraduate students in Nigeria.

Below is the draft instructional model that the researcher constructed based on the survey findings as well as the analysis and synthesis of related literature.

Section A: Model factors

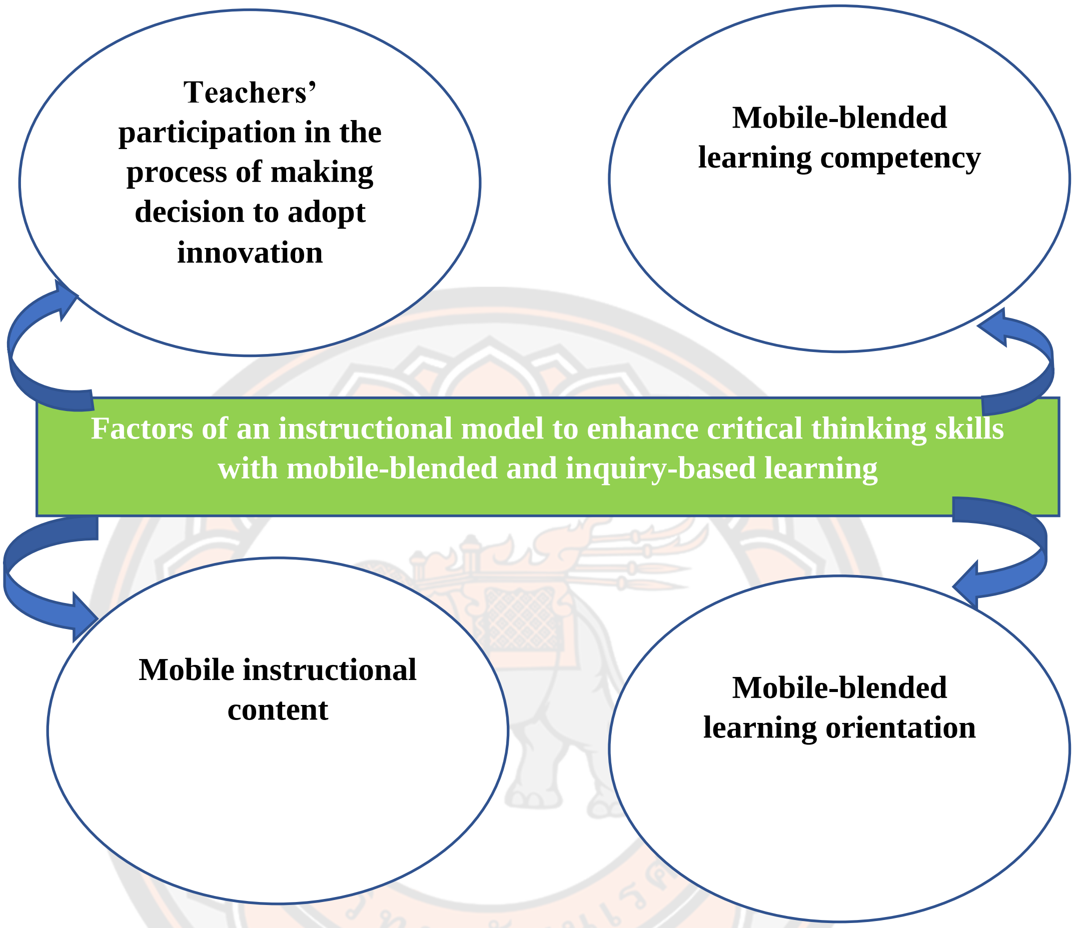

Figure 4 The factors of the draft instructional model

Teachers' participation in the process of deciding to adopt innovation

When teachers are allowed to participate in the process of deciding to adopt innovation, they feel empowered and motivated to willingly implement the decisions in their professional practice, as well as assume ownership and readily defend such a decision (Mangunda, 2003; Somech, 2010; Gelaye, 2019). Algoush (2010) emphasized that teachers' participation in the decision-making process in schools to introduce innovation, not only leads to improved communication among them and the management but also promotes the quality of such decisions. As they are the custodians of teaching/learning and implementers of school activities, their involvement in decision making ensures valid and feasible decisions are made, as well as better implementation, resulting in improved students' achievement (Gemechu, 2014; Bademo & Tefera, 2016; Reichert & Mouza, 2018). Since teachers' inclusion in the process of decision making is very essential for the improvement and overall transformation of school activities, the management should create opportunities to encourage their participation Their involvement in the process of decision making will enable the management to glean information on the possible barriers of implementation and find ways to swiftly eliminate them.

Mobile-blended learning competence

Mobile-blended learning competence was found to be an influencer for the development of critical thinking skills. The teachers' ability to manage both the online and face-to-face components of this method, is to achieve an appropriate blend that will facilitate the achievement of the desired outcome. Teachers' technological skills and ability to achieve the appropriate blend to achieve the expected outcomes are crucial for an effective blended learning environment [Alebaikan & Troudi, 2010; Korr, Derwin, Greene & Sokoloff, 2012). Teacher development training programmes should equip them with blended learning instructional design, pedagogy, learning management system usage and assessment, if they are to succeed in the mobile-blended learning environment (Oliver, & Stallings, 2014; Arney, 2015; Pulham & Graham, 2018; Law, Geng & Li, 2019). Teacher's skills to appropriately guide students in a mobile-blended learning context, direct and keep them on track towards achieving their goals. When teachers possess the appropriate skills to adopt the mobile-blended learning approach, the learners' achievement is guaranteed.

Mobile learning content

Mobile instructional content was found to be significantly associated with the development of critical thinking in students, using mobile-blended learning with inquiry-based learning. The design and delivery of instructional content for mobile learning are significantly different from those of other learning contexts (Caudill, 2007). The design of mobile learning materials should take advantage of the multimedia offered by the devices and delivered to students in chunks, because of the small screen size associated with the devices, to ensure the online content does not overwhelm the students (Makoe, 2012; Jantakoon & Piriyasurawong, 2018) and when possible, video format should be used, because these types of learning materials are most effective for blended learning (Abeysekera & Dawson, 2015; Grypp & Luebeck, 2015; Lo & Hew, 2017). This facilitates the learners' ability to be better prepared for face-to-face interaction when they study online. Teachers' online presence needs to be regular and interactive to promote students' understanding of online content. Since mobile content is the foundation of classroom activities, which is the blend, the content should complement face-to-face sessions of blended learning, and should also be available to students synchronously and asynchronously (Arends, 2004; Wilen, 2004; Brierton, Wilson, Kistler, Flowers & David, 2016). It enables collaboration of peers when it is synchronous, while it can be accessed to consolidate learning on asynchronous mode. Also, the content should be delivered to the learners via a user-friendly platform. Ease of use and functionality of the online learning platform significantly affects learners' achievement in blended learning (Loukis, Georgiou, & Pazalo, 2007; Shrain, 2012). When learners are satisfied with the functionality of the learning management system, they gain more from blended learning. The online learning content, quality of the technology, as well as how it is used in blended learning have a relationship with the learners' satisfaction and achievement.

Mobile-blended learning orientation programme

This study found that the mobile-blended learning orientation programme is associated with the successful implementation of the innovation. A robust orientation programme before the introduction of mobile-blended learning offers an opportunity to introduce the users (teachers and students) to their various roles, and appropriate hardware/software sensitization. Yi, (2008) carried out a study to examine the effect of an orientation programme on the adoption of blended learning among nursing students and claimed that the programme enhanced the communication skills and clinical practices of the students that participated in the orientation. Washington (2009), one of the major proponents of blended learning, emphasized that an orientation programme helps to promote students learning outcomes and the attainment of institutional goals. He stressed that induction and other factors, rather than dependence on technology alone result in a blend that leads to the achievement of the desired results. Orientation served as an avenue to introduce the students to the hardware and software that led to improved functionality of the students in the innovation (Nestel, Ng, Gray, Hill, Villanueva, Kotsanas, Oaten & Browne, 2010). Orientation managed by an instructional technology director is very useful, as it provides an opportunity to set up the devices, support students to set up their accounts, expose the students to the acceptable use policy of the school and guidelines on the use of some apps selected by the teachers (Reichert & Mouza, 2018). As the innovation is being implemented, the teachers and students that later join, also require a robust blended learning orientation programme, to ease their anxieties and enhance their confidence in the environment (Antwi, Tampah-Naah & Buame, 2019). Mobile-blended learning orientation, among others, provides a forum to explain to the users how and where they can seek support for effective participation, and the incentives for the teachers that will motivate them to embrace and be dedicated to the innovation.

1. Participation of teachers in the process of deciding to adopt mobile-blended and inquiry-based learning innovation.

Teachers' participation in the process of deciding to introduce technology in teaching and learning makes the decision valid because hindrances to the successful implementation are identified early enough, and measures are put in place to tackle such challenges, leading to better implementation of the innovation to achieve the desired goals.

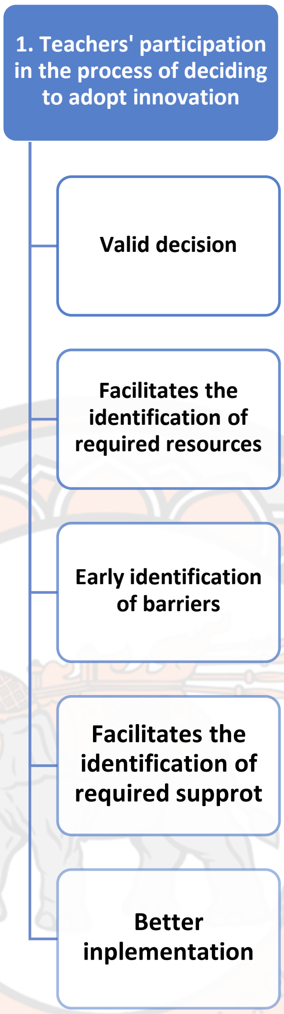

Figure 5 Teachers' participation in the process of deciding to adopt innovation

Valid decision. When teachers are involved in the process of deciding on Innovation, the process tends to yield valid and practicable decision (Algoush, 2010; Gemechu, 2014; Bademo & Tefera, 2016). As the teachers are encouraged to be part of the decision-making process to adopt technology, they are in the best position to provide useful information that will make the decision workable. This is because they are the implementers of such a decision.

Identification of resources. Teachers' participation in the process of deciding to adopt innovation facilitates the identification of the required human and material resources to drive the process (Graham, Woodfield & Harrison, 2013;

Fleming, Becker & Newton, 2017; Pandit, 2018). As the implementers of the innovation, they are in a better position to identify the need resources.

Early identification of barriers. Teachers' inclusion in the decision process to introduce innovation allows school management to identify, early enough, the barriers to effective deployment of the innovation and develop strategies to overcome them (Mojgan, Kamariah, Wong, Bahaman & Foo, 2009; Hennessy, Harrison & Wamakote, 2010; Kaliisa & Picard, 2017). As the teachers are carried along the process of deciding to introduce innovation, they can reveal the likely impediments that may militate against the successful implementation. The teachers as the implementers of mobile-blended learning are in a better position to identify the factors that will negatively influence innovation.

Identification of the needed support. As the teachers are carried along in the process of deciding to adopt innovation, they can express the area they require support to effectively implement the decision in their practice (Washington, 2009; Johnson, 2017; Fryer & Boyee, 2018).

Better implementation of the decision. When teachers are allowed to participate in the educational decision-making process, they feel empowered and motivated to willingly implement the decisions in their professional practice, as well as assume ownership and ready to defend such decision as a team (Mangunda, 2003; Somech, 2010; Gelaye, 2019). Their participation in the process that generated the decision, makes them take ownership of the decision, and willingly ensure the success of the project.

During the meeting the deliberation should be focused on the following:

1.1 The required facilities. The teachers are enabled to identify the appropriate facilities that necessary for both themselves and their students (Graham, Woodfield & Harrison, 2013; Fleming, Becker & Newton, 2017; Pandit, 2018). The information allows the management of the school to source for such facilities.

1.2 Identification of available facilities. The information on the needed facilities from the teachers, as a result of participating in the process of deciding to adopt the innovation, enables the management to identify the available facilities in the school that can be adapted for the innovation, to avoid duplication and reduce cost

(Graham, Woodfield & Harrison, 2013; Gamer & Rouse, 2016; Mozelius & Hettiarachchi, 2017). This information enables the management to avoid wastages of resources.

1.3 Identification of the non-available facilities. These are the facilities necessary for the innovation, but not available in the school (Graham, Woodfield & Harrison, 2013; Gamer & Rouse, 2016; Mozelius & Hettiarachchi, 2017). As the management can identify the existing facilities in the school that can be utilized for the innovation, others that are necessary, but not available in the school, will become obvious. The management can readily ascertain those that should be acquired and formulate the modality for the procurement.

1.4 As the available facilities in the school have been identified, the management can make a valid cost analysis of the non-existing facilities for the implementation of the project (Watson, Murin, Vashaw, Gemin, & Rapp, 2010; Graham, Woodfield & Harrison, 2013; Pandit, 2018). This is to enable the head of the department to present a valid budget for approval.

1.5 Professional development. As the teachers are encouraged to participate in the process of deciding to adopt mobile-blended learning, they are enabled to reveal the form of professional training required by them for result-oriented implementation (Buabeng-Andoh, 2012; Digedu, 2014; Hall, 2017). Most teachers are used to the traditional mode of teaching (classroom context), as teachers are about to be exposed to technology-mediated teaching and learning, it becomes important to equip them with the necessary pedagogical knowledge and skill to ensure a smooth transition.

1.6 Maintenance of the facilities. Identification of the required facilities will enable the management to initiate the appropriate technical support for the innovation (Graham, 2004; Johnson, 2017; Han, Wang & Jiang (2019). Technical support is crucial to promote both the teachers' and learners’ effective interaction with technology-mediated instructional materials because it helps to eliminate the anxiety associated with the use of technological tools for teaching/learning and close the digital gap among the teachers, as well as the students. Also, the provision of technical support promotes the functionality of the devices and the overall transformation of the innovation.

1.7 Teachers' information on the required facilities and professional development to drive the innovation will enable the management to source for the right resource persons for the training programme (Bergmann & Sam, 2014; Banditvilai, 2016; Lo, & Hew, 2017; Tawil, 2018). Also, the trainers should involve teachers who have successfully implemented blended learning in their various schools, who can practically demonstrate to the teachers, with prototypes, the various activities, and skills associated with the innovation (Bergmann & Sams, 2012; Retnowati, Ayres & Sweller, 2018; Pandit, 2018). Furthermore, ICT personnel should be part of the trainers to expose them to basic ways to proficiently resolve frequent and simple functionality problems of the devices (Heaney & Walker, 2012; Gedik, Kiraz & Ozden, 2013; Ma'arop & Embi, 2016). All these efforts should be focused on making both the teachers and their students comfortable to embrace the innovation with little or no anxiety.

1.8 Support. The teachers' involvement in the process of deciding to adopt innovation allows them the opportunity to express the forms of support they require to ensure effective implementation (Ajadi, Salawu & Adeoye, 2008; Aduke, 2008; Yilmaz, 2011; Li, Yamaguchi & Takada, 2018). The teachers require support such as teaching assistants and experienced mobile-blended learning teachers serving as mentors to the less experienced, as well as collaboration among them to share ideas on the best ways to ensure the effectiveness of the project (Bergmann & Sams, 2012; Gedik, Kiraz & Ozden, 2013; Ma'arop & Embi, 2016). Such support should also be extended to the students participating in the innovation.

2. Mobile-blended learning competency

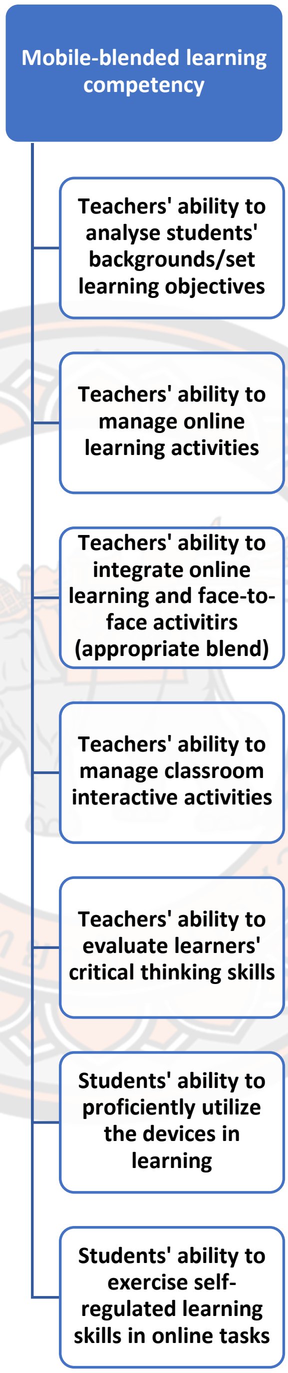

Figure 6 Mobile-blended learning competence

To facilitate the effectiveness of mobile-blended learning to achieve its intended objective, the teachers and their students require the following competencies:

Online context competencies

2.1 Teachers' ability to effectively analyze students' needs. The teachers should possess the skills to analyze and understand the background of the target learners, including their previous knowledge, skills, and attitudes. Information from such analysis enables the teacher to set appropriate learning outcomes to be acquired at the end of the instruction (Mac Callum, & Jeffrey 2013; Kljunić, & Vukovac, 2015; Kurt, 2017). Formative evaluation can be conducted to know the students' previous knowledge, skills, and attitudes.

2.2 Teacher's ability to set appropriate measurable learning objectives. After determining the students' background, the teacher should be able to establish a learning objective to be achieved at the end of both the mobile learning and face-to-face contexts (Shand, Glassett-Farrelly & Costa, 2016; Mozelius & Hettiarachchi, 2017; Kurt, 2017). The learning objective provides the basis to evaluate the students' achievement in online and face-to-face contexts.

2.3 Teachers' ability to analyze learning materials. The teacher should be able to review and select the most effective learning content that promotes the achievement of the learning outcome (Shand, Glassett-Farrelly & Costa, 2016; Mozelius & Hettiarachchi, 2017; Kurt, 2017). This involves the analysis of the students' curriculum

2.4 Teachers' ability to design and develop mobile content. The design of mobile content differs from those of other learning contexts. The teachers require the competence to design and develop the mobile content in a manner that will foster the students' understanding by using the appropriate media formats associated with the devices (Fu & Hwang, 2018; Jantakoon & Piriyasurawong, 2018). If possible, video format should be used to aid learners' understanding.

2.5 Teacher's ability to select appropriate mobile learning interface. Such an interface should be user-friendly and suitable for mobile learning, as well as easy for both the teachers and students to navigate (Shrain, 2012; Kurt, 2017). When learners can proficiently manipulate the mobile learning interface, their learning activities will be sustained, there is a tendency for them to gain in-depth knowledge from the content.

2.6 Teacher's competence to deliver mobile content appropriately (Bergmann & Sams, 2014; Alsowat, 2016; Jantakoon & Piriyasurawong, 2018). The teacher needs to be competent in the delivery of mobile content to enhance learning. As mobile devices are usually associated with small screen sizes, the instructional content should be delivered to students in manageable fragments to avoid overwhelming them with it, the contents should be delivered in chunks.

2.7 Students' competence to effectively manipulate their mobile devices as learning tools (Agbo, 2015; Li, Yamaguchi & Takada, 2018; Teo, Doleck, Bazelais & Lemay, 2019). Students' competence to proficiently utilize their mobile devices in learning tasks determines their benefits from mobile content.

2.8 Students require self-regulated learning skills in their online activities (Makoe, 2012; Futch, Howard, & Thompson, 2016). Students' ability to exercise maturity and readiness to study independently with self-regulated learning skills, determine their achievement in mobile learning.

2.9 Teacher's ability to guide and facilitate student's online learning activities. This includes explaining the complex concepts of mobile content, and scaffolding their knowledge with questions and answer session during their online study (Fu & Hwang, 2018; Cocquyt, Diep, Zhu, De Greef & Vanwing, 2018). This is to ensure they adequately understand the online content, before the classroom interactive meeting, where they are expected to use the knowledge gained from the content for problem-solving activities.

Face-to-face context competencies

As mobile-blended learning comprises of online and classroom learning sessions, the teacher needs the competence to engage students in both contexts. Below are the abilities required of the teacher to effectively manage the face-to-face encounter, which is mainly dedicated to the enhancement of critical thinking development of the students.

2.10 Ability to succinctly recap of the online content at the beginning of a face-to-face session (Roehl, Reddy & Shannon, 2013; Bergmann & Sams, 2014; Lai

& Hwang, 2016). This is to refresh the students' memory, correct misconceptions they may have about the content, and to allow them to ask questions on the content.

2.11 Ability to generate real-life and ill-structured problems to engage the students (Smy, Cahillane & MacLean, 2016; De León, 2018). Such a problem must be work-related (real-life problem) and associated with the mobile content. The essence of moving part of the classroom activities online is to allow adequate class time for problem-solving tasks during face-to-face. This enables the teacher to engage the students with activities that allow them to apply the acquired knowledge from the mobile content to solve a real-life problem, to enhance the development of their cognitive abilities.

2.12 Ability to group students into heterogeneous problem-solving teams (Edmondson & Harvey, 2017; Avdiji, Elikan, Missonier & Pigneur, 2018). The ability of a learning group to solve problems collaboratively depends on the diversity of the membership with their domains of knowledge and backgrounds. Diversity determines their level of sharing perspectives and alternative solutions to solving problems. In heterogeneous grouping, the learners with a higher level of intelligence assist the ones with lower grades in inquiry learning, which helps to eliminate the stigmatization of the low achievers when the grouping is homogenous.

2.13 Teacher's ability to ensure interaction and collaboration. Interactivity and collaboration are very effective in building and developing analytical and creative, problem-solving abilities in students (Yang, Gamble, Hung & Lin, 2014; Abosalem, 2016; Mattar, 2018). As students interact and collaborate on the same learning content, they are encouraged to share ideas and reconceptualize their information to solve problems. In constructing knowledge, learners need interaction and reflection to modify their information to resolve situations (Brunner, 1996; Brierton, Wilson, Kistler, Flowers & David, 2016). Interaction and collaboration facilitate the generation of alternative ideas that leads to diverse solutions to resolve the problem.

2.14 Ability to scaffold students' knowledge (Harris & Rooks, 2010; Gillies & Nichols, 2015; Cañas, Reiska & Möllits, 2017). As the students engage in their problem-solving tasks, the teacher should be able to guide their activities with timely questioning to facilitate their activities through the stages of inquiry activities.

2.15 Ability to evaluate students' critical thinking skills (Thomas & Thorne, 2009; Yeung 2012; Lee & Lai, 2017). The evaluation should be based on the learners' abilities to analyze, evaluate, and reconceptualize information to solve the problem. In other words, it should focus on the ability of the students to receive and internalize new knowledge while interrelating and applying such information to address unfamiliar situations. The evaluation should not only find out whether the learners have been able to reorganize the knowledge gain from the mobile content to solve problems but must also focus on the effectiveness of the mobile-blended learning strategy with a view to improving the entire approach.

3. Mobile instructional content

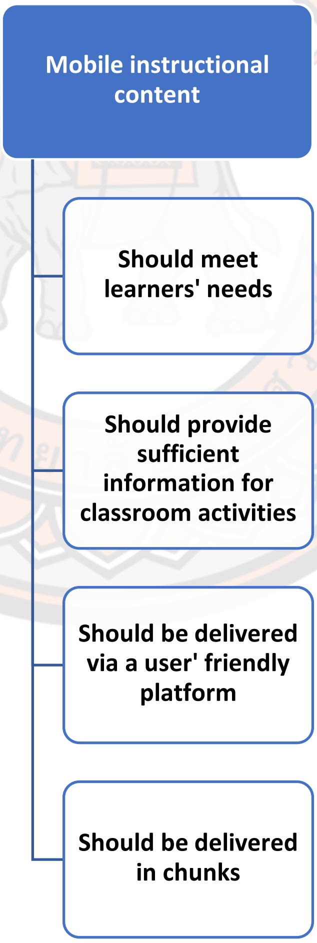

Figure 7 Mobile instructional content

The processes associated with mobile learning content include the following:

3.1 The mobile content should reflect the students' needs. The teacher ensures the content meet learners' need by finding out their background (Mac Callum & Jeffrey 2013; Kljunić & Vukovac, 2015; Kurt, 2017). What is their existing knowledge, skills, and attitudes? Formative evaluation, in the form of tests, can be conducted to ascertain their existing knowledge and what they need to learn. Once the students' background has been established, the teacher set learning objectives

3.2 The mobile content should equip students with adequate information to effectively participate in classroom activities. To achieve this, the teacher should analyze learning content to identify learning materials that will promote the achievement of the learning objectives (Mac Callum & Jeffrey 2013; Bergmann & Sams, 2014; Kurt, 2017). The analysis of learning content should be focused on the identification of learning experiences that will promote the realization of the learning objectives.

3.3 The mobile content should be designed and developed to complement face-to-face interaction sessions (Bergmann & Sams, 2014; Kurt, 2017; Jantakoon & Piriyasurawong, 2018). The development of mobile content must be linked to the learners' classroom activities to achieve a proper blend of both sessions.

3.4. Mobile content should be delivered and accessed via a user-friendly, intuitive, and smart interface (Shrain, 2012; Banditvilai, 2016; Tawil, 2018). As the learners access content from their teacher online, they should not only be able to pause and reflect on the material but should also be available to them offline to allow them continuous access to consolidate learning. When the mobile content is in synchronous mode, it promotes the learners' interactivity and collaboration and they can relate with each other in real-time, this intensifies their interaction and strengthen collaborative knowledge construction; and if available asynchronously, more useful time is given that enables them to ruminate, process and reflect on the content and this additional time is critical in developing higher-order thinking skills (Arends, 2004; Wilen, 2004; Brierton, Wilson, Kistler, Flowers & David, 2016). Furthermore, while synchronous interactivity and collaboration allow them to examine the content in real-time, they can respond instantly, enabling them to make remarks that can modify their thoughts and perceptions. Asynchronous mode enables them to present more detailed responses (giving room for more social constructivism) as they are not under pressure to respond instantly, they have the time to reflect on their response, thereby offering them the opportunity to collectively develop a more detail response that results from higher-order thinking skills.

3.5 The mobile content should be delivered in chunks (Kljunić & Vukovac, 2015; Hwang, Lai & Wang, 2015; Jantakoon & Piriyasurawong, 2018). The mobile content needs to be delivered in meaningful and manageable fragments because of the small size screen associated with mobile devices. This is to avoid overwhelming the learners with the materials. When possible, the content should be delivered in video format.

3.6 The teacher should clarify complex concepts of the content, to enhance the students’ understanding (Szpunar, Jing & Schacter, 2014; Jantakoon & Piriyasurawong, 2018; Wishart, 2018). When the teacher provides more information on complex and confusing concepts of the online content, the students’ understanding is enhanced and misconception is eliminated.

3.7 The teacher's online presence should be sustained to facilitate students’ understanding of the content (Ozdamli, & Cavus, 2011; Koper, 2014; de Witt & Gloerfeld, 2018). The students can readily access more information from the teachers if their online presence is regular. This will facilitate the students’ internalization of the content before classroom meetings.

3-8 The teacher should ask students questions while they are engaged with the online content to ascertain their understanding and application of the mobile content (Sharples, Taylor & Vavoula, 2005; Ozdamli, & Cavus, 2011; Kljunić & Vukovac, 2015). The teacher sends personalized quizzes to them to assess their understanding and application of the content. The personalized questions enable the teacher to address individual differences of the learners by accessing their various levels of understanding of the content, to effectively guide them through their online activities.

3,9 Teachers direct students to search for and study web-based materials related to the online content to consolidate their understanding (Bergmann & Sams, 2014; Alsowat, 2016; Jantakoon & Piriyasurawong, 2018). As the learners study other web-web-based materials related to the mobile content, their understanding and application of the content are enhanced.

3.10. The teachers and students require support to ensure effective utilization of the devices for teaching and learning tools functionality of the devices and to promote maximum functionality of the devices (Kenney & Newcombe, 2010; Heaney & Walker, 2012; Gedik, Kiraz & Ozden, 2013; Ma'arop & Embi, 2016). Teachers' support can also be accessed through their collaboration, experienced mobile-blended learning teachers serving as mentors to the less experienced. Similarly, when the learners get support among themselves, their sense of belonging and social ties are enhanced, which in turn strengthens their participation in online learning (Royai, 2002; Lee, Srinivasan, Trail, Lewis & Lopez, 2011; Aghaee & Keller, 2016; Fryer & Boyee, 2018). When teachers' or learners' challenges are detected as blended learning is being implemented, timely support is essential to sustain its effectiveness. The availability of technical and teaching support is among the drivers of successful blended learning in school (Han, Wang & Jiang, 2019). A robust technical support unit is crucial to promote teachers' and learners' effective interaction with technology-mediated instructional materials because it helps to eliminate the anxiety associated with the use of technological tools for learning, and close the digital gap among students (Graham, 2004; Johnson, 2017; Cocquyt, Zhu, Diep, De Greef & Vanwing, 2019).

4. Mobile-blended learning orientation

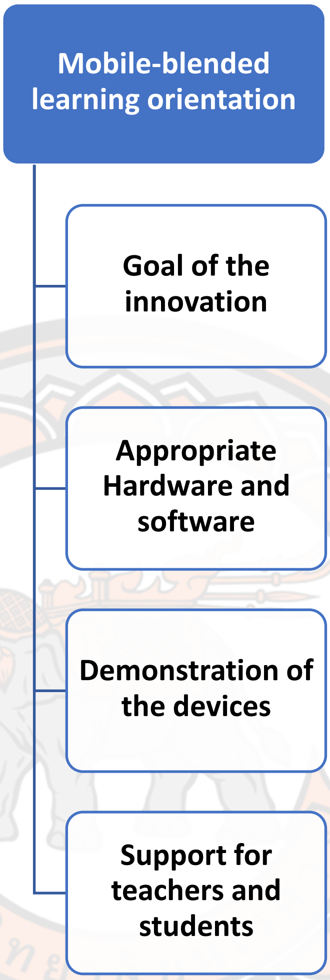

Figure 8 Mobile-blended learning orientation

The orientation programme is to provide the teachers and students refresher training before the actual implementation of the innovation. It should be focused on the following:

Goals of the innovation. The orientation programme provides an avenue to reiterate the objectives of the innovation to the teachers and students, including their various roles (Yi, 2008; Washington, 2009). This is to provide background information about the innovation and to address whatever questions the participants may have, as well as any anxiety from them.

Hardware and software. The orientation also serves as a medium to introduce the participants to the appropriate hardware and software to ensure effective implementation of the innovation (Nestel, Ng, Gray, Hill, Villanueva, Kotsanas, Oaten & Browne, 2010; Reichert & Mouza, 2018). The information on the appropriate hardware and software enables the teachers and students to operate at an optimal level for the innovation to achieve its goal.

Demonstration of devices. The induction offers the opportunity to demonstrate the functionality of the devices to the participants (Reichert & Mouza, 2018; Antwi, Tampah-Naah & Buame, 2019). This includes the practical demonstration of how to set up the devices, create individual learning account, how the devices can promote collaborative learning activities among learners, and the acceptable use policy of the school, as well as guidelines on the use of the recommended apps.

Support for participants. The induction is also aimed at the introduction of the various lifelines available to the participants to promote their effective participation in the innovation, as well as how and where they can access such support (Washington, 2009; Johnson, 2017; Fryer & Boyee, 2018). When teachers and students are sure of readily available sources of support to enhance their optimal participation, their confidence towards the innovation is boasted and anxieties are dispelled.

A draft instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills

The design phases are grouped into mobile learning and face-to-face sessions accordingly.

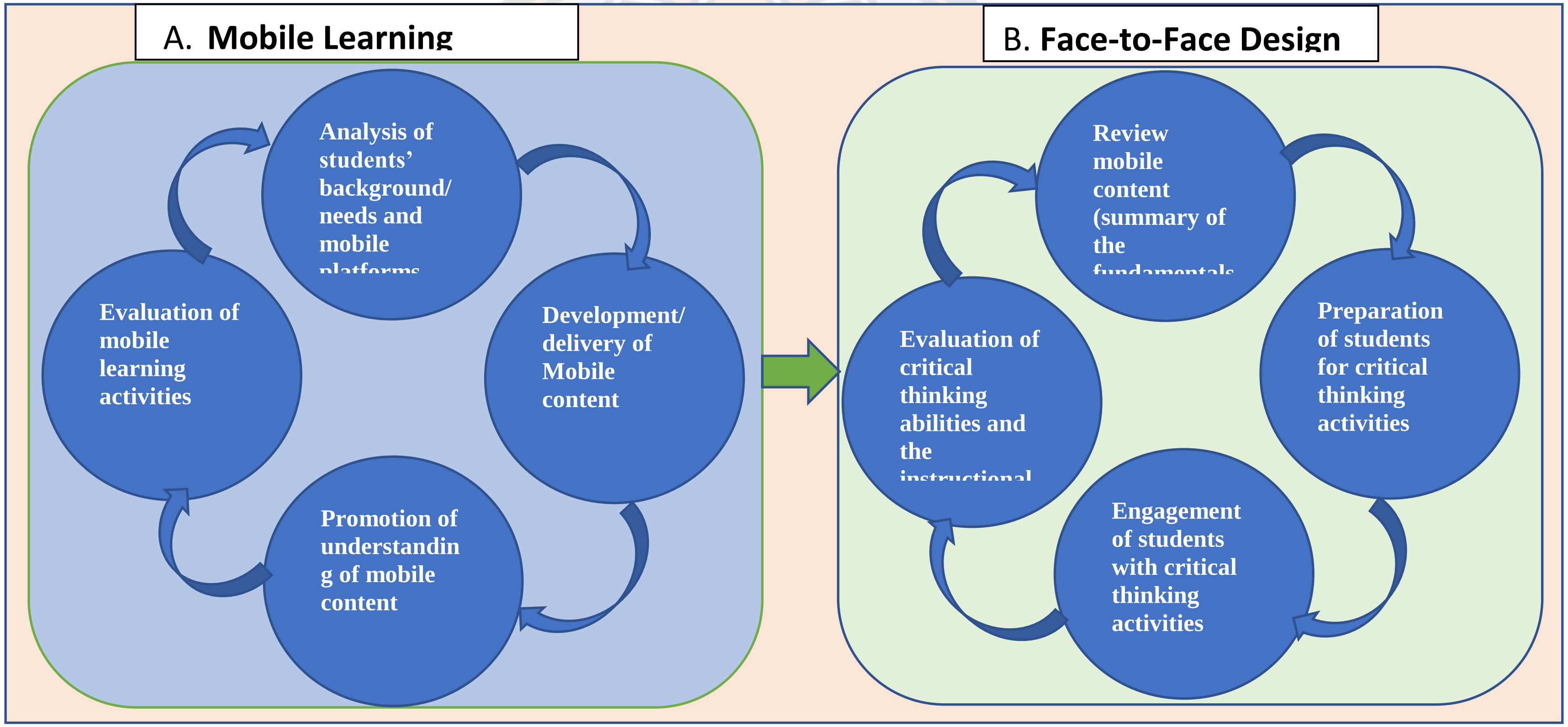

Figure 9 Flowchart of the draft model based on mobile-blended and inquiry-based learning to enhance critical thinking skills

Section B: Processes of the draft instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills

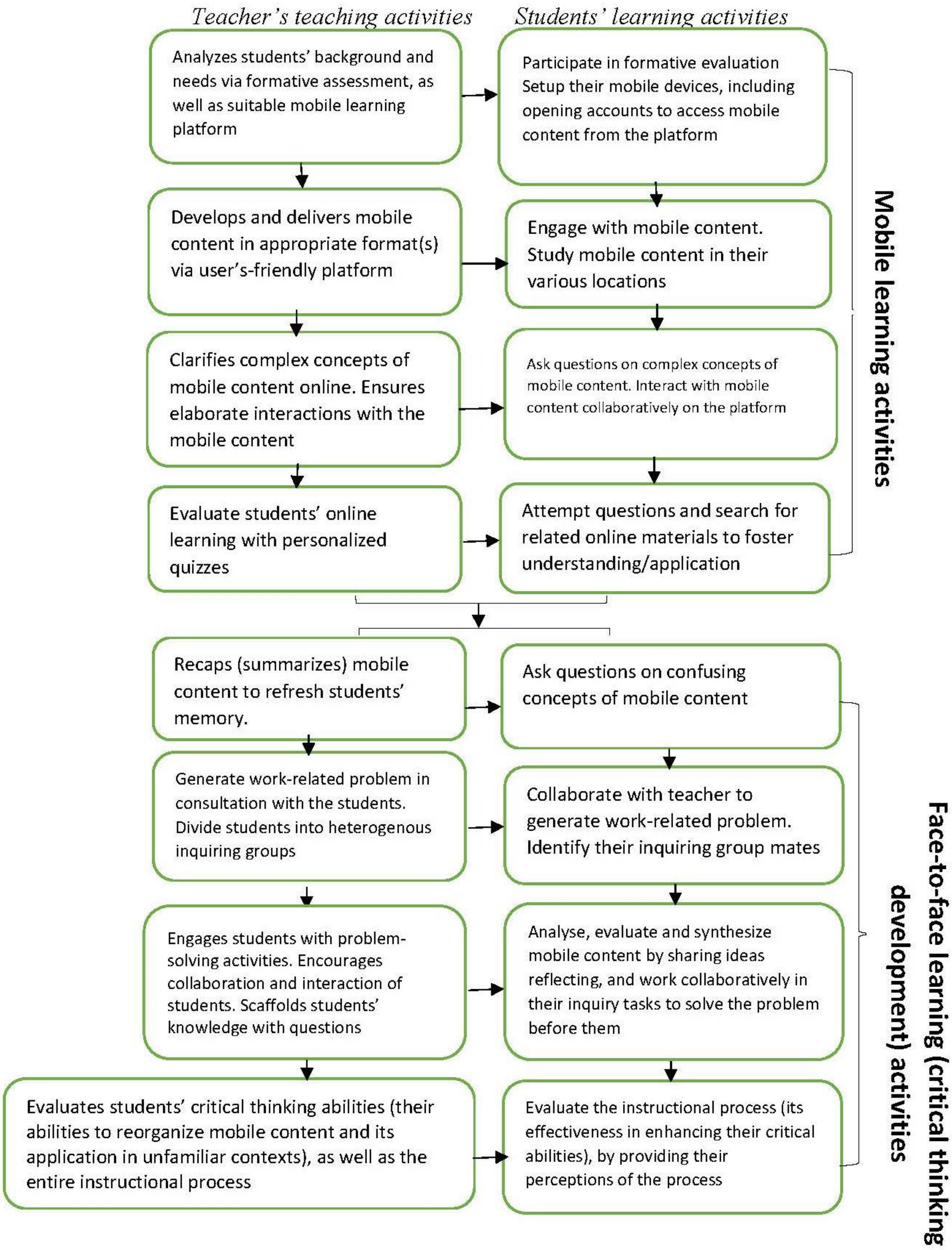

Figure 10 Processes of the draft instructional model

Processes of the draft instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills

A: Mobile context

The online design phases are to allow the teachers to adequately provide their students with mobile learning experiences that will sufficiently prepare them to use the knowledge gained from the mobile content to solve work-related problems during the face-to-face sessions.

1. Analysis

At this stage of analysis, the background of the students such as their previous knowledge and skills should be established. Once the background of the learners is known, the instructional goal is set. The instructional goal must reflect the needs of the learners. For example, the goal of this instructional design is to improve the critical thinking abilities of the students. Before the instructional goal is determined, the teacher must have assessed the existing knowledge and skills of the students. This to ensure that they possess the necessary prerequisite understanding and skills that will enable them to benefit from the instruction. Such skills should include the ability to communicate effectively and proficiently manipulate mobile devices for learning purposes.

To effectively analyse the students' background, the teacher needs to conduct a formative assessment to determine the existing knowledge, attitudes, and skills of the students and before the establishment of the learning goal. Remedial courses can be organized, if necessary, to make them properly fit for the programme. Once the instructional goal is determined, all other activities in the plan are to facilitate its achievement.

At this stage also the teacher should analyse the Business Education curriculum to identify the mobile instructional content that will facilitate the attainment of the instructional objectives. Such content should provide the learners with suitable information that will facilitate their problem-solving activities during the classroom sessions.

2. **Development/Delivery of Mobile Content**

At this phase, the identified mobile learning content at the analysis stage should be designed and developed to provide adequate experiences to the students. As the content is being developed, a suitable media format or a combination of formats (text, pictures, and videos), as well as the platform for the delivery, should be identified at this stage. The experiences the content is expected to provide for the learners should determine its format(s) as well as the mobile platform of delivery. The delivery platform should support students' online collaboration to sustain their mobile learning. When collaboration and social support are not embedded in an online learning platform, participants feel isolated and eventually withdraw from studying online content (Astleitner, 2000; Willging & Johnson, 2009; Kintu, Zhu & Kagambe, 2017). The mobile platform and the media format(s) should facilitate the understanding of the students as they interact with the content.

The online learning materials should take advantage of the multimedia offered by the technology and delivered to students in chunks, because of the small screen size associated with the devices. The online content should not overwhelm the students (Jantakoon & Piriyasurawong, 2018), and when possible, video format should be used, because video-based learning materials are most effective in blended learning (Abeysekera, & Dawson, 2015; Lo & Hew, 2017), and learners are better prepared for the face-to-face component of blended learning when they study online learning materials in video format rather than text-based content (Grypp & Luebeck, 2015). It should also be available to students synchronously and asynchronously (Keskin, & Yurdugül, 2019). Ease of use and functionality of the online learning platform should be considered because they significantly affect learners' achievement in blended learning (Loukis, Georgious & Pazalo, 2007; Shrain, 2012). When learners are satisfied with the functionality of the learning management system, they gain more from blended learning.

3. **Clarifies complex concepts of mobile content online**

The teacher should also identify strategies to promote the students' understanding of mobile content. As the students are engaged with the mobile content, the sustainability of the teachers' online presence is essential to provide additional information on complex concepts of the content as well as to ensure their interactivity and collaboration. Interactive and collaborative learning develops students' thinking ability as each student can express and share his knowledge with their peers in the same interactive and collaborative platform, and apply such knowledge in other contexts (Jones & Safrit, 1994; Abosalem, 2016). Such interactivity and collaboration offer learners the opportunity to reflect on their past and present learning dispositions leading to a deeper understanding as a result of critical thinking (Ellis & Goodyear, 2010; Mattar, 2018). Since students gain an in-depth understanding when they interact and exchange ideas on the same content, the teachers should encourage them to engage in elaborate interaction that will expose them to varied views of their peers to enhance their internalization of the content. Antwi, Tampah-Naah & Buame (2019) emphasized the need to ensure collaboration in online learning, according to them, inquiry-based learning is more effective when learners collaborate, rather than study individually. Also, the teacher should encourage the students to search for related web-based information and provide clarification to the questions they may have through the learning platform (Francl, 2014; Gilboy, Heinerichs & Pazzaglia, 2015). These teachers' activities that facilitate the learners' understanding of the mobile content can only be effectively carried out when both the teachers' and students' online presence is sustained.

4. Evaluation of mobile learning activities

The teachers design an assessment method that will enable them to determine the level of students' understanding of mobile content. After studying or watching, if in video format, the online instructional material, the teachers should ask the students questions to ascertain their understanding of the mobile content. Personalized quizzes can be sent to individual learners to scaffold their knowledge, the essence of such assessment is to enhance their learning and application of the content (Bishop & Verleger, 2013; Hew, Huang, Chu & Chiu, 2016; Lo & Hew, 2017). The evaluation should not only focus on the students' achievement from the mobile content but also the entire online learning processes (Zulkifli, Razak & Mahmood, 2018). Data on the students' perceptions of the entire mobile learning context should be collected to expose aspect(s) that require modification in the model for improvement.

B. Face-to-face context

Since the instructional content will be delivered to the students to study in their various locations via mobile technology, the processes in the classroom sessions are designed to sufficiently engage the learners' critical thinking abilities. Below are the design phases in the classroom sessions.

1. **Review mobile content (summarize the fundamentals of the content).**

The teachers present synopsis of the mobile content to the students, and ask them questions to ascertain the extent to which the students have internalized the mobile content, while the students ask and answer questions from the teachers The summary of the mobile content and the questions are to reinforce the students' understanding of the mobile content at the beginning of the classroom sessions (Grypp & Luebeck, 2015; Jantakoon & Piriyasurawong, 2018). A review of the complex concepts of the mobile content at the beginning of the in-class sessions provides the teachers with an opportunity to clarify any misconceptions the students may have about the content and also provide them the opportunity to ask the teachers questions. The focus of this phase is to refresh the students' memory and facilitate their understanding of the mobile content culminating in its effective application in the inquiry activities in the classroom.

2. **Preparation of students for inquiry-based activities**

As the teachers prepare the students for inquiry tasks, the focus is on achieving an appropriate blend of the out-of-class and in-class contexts. Both contexts are to complement each other. Face-to-face tasks should be tied to mobile activities, by ensuring that the real-life problem given to the students can be resolved with the reorganization and development of their knowledge of the mobile content. Before the students are engaged with critical thinking tasks, the teacher should generate real-life (work-related) ill-structured problems in consultation with the students and divide them into small heterogeneous inquiry learning groups. When students are presented with an ill-structured problem, it enables them to exercise their minds, and heterogeneous grouping encourages the low achievers the opportunity to be carried along by the more intelligent ones among them as they collaboratively glean information to resolve the problem. The exposure of learners to ill-structured problems triggers their reasoning ability, which enhances their critical thinking skills, as the teacher plays the role of a facilitator (Smy, Cahillane & MacLean, 2016; De León, 2018). The ability of a learning group to solve problems collaboratively depends on the diversity of the membership concerning their domains of knowledge and backgrounds (Edmondson & Harvey, 2017; Avdiji, Elikan, Missonier & Pigneur, 2018). Engaging in social interaction with peers in real-world contexts has the potential of facilitating learners' ability to reflect on previous exposure, and collaborative inquiry learning environments is critical in developing their social experiences. Grouping students into heterogeneous learning teams to participate in real-life inquiry-based exercises facilitates the development of their critical thinking abilities. This diversity, to a large extent, determines their perspectives sharing and alternative solutions to solve problems.

3. Engagement of students with inquiry-based activities

It is at this stage the students are engaged with inquiry-based learning tasks, where they are expected to reorganize and apply the knowledge gained from the mobile content to resolve the problem. As the teacher engages the students with problem-solving activities, he should ensure elaborate interaction among the students, this is to enable them to share ideas, reflect and synthesize their knowledge to provide solutions to the problems. During collaborative learning, critical thinking is enhanced through interactions among learners as they reflect on their past and present learning dispositions leading to in-depth understanding (Ellis & Goodyear, 2010; Mattar, 2018). The teacher at this stage should identify appropriate tasks that he can use to scaffold the inquiry tasks by providing the students with provoking prompts that encourage their reflection and expand their thinking horizon. The teachers Scaffold students' knowledge by regulating task difficulty. This can be achieved by asking questions that probe learners' knowledge deeply.

4. Evaluation of critical thinking abilities and the instructional process

The evaluation should be centred on the extent to which the implementation of the instructional system has facilitated the students' critical thinking skills (abilities to analyse, evaluate and synthesize knowledge, and apply it to solve problems in an unfamiliar context). As part of the evaluation, the students involved in the implementation should be required to examine the entire process and provide their various feedbacks or perceptions. The feedback from the students will enable the teacher to determine the effectiveness of the model, and provide information for its modification.

Objective 2: To develop an instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria.

Phase 3: Validation and tryout of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills.

At this phase the draft model constructed in phase 2 was presented to experts for validation, and upon completion of the validation the model was revised and tried out.

Table 6 Experts' Mean Score of model evaluation (n = 11)

Items for evaluation	Result		Level
	Mean	SD	
1. Factors associated with mobile-blended and inquiry-based learning to enhance critical thinking skills of students	4.66	0.47	Very Good
2. Components associated with mobile-blended and inquiry-based learning to enhance critical thinking skills of students	4.68	0.45	Very Good
3. Processes associated with mobile-blended and inquiry-based learning to enhance critical thinking skills of students	4.72	0.49	Very Good
Summary	4.68	0.47	Very Good

As shown in Table 6 above, the mean score of the factors associated with mobile-blended and inquiry-based learning to enhance the critical thinking skills of students was 4.66 SD 0.47. The experts agreed that the factors in the instructional model are associated with mobile-blended and inquiry-based learning to enhance the critical thinking skills of students. They indicated that the factors promote the effective implementation of mobile-blended and inquiry-based learning to enhance critical thinking skills of students. As indicated in Table 6 above, the mean score of the components associated with mobile-blended and inquiry-based learning to enhance the critical thinking skills of students was 4.68 SD 0.45. Though the experts agreed that the processes are associated with the integration of mobile-blended and inquiry-based learning to enhance critical thinking skills of students, but some of them suggested that the components should be expanded to reflect the steps in inquiry-based learning approach, for better results. Table 6 also shows that the mean score of the processes associated with mobile-blended and inquiry-based learning to enhance critical thinking abilities of students was 4.72 SD 0.49. This shows that the experts agreed that the processes are associated with mobile-blended and inquiry-based learning to enhance critical thinking skills of students, however, they suggested that the activities of both the teachers and students in the processes should be further broken down to show clearly more detailed activities of the teachers and their students.

Tryout of the instructional model

The results of the analysis of the experts' responses and their comments, as well as suggestions were used to revised the instructional model based on mobile-blended and inquiry-based learning to enhance critical abilities for business education undergraduate students in Nigeria its tryout was conducted at the Phitsanulok Vocational College, Thailand. During the instructional model evaluation, the experts suggested that the components should not just only reflect online and face-to-face activities of the teachers and students, but should include the steps in inquiry-based learning. The experts also suggested that the activities of both the teachers and students in the processes should be further broken down to show clearly more detailed activities of the teachers and their students. These suggestions were used to revised the instructional model based of mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students before the tryout was carried in Phitsanulok Vocational College, Thailand.

At the end of the tryout period, the teachers evaluated their students' critical thinking skills with the assessment criteria provided for them by the researcher. Anonymous questionnaires were designed and administered to the three teachers and students. While the questionnaire administered to the teachers focused on the practicability of the model, the items in the questionnaire for the students were to elicit their responses regarding their satisfaction, motivation, learning gains, etc., about the innovation, as well as the teachers' attributes, the teamwork. The items in the teachers' questionnaire were to seek their response on the practicability of the process, such as workload, allocation of time for both online and classroom contexts, and challenges associated with the tryout. The teachers' responses indicated that the allocation of time for mobile and classroom activities should be determined by the teachers to adequately cover the activities in their lesson plans.

Table 7 Teachers' Mean score of the evaluation of the instructional model tryout (n = 3)

Items for evaluation of the tryout exercise	Result		Level
	Mean	SD	
1. Practicability of the processes of the instructional model	4.83	0.46	Effective
2. Time allocation	4.65	0.47	Effective
3. Workload	4.53	0.41	Very effective
4. Evaluation	4.57	0.46	Effective

Table 7 shows that the mean score of the practicability of the processes of the instructional model was 4.63 SD 0.46. This indicates that the respondents and their students were able to effectively implement the activities in the various components of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria. The mean score of time allocation was 4.65 SD 0.47 as shown in Table 7. The respondents agreed that the time allocated to the activities in the various components of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria was adequate. However, they advised that the amount of time to be allocated to the various activities in the various components should be left for the teachers to decide as this will enable them to adequately cover the activities in each of the components. As shown in Table 7, the mean score of the workload was 4.53 SD 0.41. This shows that the respondents were not overwhelmed with the activities in the components, and they were able to comfortably implement them. Table 7 indicates that the mean score of the evaluation was 4.57 SD 0.46. This means that the criteria for the evaluation of students' activities in the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students was effective.

Table 8 Students' Mean score of the evaluation of the instructional model tryout (n = 67)

Items for evaluation of the tryout exercise	Result		Level
	Mean	SD	
1. The format(s) of mobile content designed	4.74	0.43	Very effective
2. Students' understanding of the mobile content	4.53	0.45	Very effective
3. Teacher's online presence	4.85	0.49	Effective
4. Peers' online presence for interactions	4.72	0.47	Effective
5. The mobile platform user-friendliness	4.48	0.47	Effective
6. The mobile content was available both in synchronous and asynchronous modes	4.35	0.45	Very effective
7. Ability to exercise self-regulated learning skills in mobile learning	4.63	0.43	Very effective
8. Ability to effectively interact and share ideas with peers during the class session	4.79	0.46	Effective

Items for evaluation of the tryout exercise	Result		Level
	Mean	SD	
9. Scaffolding leads to an in-depth knowledge of the problems and a greater ability apply to the knowledge of the mobile content to solve the problems	4.24	0.43	Very effective
10. Ability to synthesize mobile content during the face-to-face context to solve the problems presented by the teacher.	4.91	0.47	Effective
11. Facilitation of critical thinking skills to solve problems through reflection and sharing of ideas	4.57	0.44	Very effective
12. Suitable teacher's attitude	4.83	0.46	Effective

Table 8 above indicates that the mean score of the format(s) of the mobile content the teachers designed and delivered to the students to study was 4.74 SD 0.43. This means that the respondents agreed that the content was designed in an appropriate format(s). As shown in Table 8, the mean score of the respondents' understanding of the mobile content was 4.53 SD 0.45, which means they were able to internalize the mobile content in preparation for their classroom activities. Table 8 also shows that the mean score of the teachers' online presence was 4.85 SD 0.49, meaning that the teachers were able to sustain their online presence to explain complex concepts of the mobile content to their students to promote their understanding of the online instructional materials.

As shown in Table 8 above, the mean score of the students' online presence was 4.72 SD 0.47. This means that the students were constantly online to perform their activities, and this enabled their teacher to always be in touch with them and vice-versa. Table 8 indicates that the mean score of the mobile platform user-friendliness was 4.48 SD 0.47. this indicates the students were able to proficiently manipulate the learning platform to perform their online activities. Table 8 also indicates that the mobile content availability both synchronous and asynchronous was 4.35 SD 0.45. This means they were able to engage themselves with the content both online and offline. They were able to interact with their peers online concerning the content, and also study the content when offline, enabling them to consolidate their understanding and create their knowledge of the content.

Table 8 shows that the mean score of the respondents’ ability to exhibit self-regulated learning skills in their mobile learning activities was 4.63 SD 0.43. The respondents agreed that they were able to benefit from the mobile learning context as they were able to exercise maturity in their online activities. The mean score of the ability of the respondents to effectively interact and share ideas with their peers during the classroom session was 4.79 SD 0.46 (Table 8). This indicates that they were able to communicate effectively as they analyze, evaluate and reconceptualize their knowledge of the mobile instructional material during their inquiry activities. Table 8 shows that the mean score of the scaffolding of the respondents’ knowledge by their teachers with timely questions to trigger their cognitive process was 4.24 SD 0.43. They agreed that the scaffolding of their knowledge as they engage in their inquiry activities, their critical thinking process was stimulated to reorganize their knowledge of the mobile content to solve the problems presented to them by their teachers.

As shown in Table 8, the mean score of their ability to synthesize the mobile content during the face-to-face context to solve the problems was 4.91 SD 0.47. They agreed that they were able to reorganize their knowledge of the mobile content to solve the work-related problems presented by their teachers. Table 8 indicates that the mean score of the respondents’ ability to reorganize their knowledge of the mobile content through reflection and sharing of ideas to solve the problems was 4.57 SD 0.44. This shows that their critical thinking process was awakened as they reflect on and share ideas relating to their knowledge of the content, they were able to create their knowledge to effectively resolve the problems in their various inquiry groups. The mean score of the teachers’ attitude in both contexts (mobile and face-to-face) was 4.83 SD 0.46 as shown in Table 8. This means that the teachers’ disposition to their students in both the online and face-to-face contexts was positive, and this in turn encouraged them in the performance of their learning activities.

Objective 3: To propose the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for business education undergraduate students in Nigeria.

Phase 4: Proposition of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking skills for business education undergraduate students to an institution of higher education in Nigeria.

Before the proposition of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria to an institution of higher learning that offers business education at the undergraduate level for implementation, the researcher engaged the teachers and their students in exhaustive discussion sessions, where the researcher explained the objective, components, and processes of the instructional model to them, as well as answer their questions regarding the instructional model. Thereafter, its tryout was conducted before the adapted instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria was presented to the school for its implementation.

After the tryout, the same anonymous questionnaire items the researcher used in the evaluation of the tryout conducted at the Phitsanulok Vocational College, Thailand were also administered to the students. This was because the instructional model and its objective remain the same; the students were both undergraduates and; their area (business) of study is similar. Below are the results of the evaluation of the tryout exercise.

Table 9 Teachers' Mean score of the evaluation of the instructional model tryout in Nigeria (n = 3)

Items for evaluation of the tryout exercise	Result		Level
	Mean	SD	
1. Practicability of the processes of the instructional model	4.63	0.41	Very effective
2. Time allocation	4.51	0.57	Effective
3. Workload	4.68	0.49	Very effective
4. Evaluation	4.47	0.43	Very effective
Summary	4.57	0.48	Very effective

Table 9 above, shows that the mean score of the practicability of the activities in the various components of the processes of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business undergraduate students in Nigeria was 4.63 SD 0.41. This means that the respondents agreed that both the teachers' and students' activities (mobile and face-to-face), as well as the components, are implementable. They, however, remarked that they will require regular training to improve on their competencies in the design of mobile content. With regards to the time allocation, Table 9 indicates that the mean score was 4.51 SD 0.57, which means that the time allocated to the various activities was enough for the various activities in the components. Just like their Thai counterparts, they also indicated that the allocation of time to their various activities in the processes should be left for them to decide, as this will enable them to effectively implement the activities.

Table 9 indicates that the mean score of the workload was 4.68 SD 0.49, which means that the respondents agreed the workload did not overwhelm them and that it enabled them to guide their students through the stages of the inquiry-based process. Table 9 shows that the mean score of the evaluation was 4.47 SD 0.43. This reveals that the respondents agreed that the evaluation showed that both their activities and those of their students enabled them to accomplish the learning objectives in each of the contexts.

Table 10 Students' Mean score of the evaluation of the instructional model tryout in Nigeria (n = 93)

Items for evaluation of the tryout exercise	Result		Level
	Mean	SD	
1. The format(s) of mobile content designed	4.81	0.57	Effective
2. Students' understanding of the mobile content	4.48	0.42	Very effective
3. Teacher's online presence	4.63	0.51	Effective
4. Peers' online presence for interactions	4.45	0.68	Effective
5. The mobile platform user-friendliness	4.32	0.41	Very effective
6. The mobile content was available both in synchronous and asynchronous modes	4.46	0.59	Effective
7. Ability to exercise self-regulated learning skills in mobile learning	4.35	0.65	Effective
8. Ability to effectively interact and share ideas with peers during the class session	4.42	0.43	Very effective
9. Scaffolding leads to an in-depth knowledge of the problems and a greater ability to apply the knowledge of the mobile content to solve the problems	4.51	0.46	Very effective
10. Ability to synthesize mobile content during the face-to-face context to solve the problems presented by the teacher.	4.57	0.45	Very effective
11. Facilitation of critical thinking skills to solve problems through reflection and sharing of ideas	4.36	0.61	Effective
12. Suitable teacher's attitude	4.64	0.52	Effective
Summary	4.50	0.53	Effective

Table 10 above reveals that the mean score of the mobile instructional content format(s) was 4.81 SD 0.57, which means that the respondents agreed that the content was designed in a suitable format(s). As shown in Table 10, the respondents' ability to understand the mobile instructional materials mean score was 4.48 SD 0.42, meaning that they were able to understand the online content as they study it individually and collectively through interactions via the mobile delivery platform. Table 10 shows that the mean score of the teachers' presence online was 4.63 SD 0.51, which means that the teachers' online presence was regular, and this enabled the students to always reach them for more details on confusing concepts of the content.

As shown in Table 10, the students' online presence mean score was 4.45 SD 0.68. This means they were able to contact their peers via their mobile devices to interact as they engage with the content. Table 10 indicates that the mean score of the mobile platform user-friendliness was 4.32 SD 0.41, which means they were able to interact with the mobile learning platform as study the content. The mean score of the availability of the online content in both synchronous and asynchronous modes was 4.46 SD 0.59 (Table 10). This indicates they were still able to access the same content even when they had gone offline. Table 10 shows that the mean score of the respondents' ability to exercise self-regulated learning skills in their online activities was 4.35 SD 0.65, which means they were able to exercise self-discipline in their study. This quality is very important in mobile learning. As shown in Table 10 above, the mean score of the respondents' ability to effectively interact and share their ideas with peers during the class session was 4.42 SD 0.43, which means they were able to effectively interact among their various group members as they engage in their inquiry activities to find solutions to the problems before them.

Table 10 reveals that the mean score of the scaffolding of the respondents' knowledge with questions by their teachers to enable them to gain an in-depth understanding of the problems and to create knowledge to solve the problems was 4.51 SD 0.46. This means the respondents agreed that their teachers' scaffolding of their knowledge was effective enough to trigger their cognitive process. Table 10 also shows that the mean score of the respondents' ability to synthesize their knowledge of the mobile content during the face-to-face sessions was 4.57 SD 0.45, which means their teachers were able to guide them to reorganize their knowledge of the online instructional material to solve the problems during the classroom sessions. The facilitation of critical thinking skills to solve problems through reflection and sharing of ideas mean score was 4.36 SD 0.61 as shown in Table 10. This shows that through reflection and sharing of ideas, the respondents' critical thinking skills were enhanced. Table 10 shows that the means score of the teachers' attitudes in both the mobile and face-to-face contexts was 4.64 SD 0.52, which means the respondents indicate that their teachers displayed a positive attitude to them in both the online and classroom contexts.

CHAPTER V

AN INSTRUCTIONAL MODEL BASED ON MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANCE CRITICAL THINKING ABILITIES FOR BUSINESS EDUCATION UNDERGRADUATE STUDENTS IN NIGERIA

Philosophy of the model

The standard of the Nigerian educational system has continued to witness a decline over the years at all levels, contributing to the disturbingly high rate of unemployment among graduates in the country. Most classrooms in the country are still fraught with the old-fashioned instructional approaches. These methods only focus on equipping students with knowledge of concepts that do not sufficiently avail them with the required abilities to solve real-life problems in contemporary society. Modern jobs require skills that are focused on what individuals can accomplish with their acquired knowledge through analysis, evaluation and reorganization of information to solve problems. To achieve this, students need to be engaged in active learning that encourages the use of their cognitive process, in order to sufficiently prepare them for the demands of present-day jobs. Cognitive development requires that learning should not just consist of repetitive accumulation of facts and knowledge, but must also encompass effective deep conceptual change in order to support life-long learning.

It is against this background that this model finds its relevance to adequately empower the teachers with the required instructional approach, which will facilitate the enhancement of the critical thinking skills of business education undergraduates for global competitiveness. Mobile-blended learning with an inquiry-based approach, allows teachers sufficient time during its face-to-face components to effectively engage learners with problem-solving tasks that encourage their cognitive development, rather than exposing them to learning experiences that are fraught with a repetitive accumulation of facts and knowledge of concepts only.

Concept of the model

This instructional model is designed based on the following concepts:

1. **Constructivist's theory**

This model is based on Piaget's constructivist theory, which emphasized the exposure of students to learning environments that inspire and empower them to construct their knowledge to promote their thinking skills. Authentic learning, according to the social constructivist's perspective, makes learners active researchers, enables them to generate knowledge via investigation and actively experiencing reality.

When students work collectively, they are encouraged to share ideas on their inquiry activities through collaboration and interactions. This encourages them to reflect on their previous knowledge, which results in the development of their creative thinking which better equips them for lifelong learning.

2. **Blended learning**

The availability and utilization of digital facilities, have led to increased deployment of ICT-mediated instructional elements into the conventional learning environment. Blended learning is a combination of two instructional models that incorporates both the traditional face-to-face classroom system, and an online learning platform that employs a mix of asynchronous and synchronous interactions. This practice affords educators the opportunity to help their students acquire the information and terms associated with the course before class starts, which allows them the time to carry out their collaborative problem-solving tasks that engage their cognitive processes.

When students are sent learning materials to study via an online platform before class, it ensures a more collaborative and engaging environment in the classroom, which affords them adequate time to evaluate and reconceptualize the contents for problem solving in real life situations.

Higher education institutions are embracing this approach, because the traditional method of instruction mainly encourages the lower levels of Bloom's taxonomy of memorizing and the recalling of information and does not effectively promote the development of the cognitive process in students. Conversely, the engagement of students in real-time inquiry tasks, enables them to analyse, evaluate, synthesize content and apply learnt knowledge to new situations through reflection and reconceptualization of ideas. In blended learning, teachers acquire a greater amount of class time to engage students in collaborative inquiry-based learning tasks that enhances their critical thinking abilities.

3. Mobile learning

Mobile learning experiences offer valuable opportunities that supplement or replace aspects of face-to-face traditional lectures, and textbook-based approaches. It is a type of educational experience that occurs with the aid of portable technological devices like laptops, Personal Digital Assistants (PDAs), tablets, and smart phones or learning "on the move" with no classroom restrictions. The pervasiveness and utilization of these devices have led to increased deployment of mobile-technology-mediated instructional elements into the conventional educational environment. Blended learning in association with mobile technology affords educators the opportunities to help their students acquire the relevant information and terms associated with the course before class starts, which provides sufficient class time to carry out collaborative problem-solving tasks that engage their cognitive processes. Students can watch, pause and repeat the learning materials on their mobile devices, which allows them to gain a clearer understanding of the content before classroom sessions. This technology facilitates more individualized and independent learning, as well as making it possible to access all content at will. In any e-learning scenario, students are expected to exercise self-efficacy and regulative skills, while the teachers should be responsive to the interactions of the learners on the platform to achieve the desired objectives.

4. Inquiry-based learning

Inquiry-based learning is an approach that encourages learners to explore problems of interest through social interactions to create shared understanding. It enables students to develop skills to work in complicated situations, while enhancing their critical thinking abilities. This approach enables students to exercise their inquiry abilities to discover knowledge while promoting their active participation and responsibility in learning.

As students engage in self-directed learning, teachers guide them to discover new knowledge through cautious and well-planned scaffolding, such as timely and inspiring questions, demonstrations or promoting the formulation of their hypotheses for explanation. In the discovery of knowledge, such scaffolding is necessary for students to be able to investigate complex situations without subjecting them to extreme cognitive load.

It is a learning environment where students are collaboratively engaged in real-time inquiry tasks, which encourages and facilitates their abilities to analyse, evaluate, synthesize, and apply knowledge through reflection and reconceptualization of ideas. This enables them to effectively transfer their knowledge across courses and apply it to unfamiliar situations. Interactions and collaboration engage them in their learning, because as they exercise their minds to find feasible solutions to problems, their responses to their peer's questions improve their higher-order tendencies. Such social interactions enable them to share perspectives, reflect and reorganize their knowledge, and ultimately leads to the development of their critical thinking abilities.

5. Collaborative learning

Collaborative learning refers to the instructional method that offers students the opportunity to learn in a group with positive interdependence, team accountability and interactions as well as assist others to accomplish specific targets. The effectiveness of interactivity and collaboration in building and nurturing critical thinking skills is well documented in various studies (Chuang, Chiang, Yang, & Tsai, 2012; Lan, Tsai, Yang & Hung, 2012; Hwang, Hung, Chen & Liu, 2014; Yang, Gamble, Hung & Lin, 2014; Chen & Chiu, 2016). A collaborative learning environment is an effective strategy that enables students to interact among themselves by exchanging views and ideas in order to effectively accomplish their objectives. Interactive and collaborative environments empower learners to exercise their minds to find solutions to problems while developing their critical thinking tendencies, as they respond to their peer's questions in more complex and confident ways.

Learners need interaction and reflection on what they were previously exposed to, and what they are currently experiencing in both external (social) and internal (reflective) contexts in order to gain new knowledge. Piaget believed that reflection on the elements of lower-level knowledge, directly leads to the attainment of higher order thinking. Collaborative inquiry-based learning tasks facilitate students' discovery of new knowledge through the resolution of previous information while promoting their thinking skills.

In an environment where education is student-centered, learning is considered as knowledge constructing activities where learners collaboratively obtain, reorganize and use the information acquired for analyzing and solving problems. The constructivist theory averred that student are required to be exposed to learning experiences that inspire and empower them to construct their own knowledge while promoting their cognitive skills. When students engage in social interactions with peers in real world contexts, their ability to reflect on previous exposure and knowledge is facilitated, and such reflection is necessary in the enhancement of their cognitive processes.

6. Critical thinking skills

As nations across the world have become a global enclave with the generation of technologies, human productive activities have become collaborative, knowledge-based and mobile. This creates the demand for employees to possess digital, analytical and effective communication skills as machines are taking over human productive activities that require repetitive routine operations.

This development is making educational institutions emphasize on learning experiences that facilitate analysis, evaluation and synthesis of knowledge to develop skills for problem-solving through interpretation, creativity and generalization. These learning experiences promote reproductive thinking rather than productive reasoning. Critical thinking ability is a level that is beyond memorization of information or quoting facts back to an individual in exactly the same manner as they were previously expressed. It is the use of critical and creative thought that enables an individual to solve complex problems through analysis, evaluation and synthesis of knowledge. Critical thinking is observed when an individual receives and stores new knowledge, while interrelating and applying such information to address unfamiliar situations. It is the ability of individuals to achieve a complex and logical thinking process that allows them to interpret, evaluate and manipulate previous experiences, in order to confront present life challenges.

Objective of the model

The objective of this instructional model based on mobile-blended and inquiry-based learning is:

to provide Business education teachers in Nigeria with an instructional model that will enable them to enhance the critical thinking skills of their undergraduate students, by using mobile-blended learning with inquiry-based approach.

Components of an inquiry-based mobile blended learning Model

1. **Factors that facilitate teachers' activities**

The activities of the teachers in this model are divided in two (mobile and face-to-face activities). The following factors enable the teachers to perform their activities effectively:

1.1 Teachers' participation in the decision-making process. They need to be part of the decision-making process to introduce mobile-blended learning. When they are allowed to be part of the decision-making process, they become empowered and motivated to implement the new teaching approaches in their classes. Their participation enables the management to glean information on the possible barriers that will affect implementation, and find ways to circumvent them.

1.2 Mobile-blended learning teachers' orientation. The orientation offers an opportunity to introduce the teachers and students to their various roles, appropriate hardware/software sensitization, setup their devices/accounts, and expose them to the relevant school policies, regarding the innovation. The orientation also provides a forum to explain to the teachers and students how and where they can seek support for effective participation, and the incentives for the teachers that will motivate them to embrace and be dedicated to the innovation.

1.3 Teachers' competencies. Teachers require abilities to appropriately blend both the mobile and face-to-face components, to achieve the desired outcome. In addition, their ability to design and deliver mobile content in suitable formats is very important. Their skills to appropriately guide students in these learning contexts, and keep them on track to achieve their learning goals. Teachers require regular training to enhance their competence on how to redesign online instruction and manipulate the learning management system proficiently. Such training initiatives are directed towards achieving a proper blend of both components.

1.4 Teachers' support. The support for Teachers is crucial in the implementation of blended learning. This can be in the forms of teaching assistants, technical support, and exposure to successful blended learning prototypes. Such forms of support could be accessed through collaboration, experienced teachers serving as mentors to beginners, and the establishment of a technical support unit, to ensure smooth functionality of the devices across the entire innovation. This will boost their confidence and allay any anxiety they may have in embracing the innovation.

2. Factors that facilitate students' activities

Similarly, the activities of the students are divided into mobile and face-to-face activities. However, adequate support for them is a mandatory requirement, as they are the focus of the activities with regards to the innovation. When learners get support, their sense of belonging and social ties are enhanced, which in turn strengthen their participation in online learning. Technical support is crucial to promote their effective interaction with technology-mediated instructional materials, because it helps to eliminate any anxiety associated with it, and closes the digital gap among students. Prior to implementation, the need to put in place a robust blended learning lifeline for the students cannot be overemphasized, because it helps to dispel their uneasiness and promote their confidence to leverage on the benefits provided by technology, as learning tools.

3. Processes of an inquiry-based mobile blended learning Model

3.1 Teachers' mobile activities

Mobile activities refer to the activities of the teachers via mobile technology.

These mobile activities include:

3.2 Teacher design mobile content.

Teachers have to design content via mobile devices. Depending on the nature of content, the teachers should design the content in appropriate media formats (text, images or videos). The media format should promote students' understanding of the content.

3.3 Teachers deliver mobile content to students via mobile.

The content should be delivered to students in chunks, this is to ensure that it does not overwhelm them. The design of mobile learning materials should take advantage of the multimedia offered by the devices and be delivered to students in bits, because of the small screen size associated with the devices. Where possible video formats should be used.

3.4 Teachers explain complex concepts of the content to students.

In order to facilitate students' understanding and to avoid their misconception of the content, the teacher should explain the complex terms of the content to the students, by providing them with additional information.

3.5 Teachers evaluate students' mobile learning.

To determine the students' level of understanding of the mobile content, the teacher should ask students questions on the content. This enables the teacher to ascertain whether or not the students understand the content, and to provide clarification where necessary. This is to sufficiently prepare the students for the classroom context.

4. **Face-to-face activities by teachers**

These are the activities of the teachers in the classroom context.

4.1 Teacher recap the mobile content.

At the beginning of the face-to-face context, the teacher provides the students with a summary of the mobile content. This to refresh the students' memories and to sufficiently prepare them for inquiry-based tasks in the classroom.

4.2 Teachers generate work-related ill-structured problems.

This is to trigger their reasoning ability and engages their critical thinking processes. This is where the teachers link the mobile content to the classroom activities to achieve a suitable blend of both contexts of blended learning. To achieve this, the problems should be related to the mobile content, to encourage the students to analyse, evaluate and synthesize the content in their inquiry activities, to proffer possible solutions to the problems.

4.3 Teachers divide the students into heterogenous groups.

This is to reflect the various backgrounds of the students regarding their knowledge domains, to encourage their ability to share robust perspectives and offer alternative solutions in their inquiry activities.

4.4 Teachers facilitate elaborate interactions among the students

The teacher should encourage the students to engage in discussions, to helps them to share ideas, which results in reflection and reorganization of their knowledge in their inquiry learning activities. This promotes the students' ability to reconceptualize their previous knowledge with the perspectives of their peers to solve problems.

4.5 Teachers scaffold students' knowledge.

While the students engage in their collaborative inquiry learning tasks, teachers play the role of a guardian and facilitator, by scaffolding their knowledge with questions that encourage them to exercise their minds to resolve unfamiliar problems.

4.6 Teachers evaluate students' critical thinking skills

To do this the teachers need to develop critical thinking assessment check list to evaluate the students' critical thinking skills in the following:

4.6.1 Ability to separate fact-based information from inferences in the mobile content

4.6.2 Ability to analyse the mobile content and separate relevant from irrelevant information

4.6.3 Ability to relate fact-based information in the mobile content to new situations

4.6.4 Ability to identify new information that support the solutions in their inquiry activities

4.6.5 Ability to identify alternative interpretations of the content

4.6.6 Ability to reorganize relevant information to solve problem

4.6.7 Ability to reason logically in the application of content in a new situation

4.6.8 Ability to communicate ideas clearly and effectively

5. Students' mobile activities

Students perform these activities via mobile technology

5.1 Students access and study mobile content from their teacher

The students access and study mobile content from the teacher in their various locations via their mobile devices.

5.2 Students ask their teachers questions on confusing and complex concepts of the content.

This enables them to attain greater understanding of the content.

5.3 Students answer mobile quizzes from their teachers.

While the students answer quizzes from the teachers via their mobile devices, they develop the ability to apply the content.

5.4 Search and study other related online materials.

This promotes students' deeper understanding of the mobile content as they are exposed to other similar content by other educators.

6. Students' Face-to-face activities

The face-to-face context is where the teachers lead their students through inquiry tasks with the focus to develop their critical thinking skills. Below are the roles of students in this context.

6.1 Listen actively as their teacher summarizes the mobile content.

6.2 Ask their teachers questions on the mobile content.

6.3 Answer questions from their teacher on mobile content.

6.4 Partner with their teachers to generate work-related problems in line with the mobile content.

6.5 Identify their various inquiry groups.

6.6 Students interact and collaborate with their group members to analyse the problem and the mobile content.

6.7 Use teacher's questioning to analyse and evaluate their knowledge of the mobile content.

6.8 Reorganize their knowledge of mobile content to resolve the problem.

6.9 Evaluation of the processes.

The students should be given anonymous and structured questionnaire to elicit responses regarding their level of satisfaction with the processes, the design, the amount of work, motivation, learning gains, as well as the teacher's attributes, using the five-point Likert-scale. This is to provide information that will determine the modifications required for making the project more effective.

7. The mobile context

To ensure maximum benefits from the mobile context, the following are necessary:

7.1 Both teachers and students must possess ICT hardware such as mobile devices

7.2 Teachers and students must be proficient in the manipulation of their mobile devices as teaching and learning tools respectively

7.3 The mobile devices must be internet enabled

7.4 There must be application software installed in the devices that will assist the teachers and students to deliver and access mobile instructional content respectively, example of such software can be WhatsApp, Line, Facebook messenger or any other preferred learning management system.

7.5 There should be a learning community of the student where students can interact and collaborate while studying the mobile instructional content

Process of an inquiry-based mobile blended learning Model

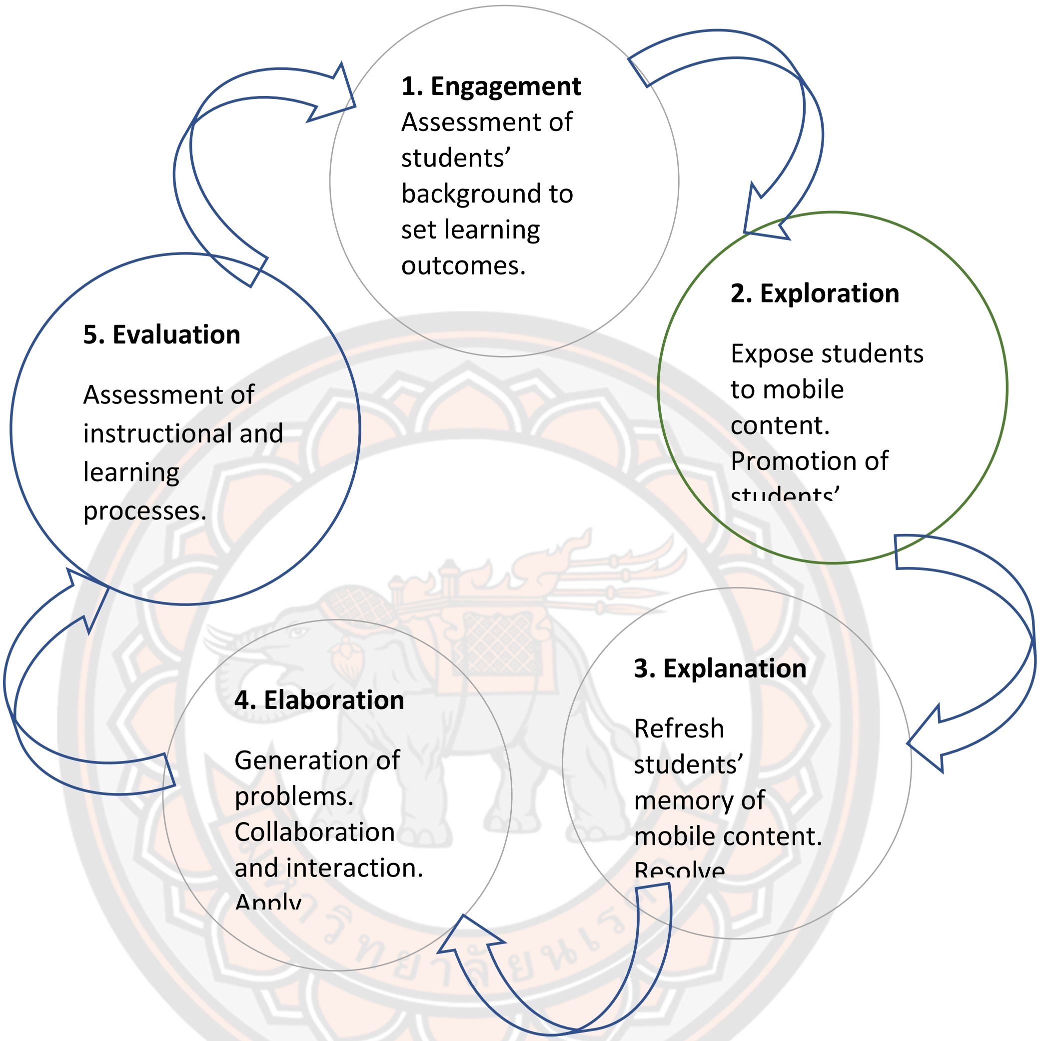

Figure 11 Steps in inquiry-based approach in mobile-blended with inquiry-based learning

Processes in inquiry-based approach with mobile-blended learning

Phase I: Engagement

The focus of teachers at this phase is on the students' existing knowledge. What is their background knowledge? It is not intended for teaching or to provide explanation to students, but to find out what they already know, which will form the basis of what they need to learn. This is achieved through formative assessments, which leads to the establishment of learning objectives.

Phase 2: Exploration

At this stage, teachers deliver mobile content in an appropriate format (video, text, image or a combination of them) and with a user-friendly platform for students to study. The content should complement face-to-face sessions, and be available to students synchronously and asynchronously. This enables collaboration when it is synchronous, while it can enable students to consolidate learning when asynchronous. The online presence of teachers needs to be consistent and interactive to enable the students to internalize the meaning of the content. As students study the mobile material, the teachers ask questions to ascertain their understanding while scaffolding their knowledge. This promotes the application of insight gained from the content and consolidates learning, to ensure sufficient preparation for interactive classroom participation.

Phase 3: Explanation

Moving the lecturing part of the class activities to an online platform, at the exploration phase, is to allow adequate time for face-to-face encounters which engages the learners in interactive inquiry tasks that promote the development of their critical thinking skills.

This stage is to enhance students' understanding of the mobile content, at the beginning of classroom sessions of mobile-blended learning. A succinct review of the online instructional material is necessary to resolve any misunderstanding of the content by the learners, and to explain more complex concepts. This is to facilitate their ability to reorganize their knowledge of the content and apply it to unfamiliar situations. Teachers ask students questions to determine their understanding of the mobile content.

Phase 4: Elaboration

At this stage students are engaged in inquiry tasks by giving them ill-structured work-related problems. The problems should be linked with the mobile content, while they are to analyse, evaluate and synthesize their knowledge of the mobile material in solving the problems. The exposure of learners to ill-structured problems triggers their reasoning ability, that enhances their critical thinking, while the teacher plays the role a of facilitator. As they engage in their inquiry activities, teachers scaffold their knowledge by asking logical questions that probe their minds to ignite critical thinking.

To ensure students' interactions and collaborative activities, they should be divided into heterogenous inquiry groups. The ability of a group to solve problems collaboratively, depends on the diversity of the membership in relation to their domains of knowledge and backgrounds. This diversity, to a large extent, determines their level of perspective sharing and their ability to proffer alternative solutions to problems.

Engaging in social interactions with peers in real world contexts has the potential of facilitating learners' ability to reflect on their previous exposure, and collaborative inquiry learning environments are critical for developing social experiences. As the students engage in collaborative problem solving, the teacher has to ensure elaborate interaction. Social interaction is very important in the development of critical thinking, because as the learners share perspectives, their reasoning horizon is broadened to accommodate and further their thinking with the views of others.

Phase 5: Evaluation

Both teachers and students are involved in the assessment. The teachers evaluate the level of the students' critical thinking with an assessment checklist. During the evaluation, the teachers' focus is on the extent to which the students have been able to reorganize their knowledge of the mobile content in their inquiry activities.

The students are given an anonymous and structured questionnaire to elicit responses from them on their satisfaction, motivation, teamwork, learning gains, etc., about the innovation, as well as the instructor's attributes, the design, amount of work, etc using five-point Likert-scale.

Both the teachers' and students' assessments are to determine whether or not the innovation is effective in achieving its goal and to identify the areas that can be improved upon for efficiency and effectiveness.

Table 11 Teachers' and students' activities in mobile-blended with inquiry-based learning to enhance critical thinking skills

Inquiry steps	Context	Teachers' activities	Students' activities	Output
Steps 1: Engagement				
1.1 Analysis of students' backgrounds	Face-to-face	1.2 Conducts a formative assessment to analyse students' background knowledge.	1.3 Students participate in formative assessment.	1.4 Teacher establishes learning outcome
1.5 Design of mobile content	Online	1.6 Reviews curriculum outline		1.7 Produces a sketch of learning activities that the students need to undergo to accomplish the set learning objectives.
1.8 Develop mobile content	Online	1.9 Reviews curriculum content to produce mobile learning content		1.10 Produces mobile learning content in suitable mobile media formats.
Step 2: Exploration				
2.1 Delivery of mobile learning content	Online	2.2 Sends mobile learning content to students via mobile device	2.3 Study mobile learning content in their various location via their mobile devises	2.4 Students develop preliminary knowledge of mobile content.
2.5 Assessment of students' understanding of mobile content	Online	2.6 Sends personalized quizzes on the mobile content to students	2.7 Students answer quizzes from teacher	2.8 Teacher identifies areas in the mobile content students need clarification
2.9 Reinforcement of students' understanding	Online	2.10 Clarifies confusing/complex concepts of mobile	2.11 Ask questions on confusing/ complex	2.12 Student acquire improved understanding

Inquiry steps	Context	Teachers' activities	Students' activities	Output
and ability to apply mobile content knowledge		content	concepts of the mobile content	of mobile content
		2.13 Asks students to search for and study online content that relates to the mobile content earlier sent to them.	2.14 Search for and study online content that relates to the mobile content sent to them by the teacher	2.15 Students generates new knowledge
		2.16 Encourage students to interact with their peers on the mobile content	2.17 Interact with their peers to share ideas on the mobile content	2.18 students help their peers to gain better understanding
Step 3: Explanation				
3.1 Refresh students' memory of mobile content	Face-to-face	3.2 Summarizes mobile content	3.3 Listen as teacher summarizes the mobile content	3.4 Teacher prepares students for class activities
3.5 Consolidation of students' understanding of mobile content	Face-to-face	3.6 Asks students questions with the view to resolves their misconceptions of concepts of mobile content	3.7 Answer questions on mobile content	3.8 Teacher facilitates students' understanding of mobile content
Step 4: Elaboration				
4.1 Generation of work-related problems	Face-to-face	4.2 Generates work-related problems with the students in line with the mobile content	4.3 Generate work-related problems with the teacher in line with the mobile content	4.4 Teacher and students establish real-life problem
4.5 Division of students into inquiry groups	Face-to-face	4.6 Divides students into heterogenous groups to reflect their knowledge backgrounds	4.7 Students identify their various inquiry groups	4.8 Students are divided into inquiry groups to promote collaboration

Inquiry steps	Context	Teachers' activities	Students' activities	Output
4.9 Presentation of work-related problems to the students	Face-to-face	4.10 Present work-related problems to each of the inquiry groups	4.11 Students interact and collaborate with their group members to analyse the problem and the mobile content	4.12 students are presented with inquiry learning tasks
4.13 Facilitation of elaborate interact	Face-to-face	4.14 Encourages the students to analyse the problems by asking them questions	4.15 Use questions from teacher to guide their analysis of the problem	4.16 Students interactions are enhanced
4.20 Application of knowledge to a new situation	Face-to-face	4.17 Facilitates students' knowledge of the mobile content by asking them questions	4.18 Use teacher's questioning to analyse and evaluate their knowledge of the mobile content	4.19 Students' knowledge is scaffolded
			4.21 Reorganize their knowledge of mobile content to resolve the problem	4.22 Apply synthesized knowledge to resolve problem
Step 5: Evaluation 5.1 Evaluation of critical thinking skills with rubrics	Face-to-face	5.2 Assesses the students' abilities in the analysis, evaluation and synthesis of the mobile learning content in their inquiry tasks		5.3 Teacher determines the effectiveness of the instructional process

Inquiry steps	Context	Teachers' activities	Students' activities	Output
5.4 Evaluation of the inquiry learning process	Face-to-face		5.5 Assess how the inquiry learning process has enhanced their critical thinking skills.	5.6 Students determine the effectiveness of the learning process.

Criteria for assessing critical thinking skills in an inquiry-based mobile blended learning

1. Ability to separate fact-based information from inferences in the mobile content
2. Ability to analyse the mobile content and separate relevant from irrelevant information
3. Ability to relate fact-based information in the mobile content to new situations
4. Ability to identify new information that support the solutions in their inquiry activities
5. Ability to identify alternative interpretations of the content
6. Ability to reorganize relevant information to solve problem
7. Ability to reason logically in the application of content in a new situation
8. Ability to communicate ideas clearly and effectively.

An instructional model based on mobile-blended and inquiry-based learning to enhance students' critical thinking abilities of business education undergraduate students in Nigeria

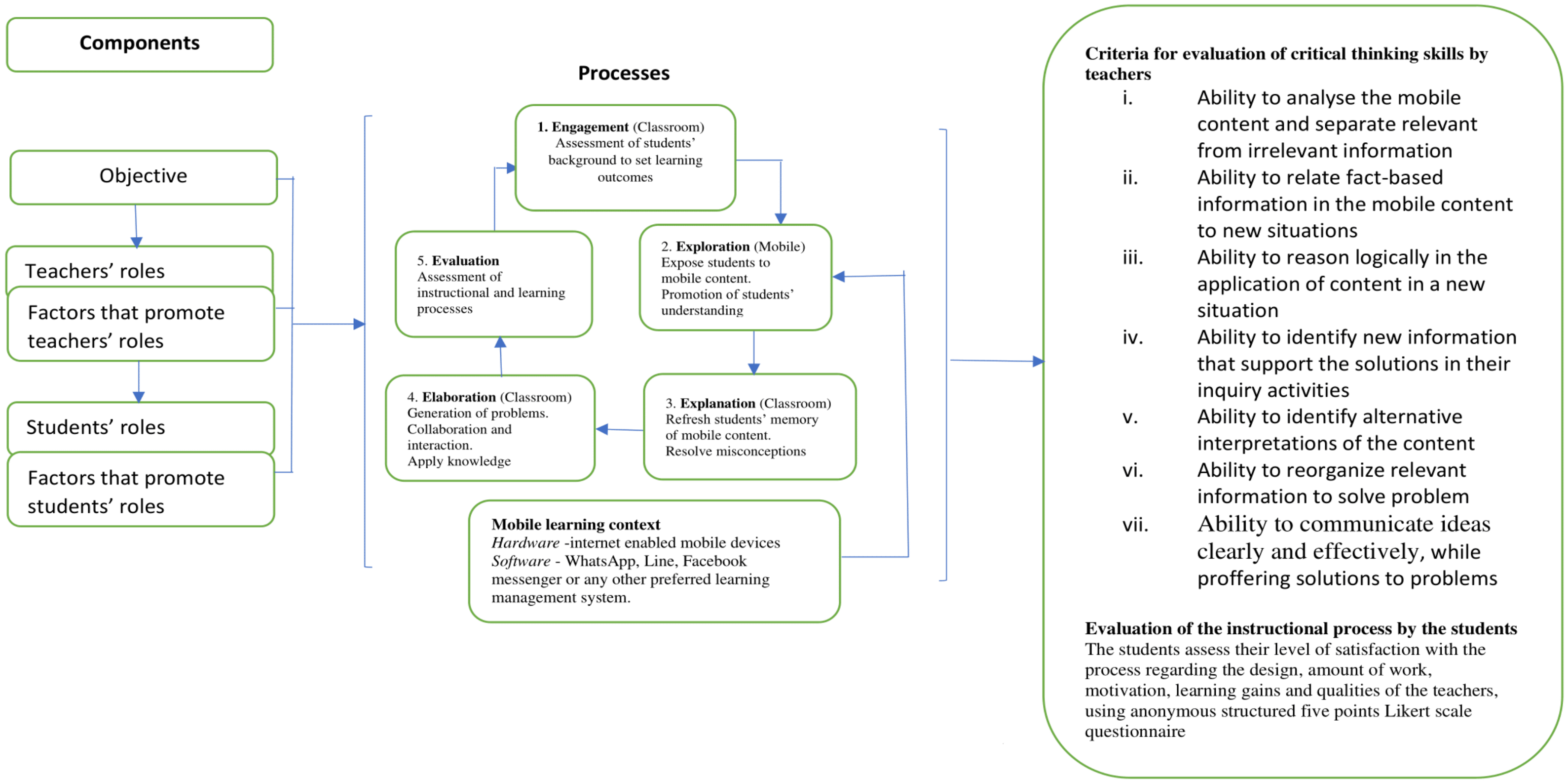

Figure 12 A flowchart of the instructional model

CHAPTER VI

CONCLUSION, DISCUSSIONS AND RECOMMENDATIONS

Conclusion

The activities carried out at the various phases of this study to accomplish the objectives reveal that the critical thinking abilities of business education undergraduate students can be enhanced through the effective implementation of mobile-blended and inquiry-based learning. As today's world is becoming more complex and dynamic, the development of individuals' critical thinking skills has become more important.

These skills enable individuals to think creatively to find solutions to the challenges in their environment. When students are equipped with these skills they are empowered to effectively contribute positively to society. To achieve this, business education teachers need to embrace modern approaches that will facilitate their ability to engage their students in active learning for the enhancement of their cognitive processes.

To effectively adopt inquiry-based mobile-blended learning for the development of critical thinking abilities in business education undergraduates, the study found that higher educational institutions should encourage the participation of teachers in the process of deciding to adopt the innovation, regular training of teachers to acquire the requisite competencies, exposure of the teachers and their students to mobile-blended orientation, and robust support were found to be factors that enable them to perform their various roles effectively.

The research participants indicated that, since the mobile content is the foundation of the classroom activities, it should complement the face-to-face session which is dedicated to the enhancement of the critical thinking skills of the students. Teachers should possess the ability to effectively design, develop and deliver the content to facilitate their students understanding of it.

To ensure a smooth implementation of the innovation and maximum benefits, adequate support for the teachers and their students is essential. Support for teachers can be in the form of teaching assistants, technical support, and exposure to successful blended learning prototypes. Such forms of support can be accessed through teacher collaboration, experienced teachers serving as mentors to the beginners while establishing technical support units, to ensure effective functionality of the devices and the entire innovation.

The online learning community was found to be one of the processes for implementing mobile-blended learning to enhance students' critical thinking skills. This is because it fosters collaborative inquiry learning activities among its members, leading to the reconceptualization of knowledge. Social interaction is very important in the development of critical thinking because as the learners share perspectives, their reasoning horizon is broadened to accommodate and further their thinking with the views of others. Studies have shown that the lack of interaction leads to failure and ultimately their withdrawal from the online platform. Similarly, teachers can collaborate with their colleagues on issues relating to their practices that ensures effective implementation of the innovation.

The students require support to maximize the benefits from mobile-blended learning. When they support themselves, their sense of belonging and social ties are enhanced, which in turn strengthens their participation in both their online learning and inquiry activities. Support from their teachers and peers is essential for encouraging and sustaining their online studying. The creation of a blended learning community promotes collaborative and interactive study that encourages them to assist each other in their learning. This is important because when collaboration and social support are not embedded in online learning platforms, participants feel isolated and eventually withdraw from studying the mobile content. Technical support is crucial to promote their effective interaction with the technology-mediated instructional materials because it helps to eliminate the anxiety associated with the use of technological tools and close the digital gap among them.

The entire innovation needs to be evaluated periodically, the evaluation is to identify the associated challenges, and to provide a strategy to strengthen it. The development of positive attitudes in the teachers toward the innovation was also found to be a critical factor for successful integration, this promotes their comfort and ultimate dedication.

Discussion

This chapter discusses the findings of this study in relation to the factors and processes associated with the adoption of mobile-blended learning with the inquiry-based approach, to enhances the critical thinking skills of undergraduate students.

Teachers' participation in the process of making the decision to introduce innovation in schools, was also found to be associated with effective implementation of the educational strategy that enhances undergraduates' cognitive skills. This finding is consistent with many previous studies. When teachers assume ownership of the decision to implement blended learning in their professional activities, it is as a result of their participation in the process. When teachers are given the opportunity to participate in the educational decision-making process, they become empowered and motivated to implement the new teaching approaches in their classes (Mangunda, 2003; Somech, 2010; Gelaye, 2019). Teachers' participation in the decision-making process in schools, not only leads to improved communication among them and the school management, but also promotes the quality of such decisions (Algoush, 2010). As they are the custodians of teaching/learning and implementers of school activities, their involvement in decision making ensures valid and feasible choices are made, as well as better implementation, resulting in improved students' achievements (Gemechu, 2014). Teachers' inclusion in the process of decision making is essential for the improvement and overall transformation of school activities, therefore, school management should encourage their participation (Bademo, & Tefera, 2016). This will enable the management to glean information on the possible barriers that will affect implementation, and find ways to circumvent them.

The study found that competence was an influencer for the development of critical thinking skills using mobile-blended learning in conjunction with the inquiry-based method. Teachers' abilities to appropriately blend both the online and face-to-face components, determine the achievement of the desired outcome. Many researchers have highlighted the importance of competencies in a mobile-blended learning environment. Teachers' technological skills and ability to adopt the appropriate blend to achieve the expected outcomes, are crucial for effective blended learning environments (Alebaikan, & Troudi, 2010; Korr, Derwin, Greene, & Sokoloff, 2012). Teacher training should equip them with mobile learning instructional design, pedagogy, learning management system usage and assessment, if they are to succeed in this specific learning environment (Oliver, & Stallings, 2014; Arney, 2015; Pulham & Graham, 2018). Law, Geng, & Li (2019) emphasized that teacher's skills to appropriately guide students in these learning contexts, and keep them on track to achieve their learning goals. When teachers possess the appropriate skills to adopt this new innovation, learners' achievements are guaranteed.

Online content was found to be significantly associated with the development of students' critical thinking, when adopting this strategy, which has been confirmed by many scholars. The design and delivery of instructional content for mobile learning is significantly different from those of other learning contexts (Caudill, 2007). The design of the materials should take advantage of the multimedia offered by the technology and delivered to students in chunks, due to the varying screen sizes associated with the devices. The online content should not overwhelm the students (Jantakoon, & Piriyasurawong, 2018), and where possible video format should be used, because visual learning materials are more effective when using blended learning (Abeysekera, & Dawson, 2015; Lo & Hew, 2017). Learners are better prepared for face-to face interactions when they study online using video formats, rather than text-based content (Grypp, & Luebeck, 2015). The online presence of teachers needs to be consistent and interactive to enable the students to internalize the meaning of the content. Since mobile content is the foundation of classroom activities, the content should complement face-to-face sessions, and be available to students synchronously and asynchronously (Keskin, & Yurdugül, 2019). This enables collaboration when it is synchronous, while it can enable students to consolidate learning when asynchronous. In addition, the content should be delivered to the learners via user-friendly platforms, because the ease of use and functionality of it, significantly enhances learners' achievements in blended learning (Loukis, Georgious, & Pazalo, 2007; Shrain, 2012). When learners are satisfied with the functionality of the system, they acquire greater knowledge (Islam, 2014; Goyal, &

Tambe, 2015). The online content, quality of the technology as well as how it is used, has a direct relationship to learners' satisfaction and achievements.

This study found that the orientation of mobile-blended learning is associated with the development of students' critical thinking when adopting this strategy. This finding is supported by the works of other researchers. A robust orientation prior to the introduction of mobile-blended learning, offers an opportunity to introduce the users (teachers and students) to their various roles, appropriate hardware/software sensitization, setup their devices/accounts, and expose them to the relevant school policies (Nestel, Ng, Gray, Hill, Villanueva, Kotsanas, Oaten, & Browne, 2010; Reichert & Mouza, 2018). Yi (2008) carried out a study to examine the effect of orientation on the adoption of blended learning among nursing students, and claimed that it enhanced communication skills and clinical practices of the students. Washington (2009), one of the major proponents of blended learning, emphasized that orientation helps to promote students learning outcomes and the attainment of institutional goals. He stressed that induction as well as other factors, rather than sole dependence on technology, result in a blend that leads to achievement of the desired goals. While the innovation is being implemented, the teachers and students who join later also require robust orientation, which will ease their anxieties and enhance their confidence in this new educational environment (Antwi, Tampah-Naah, & Buame, 2019). Mobile-blended learning orientation, among others, provides a forum to explain to the users how and where they can seek support for effective participation, and the incentives for the teachers that will motivate them to embrace and be dedicated to the innovation.

Below is the discussion of the findings of this study, in relation to the processes associated with the adoption of mobile-blended learning with inquiry-based tasks, to enhance the critical thinking skills of undergraduates.

The online learning community was found to be one of the processes for implementing mobile-blended learning to enhance students' critical thinking skills. This is because it fosters collaborative inquiry learning among its members, leading to reconceptualization of knowledge. Antwi, Tampah-Naah, & Buame (2019) emphasized the need to ensure collaboration in online teaching and learning, rather than studying individually. Social interaction is very important in the development of critical thinking, because as the learners share perspectives, their reasoning horizon is broadened to accommodate and further their thinking with the views of others. Studies have shown that the lack of interaction leads to failure and ultimately their withdrawal from the online platform (Astleitner, 2000; Zielinski, 2000; Willging, & Johnson, 2009; Kintu, Zhu, & Kagambe, 2017). Similarly, teachers are able to collaborate with their colleagues on issues relating to their practices that ensures effective implementation of the innovation.

The support for Teachers was found to be crucial in the implementation of blended learning. This can be in the forms of teaching assistants, technical support and exposure to successful blended learning prototypes, as well as orientation. Such forms of support could be accessed through collaboration, experienced teachers serving as mentors to beginners and the establishment of a technical support unit, to ensure smooth functionality of the devices across the entire innovation (Heaney & Walker, 2012; Kenney & Newcombe, 2010; Gedik, Kiraz, & Ozden, 2013; Ma'arop, & Embi, 2016). This will boost their confidence and allay any anxiety they may have in embracing the innovation. Teachers require regular training to enhance their competence on how to redesign online instruction and manipulate the learning management system proficiently (Arney, 2015; Pulham, & Graham, 2018). Such training initiatives are directed towards achieving a proper blend of both components. In the work of Han, Wang & Jiang (2019) technical and teaching support were found to be among the drivers of successful blended learning in schools.

Adequate support for students is a mandatory requirement, as they are the focus of the activities with regards to the innovation. Rovai (2002) stated that when learners get support, their sense of belonging and social ties are enhanced, which in turn strengthen their participation in online learning. Support from teachers and peer are essential to encourage and sustain learners in online learning (Lee, Srinivasan, Trail, Lewis, & Lopez, 2011; Fryer, & Boyee, 2018). concluded in their various studies, that teachers' online support is necessary for the promotion of higher order thinking in students, because it is a reflection of the constructivist' approach to teaching and learning, and also guarantees their sustainability while learning (Johnson, 2017; Fryer, & Boyee, 2018). Furthermore, Aghaee, & Keller (2016) observed that online peer support is very helpful for undergraduates to guarantee effective online learning. In addition, Han, Wang, & Jiang (2019) emphasized that when challenges are detected while blended learning is being implemented, timely support is essential to sustain its effectiveness. Studies have shown that technical support is crucial to promote effective interaction with technology mediated instructional materials, because it helps to eliminate any anxiety associated with it, and closes the digital gap among students (Graham, 2004; Johnson, 2017; Cocquyt, Zhu, Diep, De Greef, & Vanwing, 2019). Prior to implementation, the need to put in place a robust blended learning lifeline for the students cannot be overemphasized, because it helps to dispel their uneasiness and promote their confidence to leverage on the benefits provided by technology, as learning tools.

The responses of the majority of the respondents of this study indicated the need to create a mobile-blended learning innovation fund, which will serve as a source of incentives to the teachers charged with implementation. A greater number of them agreed that incentives such as financial compensation, sponsorship for seminars and provision of mobile devices would motivate them to embrace mobile-blended learning, to enhance critical thinking abilities of their students. The provision of incentives like transport fares during face-to-face sessions and grants to participate in conferences, workshops, loans and bonuses by managements, has helped various schools, globally, to encourage the implementers of blended learning to be dedicated (Raphael, & Mtebe, 2016). In addition, Porter, Graham, Spring, & Welch (2014) stated that many educational institutions have successfully introduced and sustained blended learning with the provision of stipends and devices to the teachers. Some studies have also reported other incentives associated with the use of technological tools for teaching to include additional time, technical support, sponsorship for training and other forms of compensation (Lau, & Yeun, 2013; Jaschik, & Lederman, 2013; Digedu, 2014; Hall, 2017). The creation of mobile-blended learning innovation fund will help to facilitate the provision of these incentives to encourage the teachers towards the adoption, as well as the overall transformation of the innovation in tertiary institutions.

Teachers' online activities to enhance critical thinking, should offer students adequate preparations for classroom interactive learning, by designing mobile instructional content to meet their needs. Delivering such materials in an appropriate format for students to study in their various locations, providing online clarification regarding confusing concepts, and sending personalized quizzes to students to ascertain their understanding of the content. The out-of-class blended learning sessions should enable the learners sufficient information for problem solving in face-to-face environments. As the students study the material in text or video format, the teacher asks questions to ascertain their understanding while scaffolding their knowledge (Bishop, & Verleger, 2013; Hew, Huang, Chu, & Chiu, 2016; Lo, & Hew, 2017). This promotes the application of insight gained from the content and consolidates learning, to ensure sufficient preparation for interactive classroom participation.

Classroom activities such as recapping the online material to refresh the students' memories, generating real-life problems, dividing them into small groups, ensuring elaborate discussion and scaffolding their knowledge by asking logical questions that are associated with the enhancement of critical thinking. A succinct review of the online instructional material is necessary to resolve any misunderstanding of the content by the learners, and to explain more complex concepts (Grypp, & Luebeck, 2015; Chao, Chen, & Chuang, 2015; Lai & Hwang, 2016; Lo & Hew, 2017). In the study by Choi & Lee (2009), preservice teachers were presented with ill-structured problems, and the results showed significant improvement in their cognitive and problem-solving skills. The exposure of learners to ill-structured problems triggers their reasoning ability, that enhances their critical thinking, while the teacher plays the role of facilitator (Smy, Cahillane, & MacLean, 2016; Jantakoon, & Piriyasurawong, 2018; De León, 2018). Grouping students into small heterogenous teams to participate in real-life inquiry-based exercises, has been found to be among the most effective processes in developing their critical thinking abilities. The ability of a group to solve problems collaboratively, depends on the diversity of the membership in relation to their domains of knowledge and backgrounds (Edmondson & Harvey, 2017; Avdiji, Elikan, Missonier, & Pigneur, 2018). This diversity, to a large extent, determines their level of perspective sharing and their ability to proffer alternative solutions to problems. As the students are engaged in collaborative problem solving, the teacher has to ensure elaborate interaction. Engaging in social interaction with peers in real world contexts has the potential of facilitating learners' ability to reflect on previous exposure, and collaborative inquiry learning environments are critical for developing social experiences (Hwang, Shi, & Chu, 2011; Fu, & Hwang, 2018). Such social interactions promote the development of students' critical thinking abilities that enables them to effectively transfer their knowledge across courses and apply it to unfamiliar situations. As they collaborate, effective implementation of inquiry instruction, requires teachers to appropriately scaffold tasks that will enable their students to understand how to exercise their minds, acquire step-by-step knowledge on how to resolve situations, how to collaborate with peers and how to deeply reflect on their learning (Harris, & Rooks, 2010; Gillies, & Nichols, 2015).

This study found that the following online activities of the students were important to prepare them sufficiently for their interactive face-to-face sessions: studying mobile instructional content from their teachers, communicating with them anytime anywhere for clarification on confusing concepts, and exchanging ideas among themselves. Searching for and studying related information and attempting online quizzes on the content from their teachers, to consolidate their learning. Moving the lecturing part of the class activities to an online platform, is to allow adequate time for face-to-face encounters which engages the learners in interactive inquiry tasks that promote the development of their critical thinking skills (Bergmann, & Sam, 2014; Grypp, & Luebeck, 2015; Jantakoon, & Piriyasurawong, 2018). By using mobile devices, the gap between teachers and learners is eliminated as they enable teachers to offer guidance to their students' that are engaging in online learning activities (Song, & Siu, 2017; Wishart, 2018). Mobile learning tools motivate students to participate actively in learning, because as they collaborate with their peers, they are encouraged to share perspectives on issues relating to their learning content (Boyce, Mishra, Halverson & Thomas, 2014; Ciampa, 2014; Davie, 2017). During online encounters, learners can access various online platforms that offer educational materials to consolidate their learning (Ozdamli, & Cavus, 2011; Lepp, Barkley, & Karpinski, 2014; Mwapwele, & Roodt, 2016). When teachers' follow-ups are incorporated in online learning, it enhances their students' abilities to apply what they have learnt (Szpunar, Jing & Schacter, 2014; Jantakoon & Piriyasurawong, 2018). These activities when carried out effectively, provide an adequate background for learners to effectively participate in the face-to-face interactive sessions of blended learning.

The study revealed that students' classroom activities, such as asking questions regarding confusing concepts in the mobile content, and interacting extensively to reconceptualize new knowledge, while promoting their problem-solving abilities. Questions and answers should be an integral part of reviewing the online content at the beginning of face-to-face meetings, which enables the teacher to assess and reinforce their understanding of it (Grypp & Luebeck, 2015; Jantakoon & Piriyasurawong, 2018). When students engage in collaborative inquiry learning with peers in real world contexts, their critical thinking skills are activated to resolve unfamiliar problems (Hwang, Shi & Chu, 2011; Fu & Hwang, 2018). Such collaboration should be centered on adequate interactions and tasks, that will guarantee their ability to analyze, evaluate and synthesize their knowledge to solve problems.

Recommendations

This research recommends the following for effective implementation of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria.

Most importantly, the government should increase the funding of education to promote the integration of technology in the educational sector. Technology integration requires funds for procurement and implementation, as well as continuous maintenance and development of the staff for proper utilization. Adequate financial and staff support is important if teachers are expected to adopt technology appropriately to promote learning for their students.

Development of the necessary competencies through regular robust training for the teachers should be integrated into the policies of the institutions. This will enhance their professional skills to effectively engage their students in the development of their critical thinking skills. These competencies include abilities to proficiently manipulate mobile devices as educational tools, the ability to develop and design mobile content to facilitate students' understanding, the ability to adopt an appropriate blend of the mobile and classroom activities, the ability to scaffold learners' knowledge to trigger their critical thinking process, etc.

The government and higher education institutions should initiate drastic measures to make internet connectivity available in schools for both teachers and their students as it is obtainable in most countries in the world. This will not only facilitate the implementation of the instructional model based on mobile-blended and inquiry-based learning to enhance critical thinking abilities for business education undergraduate students in Nigeria but will enhance the teachers' and their students' access to vast and richer educational material. The high cost presently associated with internet connectivity presently in most African countries, including Nigeria can discourage both teachers and their students to embrace online learning.

School management should encourage teachers' participation in the process of deciding to introduce innovation in schools. Their participation in the decision-making process in schools, not only leads to improved communication among them and the school management but also promotes the quality of such decisions. This was also found to be associated with the effective implementation of the educational strategy that enhances undergraduates' cognitive skills. This practice encourages the teachers to assume ownership of the decision to implement blended learning in their professional activities. When teachers are allowed to participate in the educational decision-making process, they become empowered and motivated to implement the new teaching approaches in their classes.

A robust mobile-blended learning orientation programme should be conducted before the introduction of the innovation. This offers an opportunity to introduce the users (teachers and students) to their various roles, and appropriate hardware/software sensitization. Orientation programme helps to promote students learning outcomes and the attainment of institutional goals. Mobile-blended learning induction and other factors, rather than dependence on technology alone result in a blend that leads to the achievement of the desired results. It provides an opportunity to set up the devices, support students to set up their accounts, expose the students to the acceptable use policy of the school, and guidelines on the use of some apps selected by the teachers. As the innovation is being implemented, the newly employed teachers and newly admitted students that later join, also require a robust blended learning orientation programme, to ease their anxieties and enhance their confidence in the environment. Mobile-blended learning orientation, among others, provides a forum to explain to the users how and where they can seek support for effective participation, and the incentives for the teachers that will motivate them to embrace and be dedicated to the innovation.

Mobile learning community should be institutionalized to promote students' collaboration as one of the processes for implementing mobile-blended learning to enhance students' critical thinking skills. This is because it fosters collaborative inquiry learning among its members, leading to the reconceptualization of knowledge. The need to ensure collaboration in mobile teaching and learning, rather than studying individually should be emphasized. Social interaction is very important in the development of critical thinking because as the learners share perspectives, their reasoning horizon is broadened to accommodate and further their thinking with the views of others. The lack of interaction leads to failure and ultimately their withdrawal from the mobile learning platform. Similarly, teachers should collaborate with their colleagues on issues relating to their practices to ensure effective implementation of the innovation.

The creation of a mobile-blended learning innovation fund is very important, which will serve as a source of incentives to the teachers charged with implementation. Such innovation fund will readily serve as a source for financial compensation, sponsorship for seminars, and provision of suitable mobile devices would motivate them to embrace mobile-blended learning. The provision of incentives like transport fares during face-to-face sessions and grants to participate in conferences, workshops, loans, and bonuses by managements, has helped various schools, globally, to encourage the implementers of blended learning to be dedicated. In addition, many educational institutions have successfully introduced and sustained blended learning with the provision of stipends and devices to the teachers.

Education institutions should establish technical support units to encourage the integration of innovation in their schools. Where there is the absence of on-site support or limited technical support in schools, teachers avoid utilizing technology in their professional activities. Technical support is crucial to promote both the teachers' and learners' effective interaction with technology-mediated instructional materials because it helps to eliminate the anxiety associated with the use of technological tools for teaching/learning and close the digital gap among the teachers, as well as the students. Also, the provision of technical support promotes the functionality of the devices and the overall transformation of the innovation.

Limitations of the study

The major constraints the researcher encountered in the course of the study were the Covid-19 pandemic and the strike embarked upon by the tertiary institutions in Nigeria, which lasted for almost a year. These initially hindered the researcher's ability to travel to Nigeria for the tryout of the instructional model on time, until after the ease of the international travel restrictions and the suspension of the strike, when it was later conducted in Nigeria.

Recommendations for future research

Since this study was focused on the teachers that teach business education undergraduate students, the next study should be centred on business education undergraduate students. The research should investigate the factors, components, and processes that will enable them gain maximally from mobile-blended and inquiry-based learning, with regard to the enhancement of their critical thinking abilities.

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APPENDIX

APPENDIX A CHARACTERISTICS OF MOBILE LEARNING IN A FORMAL CONTEXT

S/N	Characteristics	Authors	Remark
1.	Place	• Kljunić, & Vukovac, 2015; • Mehdipour, & Zerehkafi, 2013; • Sarrab, Al Shibli & Badursha, 2016	Students learn in the classroom, dormitory, and even while on the move (field, bus, train, canteen)
2.	Ubiquity	• Ozdamli, & Cavus, 2011 • Sampson, Isaias, Ifenthaler & Spector 2013; • Mehdipour, & Zerehkafi, 2013 • Delcker, Honal & Ifenthaler 2018; • Kuhnel, Seiler, Honal, & Ifenthaler 2018	Students can learn without constraints, that is, anytime and anywhere
3.	Portability	• Ozdamli, & Cavus, 2011; • Kljunić, & Vukovac, 2015; • Al-Adwan, Al-Madadha, & Zvirzdinaite, 2018	Mobile learning tools are small in size (small enough to be handheld), they are lightweight, this enables students to always take them along wherever they go so they can utilize them for unrestricted access to learning.

S/N	Characteristics	Authors	Remark
4,	Instant access to learning material	• Cavus & Ibrahim, 2009 • Eteokleous, & Ktoridou, 2009 • Cohen, 2010 • Ozdamli, & Cavus, 2011; • Mehdipour, & Zerehkafi, 2013; • Chang, Lai & Hwang (2017); • Durek, Kadoic & Redep (2018); • Mtebe & Raphael (2018)	Teachers and learners can access teaching and learning material at their own desired time. Real-time and immediate access to educational materials
5.	Privacy	• Chidi, 2002 • Ozdamli, & Cavus, 2011 • Zhang, 2003 • BenMoussa, 2003	This enables each learner to work on his learning activity without interference from others. And it also permits learners to communicate and interact with their peers as the need arises.
6.	Pedagogical change	• Ozdamli, & Cavus, 2011 • Mehdipour, & Zerehkafi, 2013; • Kljunić, & Vukovac, 2015;	Change in methods of teaching and learning results in more voice instructions, graphical elements, video, and animations. In addition, it changes the roles of both the teacher and the learner. The learner is responsible for their learning while the teacher serves as a

S/N	Characteristics	Authors	Remark
			facilitator/consultant.
7.	Blended learning	• Brindley, 1984 • Lauricella & Kay, 2013; • Norazah, Mohamed, & Melor, 2010; • Ozdamli, & Cavus, 2011; • Oye, Salleh & Iahand, 2011; • Hayati, Jalilifar & Marshadi, 2013	Teachers can provide formal educational material that can be learned in an informal context. Community-centered content enhances collaboration that leads to knowledge construct. Mobile tools can be utilized alongside classroom learning, writing assignments, doing project or research
8.	Improve communication and interactivity	• Mahdizadeh, Biemans, & Mulder, 2008; • Ozdamli, & Cavus, 2011; • Mehdipour, & Zerehkafi, 2013; • Koper (2014) • Davies (2014); • de Witt & Gloerfeld (2018);	Students actively engage in classroom discussions and their learning. Communication between students and teachers is enhanced through unrestricted synchronous and asynchronous communication. In addition, students' communication becomes richer and flexible through text messages, video, and audio teleconferences.
9.	Collaboration	• Winter, Cotton, Gavin & Yorke, 2010; • Ozdamli, & Cavus, 2011; • Ferreira, Moreira, Pereira	The possibility of unrestricted communication and community-centered

S/N	Characteristics	Authors	Remark
		& Durão, 2015 Al-Rahmi & Zeki, 2017 • Peter, Adelaiye, & Bijik, 2018	content leads to active collaboration between the learner and the teacher as well as among learners.
10.	Evaluation and feedback	• Sharples, Taylor, & Vavoula, 2005; • Behera, 2011 • Mehdipour, & Zerehkafi, 2013	Feedback to the student can be one-on-one and is available both synchronously and asynchronously. And scoring is determined by the learner's performance and improvement. In addition, assignments and quizzes can be conducted online at anytime and anywhere that the internet can be accessed. furthermore, the test can be personalized, that is, adapted to the learner's specific needs and scores or feedback obtained instantly.
11.	Location-aware	• Homan & Wood, 2003; Motiwalla, 2007; • Ozdamli, & Cavus, 2011 • Mehdipour, & Zerehkafi, 2013; • Kljunić, & Vukovac, 2015;	Presentations, exams, and assignments can be monitored from a remote location, assignments can be accessed at any place and time and students participating in learning and evaluation can be

S/N	Characteristics	Authors	Remark
			practically tracked directly on site.
13.	Digital skills	• Oye, Salleh & Iahad, 2011; • Hayati, Jalilifar & Marshadi, 2013; • Lauricella & Kay, 2013	As the teacher and students utilize mobile devices for teaching and learning, they become conversant with the technology and develop proficient skills in the manipulation of the technology.
14.	Learner's motivation and retention	• Uden, 2007; • Basoglu, & Akdemir, 2010; • Lohr, 2011; • Jamil, Keith, & Jamil, 2013; • FitzGerald, Ferguson, Adams, Gaved, Mor, & Thomas, 2013; • Marzouki, Idrissi, & Bennani, 2017	Mobile learning facilitates learners' motivation and improves their retention abilities leading to higher learning achievement.

APPENDIX B ELEMENTS OF MOBILE INSTRUCTION

S/N	Elements	Authors	Remarks
1.	Students	• Makoe, 2010; • Ozdamli, & Cavus, 2011; • Mac Callum, & Jeffrey 2013 • Kljunić, & Vukovac, 2015;	students are in the center of all the activities of mobile learning and all other elements are to assist them. Mobile learning is based on learner's peculiarities (interests, experiences, and needs). In mobile learning, students have more control over their learning. In addition, they are responsible for the learning process, from defining their goal to the evaluation of the learning process. Students who are proficient in the manipulation of mobile devices are more comfortable in utilizing them for their studies than those who are less competent. Innovative students stay connected to their associates, share information, and study collectively.
2.	Teacher	• Makoe, 2010; • Ozdamli, & Cavus, 2011; • UNESCO, 2011;	Technology in education has changed the teacher’s role from an expert through

S/N	Elements	Authors	Remarks
		Kljunić, & Vukovac, 2015;	knowledge presenter to that of a moderator of the educational content in the information age and they are more of consultants and facilitators. They now guide the learners to gain their various full potentials by identifying their individual goals and interests and guiding them towards accomplishing them.
3.	Environment	• Makoe, 2010; • Ozdamli, & Cavus, 2011; • Siragusa, Dixon & Dixon, 2007 • Kljunić, & Vukovac, 2015;	Environment refers to the platform where students access educational materials and other information. Students who utilize their mobile devices for learning should be able to access learning content, be aware of learning objectives, assignment requirements, and necessary resources through the platform. In addition, the platform should enhance the interaction between students as well as between them and their teachers and it has to be such that it

S/N	Elements	Authors	Remarks
			can be readily accessed by all mobile devices to facilitate communication with the teacher and their peers.
4.	Content	• Siragusa, Dixon & Dixon, 2007; • Taleb & Sohrabi, 2012; • ICT-AAC. Matematički vrtuljak, 2014	Content in mobile learning should be enhanced with graphics, video, games, presentations, and other multimedia elements. Educational content for mobile devices can be divided into three categories: HTML content, video content, and audio content.
5.	Assessment	• Sharples, Taylor, & Vavoula, 2005 • Ozdamli, & Cavus, 2011; • Kljunić, & Vukovac, 2015;	Students' assessments in mobile learning should be made via database logs, online exams, fora, quizzes, or project evaluation. Grading should help students to clear all the doubts they have about the course and at the same time learn more about the course content.

APPENDIX C TEACHER AND STUDENT'S ACTIVITIES IN A MOBILE LEARNING ENVIRONMENT

S/N	Task	Teacher's activity	Student's activity	Medium	Author
1.	Access to educational materials in both formal and informal contexts	Teachers send learning material to students anytime	Students access learning material in the classroom, dormitory, and even while on the move (field, bus, train, canteen)	Mobile learning tool	Bergmann & Sams, 2012; Mehdipour, & Zerehkafi, 2013; Kljunić, & Vukovac, 2015; Hwang, Lai & Wang, 2015
2.	Interactivity between teacher and the students	Teachers communicate with students anytime anywhere	Students communicate with teachers anytime anywhere about guidance and any confusing concepts	Mobile learning tool	Ozdamli, & Cavus, 2011; Koper, 2014; de Witt & Gloerfeld, 2018)
3.	Collaborative	Teachers divide students into groups to solve a problem	Students brainstorm and collectively construct knowledge to solve problems both face-to-face and on the platform through their mobile devices	Mobile learning tool	Bergmann & Sams, 2012; Hwang, Lai & Wang, 2015; Ferreira, Moreira, Pereira & Durão, 2015
4.	Lifelong learning	Teachers give students tasks to search for related information on concepts on the	Students search for related information on concepts and write down questions that may arise which they	Mobile learning tool	Oye, Salleh & Iahad, 2011; Hayati, Jalilifar & Marshadi, 2013; Francl, 2014; Gilboy,

S/N	Task	Teacher's activity	Student's activity	Medium	Author
		internet	present to the teacher either through mobile devices or during the classroom process		Heinerichs & Pazzaglia, 2015
5.	Blended learning	Teachers record the fundamental knowledge and concepts of a learning activity and upload the video to the learning platform before the class activity	Students watch the video individually at their own convenient time and place and gain fundamental knowledge about the learning activity before the class	Mobile learning tool	Abeysekera & Dawson 2014; Bishop & Verleger 2013; Kim, Kim, Khera & Getman, 2014
6.	Pedagogical change	In addition to providing knowledge to students, the teacher becomes a facilitator who motivates (with more voice instructions, graphical elements, video, and animations) students to construct and apply knowledge.	Students watch/listen/read contents sent by the teacher, write down areas that need clarification and present them to the teacher for both individual and group guidance.	Mobile learning tool	Lu & Churchill, 2014; Kljunić, & Vukovac, 2015; Bergmann & Sams, 2012; Barhoumi, 2015

S/N	Task	Teacher's activity	Student's activity	Medium	Author
7.	Evaluation and feedback	Teachers send personalized quizzes or any other form of assessment to students and after the student's attempt teacher send the score to the student	Students attempt the quizzes and send the response to the teacher; the student also accesses his progress on the course immediately after the assessment	Mobile learning tool	Sharples, Taylor, & Vavoula, 2005; Behera, 2011; Mehdipour, & Zerehkafi, 2013; So, 2016.

APPENDIX D NATURE AND ELEMENTS OF CRITICAL THINKING SKILLS

S/N	Elements	Authors	Remarks
1.	Learning processes that involve analysis, synthesis, and evaluation of information focus on higher-order thinking abilities while learning that focuses on knowledge, understanding, and application of information are associated with lower-order thinking abilities.	• Fisher, 2010; • Bergmann & Sams, 2014; • Alsowot, 2016; • Apino & Retnawati, 2017.	Not all learning help students to develop skills necessary to analyze, interpret and evaluate information
2.	Learning experiences that emphasize analysis, evaluation, and synthesis help to develop skills for problem-solving, forecasting, interpretation, creativity, and generalization.	• Maier, 1937; • Wilks, 1995; • Thomas & Thorne, 2009.	Critical thinking is beyond mere memorization of facts or reproducing information the way it was previously expressed
3.	Critical thinking is observed when an individual receives and stores new knowledge in his memory and interrelates and creatively applies such information to address unfamiliar situations.	• Yeung, 2012; • Apino & Retnawati, 2017; • Lee & Lai, 2017.	Critical thinking is the ability of an individual to interpret, analyze, evaluate, manipulate previous experiences to confront present life challenges.
4.	Critical thinking is a cognitive process that requires the ability of learners to examine their thinking and improve on the process and it demands that students utilize critical thinking skills rather than memorize or accept what they read or what they are told without subjecting it to thinking critically.	• Schafersman, 1991; • Templeaar, 2006; • Scriven & Paul, 2008.	Critical thinking enables an individual to make a clear and feasible decision between information and the situation
5.	Creativity thinking is the ability to evolve innovative ideas or products through elaboration, clarification,	• Yang & Cheng, 2010; • Zeng, Proctor &	Creativity thinking is the ability to think clearly and

S/N	Elements	Authors	Remarks
	analysis, and assessment of existing options	Salvendy, 2011; • Jarvis, Dickie & Brown, 2013.	distinctively
6.	Creative and critical thinking abilities come to life when a learner is confronted with an unfamiliar situation and critical thinking is an aspect of the process of assessing the evidence obtained through creative thinking in an attempt to address the situation	• Lewis & Smith, 1993; • Crowl, Kaminsky, & Podell, 1997; • King, Goodson & Rohani, 1998; • Cañas, Reiska & Möllits, 2017.	An individual need to be confronted with a problem to activate his/her creative and critical thinking abilities
7.	Analytical ability is a cognitive process that focuses on the identification, assessment, and generalization of knowledge as well as its application to a new situation.	• Toporovsky, 2011; • Subramanian, 2017; • Arya Wulandari, Sa'dijah, As'ari & Rahardjo, 2018.	It involves reviewing, understanding, interpreting, and evaluating as well as manipulating such information to resolve a situation
8.	Problem-solving skill is the capacity to identify problems, obtain and analyze appropriate information, suggest feasible solutions, and take the most effective solution to overcome the problem.	• Wiley, 1998; • King, Goodson & Rohani, 1998; • Wang & Chiew, 2010.	A problem must first be identified and understood before obtaining and manipulating information for a workable solution.

APPENDIX E STRATEGIES FOR DEVELOPING CRITICAL THINKING ABILITIES IN STUDENTS

S/N	Strategies	Authors	Remarks
1.	Interactivity and collaboration are very effective in building and developing critical thinking, analytical, creative, problem-solving abilities in students.	• Hwang, Hung, Chen, & Liu, 2014; • Yang, Gamble, Hung & Lin, 2014; • Chen & Chiu, 2016.	As students interact and collaborate on the same learning content, they share ideas and reconceptualize their information.
2.	Since thinking does not happen naturally, a systematic and prolonged inquiry is an essential component in the development of higher-order thinking abilities.	• Dewey, 1933; • Newmann, 1988; • Cañas, Reiska & Möllits, 2017.	Thinking ability has to be activated with procedural inquiry-based learning activities.
3.	Interactive and collaborative learning develops students' thinking ability as each student can express and share his knowledge with other students and modify their information as they exchange perspectives through reflection.	• Fogarty & McTighe, 1993; • Jones & Safrit, 1994; • Abosalem, 2016; • Mattar, 2018.	Interactive and collaborative learning help students enrich their individual experiences.
4.	In constructing knowledge, learners need interaction and reflection (reflection leads to higher-order knowledge) on what they were previously exposed to and that which they are currently experiencing,	• Brunner, 1996; • Brierton, Wilson, Kistler, Flowers & David, 2016.	Collaborative learning helps students to resolve their previous knowledge in a higher order.
5.	Mobile technology offers better means of interaction and collaboration because of its convenience, connectivity, personalization, and interactivity.	• Sharples, 2000; • Terras & Ramsay, 2012; • Fu, & Hwang, 2018.	Learners are comfortable in using mobile devices for collaborative learning because of the qualities of the devices.

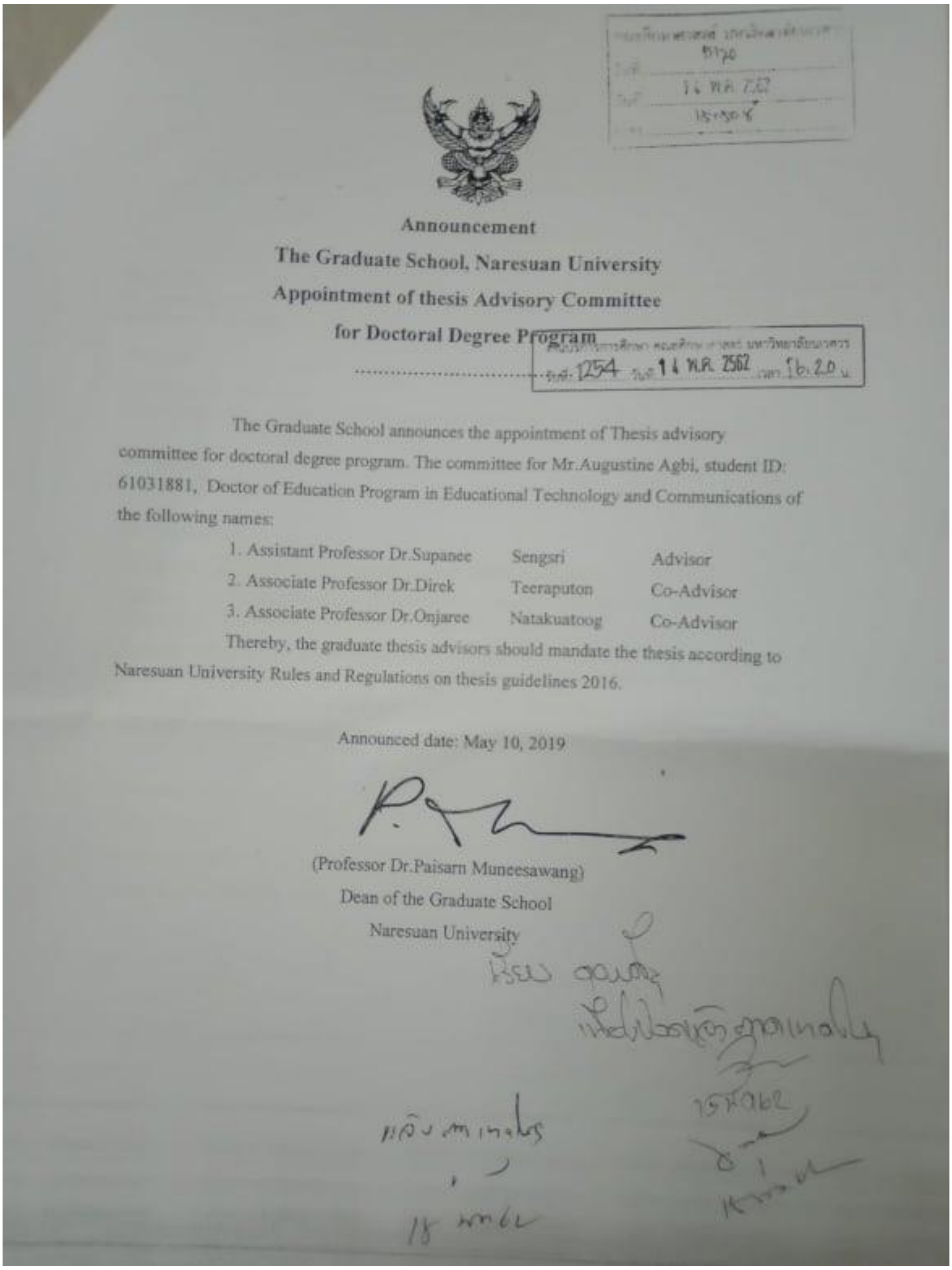
S/N	Strategies	Authors	Remarks
6.	Social collaboration with peers in real-world contexts facilitates learners' ability to reflect on their previous exposure and such collaboration enhances critical thinking skills that enable students to effectively transfer their knowledge across courses and apply it to unfamiliar situations.	• Perkins & Salomon, 1992; • Hwang, Shi, & Chu, 2011; • Toledo & Dubas, 2016.	Real-time collaboration fosters reflections and allows students to gain deeper knowledge and reconceptualization of information for solving problems.
7.	Synchronous collaboration intensifies interaction and strengthens collaborative knowledge construction, while asynchronous collaboration affords more time for learners to ruminate, process, and reflect on the content and thus more time is critical in developing higher-order thinking skills.	• Arends, 2004; • Wilen, 2004; • Brierton, Wilson, Kistler, Flowers & David, 2016.	Real-time collaboration boosts interaction and reinforces collaborative efforts in reconceptualizing knowledge, while asynchronous allows the learners more time to reflect, analyze, and reorganize information for richer content.
8.	Since there is extensive cognitive processing when an individual explains his perspective to another on the same content, mobile collaboration should be an appropriate platform for learners to cooperatively work to develop their critical thinking abilities.	• Palinscar, 1998; • Toh, So, Seow, Chen & Looi, 2013; • Brierton, Wilson, Kistler, Flowers & David, 2016.	Learners exercise their cognitive process when they share ideas on the same learning material and mobile devices offer an effective means of such collaboration among learners because they already know how to manipulate the devices and are always with them.

APPENDIX F FACTORS THAT INFLUENCE THE UTILIZATION OF TECHNOLOGY IN TEACHING AND LEARNING

S/N	Factors	Authors	Remarks
1.	Whether as a beginner or experienced teachers, studies have shown that ICT competence is a major factor that determines the level of technology use in classrooms	Bauer & Kenton, 2005; Wozney, Venkatesh, & Abrami, 2006; Franklin, 2007.	Effective educational innovation depends greatly on the knowledge and skills of teachers as they can only offer what they possess.
2.	Integration of technology can be obstructed by the prevailing leadership in an institution, particularly when the leadership is not committed to technology utilization for teaching and learning and where the teachers are not involved in the process of deciding to adopt innovative initiatives.	Fullan, 1991; Vannatta & Fordham, 2004; Mojgan, Kamariah, Wong, Bahaman & Foo, 2009; Hennessy, Harrison & Wamakote, 2010; Kaliisa & Picard, 2017	School leadership needs to be favourably disposed to the use of technology in teaching and learning, and involve the teachers who are to use such technology while making an innovative decision for the integration to be successful
3.	Poor ICT legislative frameworks make it difficult for teachers to explore ICT tools in teaching and learning activities thereby constraining them to the use of traditional methods and approaches in their professional activities.	Cole, 1996; Saljo, 1999; Crook, 2001; Watson, 2001; Sutherland, 2004; Aduwa-Ogiegbaen & Iyamu, 2005; Adomi & Kpangban, 2010; Agbetuyi & Oluwatayo, 2012.	Better ICT legislative frameworks enable the adequate provision of facilities, logistics, and appropriate training that will translate to the successful integration of technology into teaching and learning activities.
4.	Where there is an absence of on-site support or limited technical support in schools, teachers avoid utilizing computers in the classrooms.	Cuban, Kirkpatrick & Peck, 2001; Snoeyink & Ertmer, 2002; Li, Yamaguchi & Takada, 2018	The presence of an effective technical support unit in school gives the teachers confidence and

S/N	Factors	Authors	Remarks
			readiness to try out the technology in their professional activities knowing that there is always a lifeline when and wherever they experience hitches.
5.	The high cost of internet connectivity in developing countries makes it difficult for both teachers and students to access the opportunity and benefits ICTs offer in an educational context.	Odongo, 2010; Brown & Mbati, 2015; Albert & Asaad, 2017	Unrestricted access to the internet is the gateway to the benefits offered by ICT in education.
6.	Where 1-5 above are not adequately provided the teacher will develop a negative attitude towards the adoption of technology in the instructional process and will tend to avoid using it.	Almusalam, 2001; Mojgan, Kamariah, Wong, Bahaman & Foo, 2009; Vrasidas, 2015; Li, Yamaguchi & Takada, 2018.	When teachers lack the required competence and the necessary support to adopt technology, they will develop bias opinions against it.

APPENDIX G APPOINTMENT OF THESIS ADVISORY COMMITTEE FOR DOCTORAL DEGREE PROGRAM



Announcement

The Graduate School, Naresuan University

Appointment of thesis Advisory Committee

for Doctoral Degree Program

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1254 16 พ.ค. 2562 16.20 น.

The Graduate School announces the appointment of Thesis advisory committee for doctoral degree program. The committee for Mr.Augustine Agbi, student ID: 61031881, Doctor of Education Program in Educational Technology and Communications of the following names:

1.	Assistant Professor Dr.Supanee	Sengsri	Advisor
2.	Associate Professor Dr.Direk	Teeraputon	Co-Advisor
3.	Associate Professor Dr.Onjaree	Natakuatoog	Co-Advisor

Thereby, the graduate thesis advisors should mandate the thesis according to Naresuan University Rules and Regulations on thesis guidelines 2016.

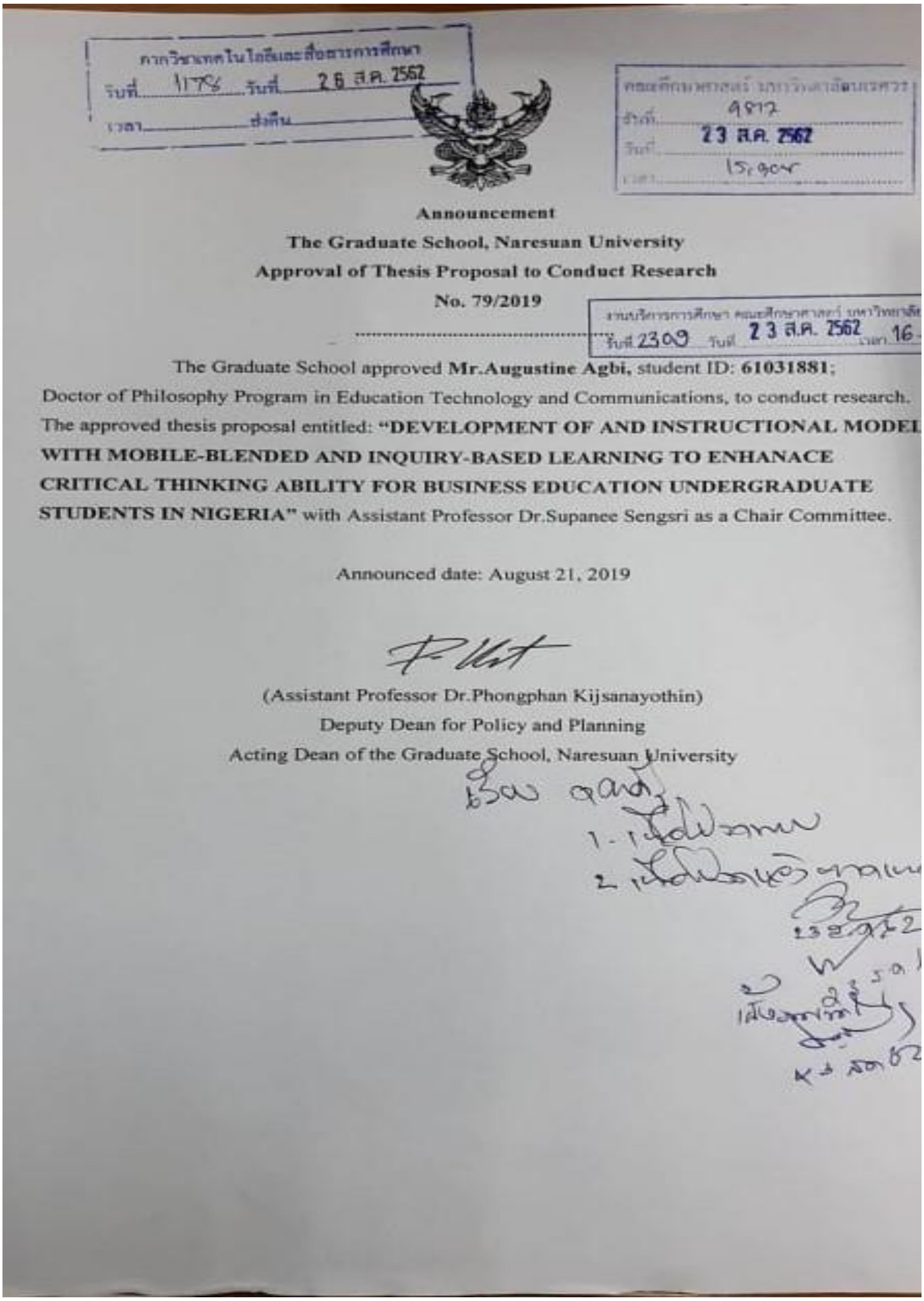
Announced date: May 10, 2019

(Professor Dr.Paisarn Muneesawang)

Dean of the Graduate School

Naresuan University

APPENDIX H APPROVAL OF THESIS PROPOSAL TO CONDUCT RESEARCH



ภาควิชาเทคโนโลยีและสื่อสารการศึกษา
รับที่ 1178 วันที่ 26 ส.ค. 2562
เวลา ส่งคืน

คณะศึกษาศาสตร์ มหาวิทยาลัยนเรศวร
รับที่ 4817
วันที่ 23 ส.ค. 2562
เวลา 15.40

Announcement

The Graduate School, Naresuan University

Approval of Thesis Proposal to Conduct Research

No. 79/2019

งานบริการการศึกษา คณะศึกษาศาสตร์ มหาวิทยาลัย
รับที่ 2309 วันที่ 23 ส.ค. 2562 เวลา 16

The Graduate School approved **Mr.Augustine Agbi,** student ID: **61031881**; Doctor of Philosophy Program in Education Technology and Communications, to conduct research. The approved thesis proposal entitled: **"DEVELOPMENT OF AND INSTRUCTIONAL MODEL WITH MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANACE CRITICAL THINKING ABILITY FOR BUSINESS EDUCATION UNDERGRADUATE STUDENTS IN NIGERIA"** with Assistant Professor Dr.Supanee Sengsri as a Chair Committee.

Announced date: August 21, 2019

(Assistant Professor Dr.Phongphan Kijsanayothin)

Deputy Dean for Policy and Planning

Acting Dean of the Graduate School, Naresuan University

APPENDIX I CONFIRMATION FORM OF THESIS INVOLVING/NOT INVOLVING WITH RESEARCH ETHICAL ISSUE

GS. 14

Confirmation form of thesis involving/not involving with research ethical issue

Following the international standard of research ethical issue, the thesis proposal must be approved by Naresuan University Ethical Committee for Human Research.

I am Assoc. Prof. Supanee Sengsri, Ph.D. the thesis advisor of student name

Student Name (Mr., ~~Mrs.~~ ~~Miss~~) Augustine Agbi NU ID 61031881

Program ☐ Master's Degree .... Program........

☑ Doctoral Degree .... Program........

Field of study EDUCATIONAL TECH AND COMM Faculty/College EDUCATION

Thesis Title:

Thai: ....

English: DEVELOPMENT OF AN INSTRUCTIONAL MODEL WITH MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANCE CRITICAL THINKING ABILITIES FOR BUSINESS EDUCATION UNDERGRADUATE STUDENTS IN NIGERIA

I confirm that this thesis follows:

☐ Research Ethics for Human Research

- ☑ Not involved
- ☐ Involved and Approved by the committee (No. certificate........ date........)

☐ Ethics for Laboratory Animals

- ☑ Not involved
- ☐ Involved and Approved by the committee (No. certificate........ date........)

☐ Biosafety

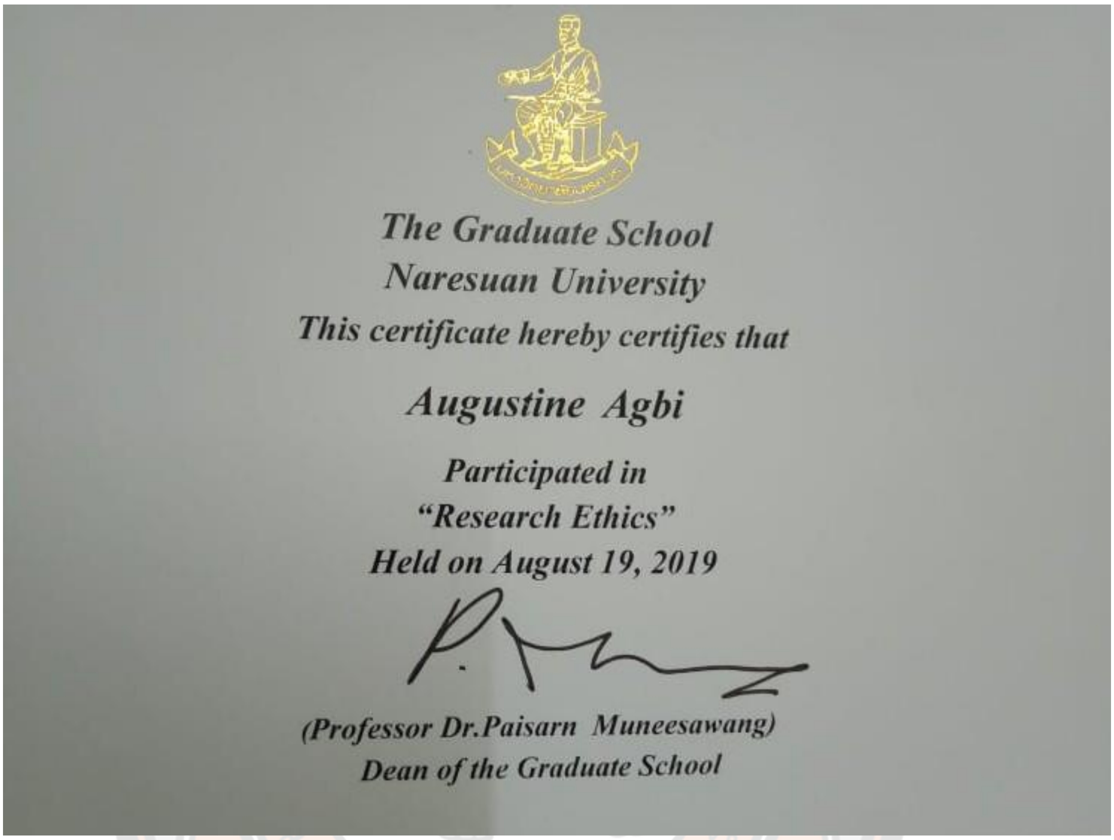
- ☑ Not involved
- ☐ Involved and Approved by the committee (No. certificate........ date........)

Supanee Sengsri Advisor

(Assoc. Prof. Supanee Sengsri Ph.D)

Date 10 / 06 / 2020

APPENDIX J RESEARCH ETHIC CERTIFICATE



APPENDIX K NIDA CLINICAL TRIAL NETWORK CERTIFICATE OF COMPLETION

NIDA Clinical Trials Network

Certificate of Completion

is hereby granted to

Augustine Agbi

to certify your completion of the six-hour required course on:

GOOD CLINICAL PRACTICE

MODULE:	STATUS:
Introduction	N/A
Institutional Review Boards	Passed
Informed Consent	Passed
Confidentiality & Privacy	Passed
Participant Safety & Adverse Events	Passed
Quality Assurance	Passed
The Research Protocol	Passed
Documentation & Record-Keeping	Passed
Research Misconduct	Passed
Roles & Responsibilities	Passed
Recruitment & Retention	Passed
Investigational New Drugs	Passed

Course Completion Date: 18 March 2019

CTN Expiration Date: 18 March 2022

Tracee Williams, Training Coordinator

NIDA Clinical Coordinating Center

Good Clinical Practice, Version 5, effective 03-Mar-2017

This training has been funded in whole or in part with Federal funds from the National Institute on Drug Abuse, National Institutes of Health, Department of Health and Human Services, under Contract No. [illegible]

APPENDIX L SURVEY QUESTIONNAIRE FOR BUSINESS EDUCATION TEACHERS

Thesis title: Development of an Instructional Model with Mobile-Blended and Inquiry-Based Learning to Enhance Critical Thinking Abilities for Business Education Undergraduate Students in Nigeria**.**

Research objective one: To identify and study the relationship between the factors, sub-factors, and the processes that influence the use of mobile-blended and Inquiry-based learning to enhance critical thinking abilities

Please **tick** to indicate your degree of agreement or disagreement on the relationship between the following items (factors, sub-factors, and processes) **and** the enhancement of critical thinking skills in business education undergraduate students in Nigeria with mobile-blended and Inquiry-based learning.

Gender: Male [ ] Female [ ]

Highest Academic Qualification: Bachelor's degree [ ] Master's degree [ ]

Ph.D. [ ]

Teaching experience: Less than 10 years [ ] 10-20 years [ ] 20- 30 years [ ]

Above 30 years [ ]

Factors and sub-factors	**Strongly agree 5**	**Agree 4**	**Neutral**	**Disagree 2**	**Strongly disagree 1**
1. School policy. The utilization of mobile technology in teaching and learning is influenced by the prevailing policy of the administrator of the school					
1.1 Regular competency training for teachers on how to:					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
1.1.2 develop instructional content for mobile delivery to student					
1.1.3 promote mobile learning collaboration among students					
1.1.4 assess students' learning activities with mobile technology					
1.1.5 send feedback to students with mobile technology.					
1.2 Decision making process on innovation					
1.2.1 Teachers should be part of the decision-making process to introduce mobile learning technology					
1.2.2 The inclusion of teachers in such decision-making process enables them to be committed to the innovation					
1.2.3 Teachers' inclusion in the decision process to introduce innovation affords management the opportunity to identify their needs in relation to the innovation and develop strategies to address the needs.					
1.3 Provision of Mobile-blended learning facilities					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
1.3.1 School policy should support the provision of mobile technology facilities for teachers					
1.3.2 School policy should support the provision of mobile technology facilities for students					
1.3.4 The availability of mobile technology facilities to both teachers and students encourages the use of such facilities for teaching and learning.					
1.4 Workload for teachers When introducing mobile-blended learning, management policy should acknowledge the time needed by teachers to: 1.4.1 redesign instructional material for online delivery to students to study					
1.4.2 engage learners in mobile collaborative learning activities					
1.4.3 scaffold learners' knowledge via timing questioning and mentoring					
1.5 Provision of technical support. School policy should encourage the provision of technical support for the integration of mobile technology into teaching and learning activities.					

Factors and sub-factors	**Strongly agree 5**	**Agree 4**	**Neutral**	**Disagree 2**	**Strongly disagree 1**
1.5.1 The provision of technical support fosters teachers' confidence to integrate mobile technology into their professional activities					
1.5.2 The provision of technical support ensures that the necessary repairs and maintenance are carried out to guarantee regular use of the innovation.					
1.6 Stable electricity supply. Provision of adequate power supply in school premises by management promotes the use of mobile technology in teaching and learning activities.					
2. Teacher					
2.1 Teachers' attitudes. 2.1.1 If the teacher's attitude towards mobile technology integration into education is positive, there is the likelihood that he/she will strive to utilize it in teaching and learning activities.					
2.1.2 Teachers with negative attitude towards mobile technology utilization in educational activities will do everything possible to avoid its use					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
in their professional activities.					
2.1.3 Most educators with negative attitude towards the use of mobile technology in education do not possess the required knowledge and skills that would enable them arrive at the decision to utilize it in their teaching and learning activities.					
2.2 Teaching experience. 2.2.1 The length of teaching experience influences the use of mobile technology in teaching and learning activities by teachers.					
2.2.2 Teachers with lesser number of years in teaching profession are more likely to use mobile technology in their professional activities than their older counterparts					
2.2.3 Teachers with a greater number of years in teaching are more likely to use mobile technology in teaching and learning activities.					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
2.3 Mobile-blended learning competence. 2.3.1 Both beginner or experienced teachers requires mobile-blended learning competence training.					
2.3.2 Only older teachers require mobile-blended learning competence training.					
2.3.3 Only fresh teachers require mobile-blended learning competence training					
2.3.4 Teachers that possess mobile-blended learning competence will readily integrate it into their professional activities					
3. Students.					
3.1 Ability of self-regulated learning *(learner's ability to establish goals, determine proper strategy, monitor attainment and restructure learning technique when necessary while managing his/her time effectively)* 3.1.1 Every student has self-regulated learning skills					
3.1.2 Only students with self-regulated learning skills possess the maturity and readiness to benefit from mobile learning					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
3.2 Students' mobile learning competence determines their benefits from mobile-blended learning activities.					
3.3 Time management skill. The ability of students to manage their time effectively determines their achievement in mobile learning since it involves independent study.					
3.4 Mobile learning orientation programme. 3.4.1 Students are more favourably disposed to mobile-blended learning innovation, if they are exposed to orientation programme prior to their participation in the innovation. 3.4.2 In such programmes, students are introduced to how they can benefit from mobile technological devices in relation to their learning activities and the roles they are expected to play for maximum benefits.					
4. Mobile instructional content. 4.1 The design of instructional content for mobile technology is not the same					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
with other contexts.					
4.2 Owing to the small size of the screen of mobile devices, mobile learning content should be concise and brief so as not to overwhelm the learners. In other words, the content should be delivered to students in bits.					
4.3 The learners' needs should be assessed and analyzed to determine the mobile instructional content. This is to ensure the content meets their needs.					
4.4 Mobile content should be engaging and applicable to everyday needs in order to activate the interest of the learners					
4.5 Mobile instructional content design should take advantage of rich multimedia such as audio and video, particularly, the use of video due to the small-size screen factor of most mobile devices.					
4.6 Mobile content should be delivered and accessed via user-friendly, intuitive and smart interface. As learners access content from teacher online, they should not only be able to pause and reflect					

Factors and sub-factors	**Strongly agree 5**	**Agree 4**	**Neutral**	**Disagree 2**	**Strongly disagree 1**
on the material but should also be available to them offline to afford them the opportunity of continuous access to consolidate learning.					
5. Technology characteristics.					
5.1 Benefits. If teachers perceive the usefulness (advantages) of mobile technology in teaching and learning activities, they will likely adopt it in such activities					
5.2 Ease of use If mobile technology can be manipulated easily by teachers to improve teaching and learning, there is the tendency that they will adopt it in educational activities.					
5.3 Trialability. If mobile technology can be readily experimented in educational context, there is the likelihood that teachers will adopt it, if they find it beneficial to their professional activities.					
5.4 Compatibility. The compatibility of mobile technology with the existing practices and norms of an educational organization determines the level					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
teachers will integrate it in teaching and learning activities.					
5.5 Internet connectivity The high cost associated with internet connectivity in developing countries can influence both teachers and students' decision to use mobile technology in their teaching and learning activities.					
Processes					
1. Institution *Strategy* 1.1 Institution should identify its challenge that can be overcome with the adoption of mobile-blended learning. The challenge this study seek to overcome is how to improve critical thinking skills of students, using mobile-blended and inquiry-based learning.					
1.2 Teachers should be adequately provided with knowledge and skills on how mobile-blended and inquiry-based learning can be used to achieve the intended goal and objectives					
1.4 Schedule 1.4.1 Specification of time for classroom activities					
1.4.2 Specification of time for					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
online activities					
1.5. Support *5.1 Teachers' support for:* 1.5.1 Online course design and development					
1.5.2 Media creation of course materials					
1.5.3 Time management skills					
1.5.4 Experienced faculty members should serve as mentors to those with lesser knowledge and skills on mobile-blended and inquiry-based learning strategy					
1.5.4 Exposure of teachers to blended learning prototypes strategies that have been successful					
1.5.5 Provision of incentives in form of financial benefits, release time, equipment, promotion for teachers.					
1.6 Creation of innovation fund. 1.6.1 The creation of innovation fund to provide hardware/software and training					
1.6.2 The creation of innovation fund to facilitates the provision of incentives for mobile-blended learning					
1.6.3 The creation of innovation fund to ensure					

Factors and sub-factors	**Strongly agree 5**	**Agree 4**	**Neutral**	**Disagree 2**	**Strongly disagree 1**
continuous transformation of mobile-blended learning.					
1.7 Students' support service center: 1.7.1 To facilitate students' access to mobile-blended learning facilities (hardware and software)					
1.7.2 To provide support to equip students with the knowledge and skills necessary to succeed in a mobile-blended learning environment.					
1.8 Creation of Mobile-blended learning community 1.8.1 Learning community to enhance collaborative learning among members of mobile-blended learning					
1.8.2 Mobile-blended learning community is essential to sustain students' commitment and ensure they progressively move through the phases of critical inquiry					
1.9. Evaluation 1.9.1 There should be an institutional policy on standards and outcomes to be measured					
1.9.2 Evaluation of mobile-blended learning strategy					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
should cover the teaching, learning, technology, and administration of the innovation.					
1.9.3 Results of evaluation should be communicated to all the stakeholders					
2. Teachers' activities. *2.1 The following are the processes the teachers must follow to make mobile-blended and inquiry-based learning effective, to improve critical thinking of the students*					
2.1.1 Design/redesign learning content in line with identified learning objectives					
2.1.2 Utilize graphics and audio or video files effectively					
2.1.3 Design mobile instructional content to meet learners' needs					
2.1.4 Deliver mobile instructional materials in appropriate format(s) to students to study before the class meeting					
2.1.5 Provide online clarification to the student on confusing concepts					
2.1.6 Send online personalized					

Factors and sub-factors	**Strongly agree 5**	**Agree 4**	**Neutral**	**Disagree 2**	**Strongly disagree 1**
quizzes to assess students' understanding of the mobile content.					
2.1.7 Send feedback of assessment to the students					
2.2 The following are the processes the teachers must follow in order to make face-to-face classroom learning enhance critical thinking skills					
2.2.1 Recap the mobile instructional material to refresh the students' memory and answer any questions they may have.					
2.2.2 Generate ill-structured and work-related problems for students to solve					
2.2.3 Allocate students to small heterogenous inquiry-based learning groups					
2.2.4 Assign different roles to groups or group members					
2.2.5 Ensure individual accountability and positive interdependence					
2.2.6 Ensure elaborate students' discussion					
2.2.7 Facilitate students' inquiry-based learning by asking logical questions that probe their knowledge					

Factors and sub-factors	**Strongly agree 5**	**Agree 4**	**Neutral**	**Disagree 2**	**Strongly disagree 1**
3. Students' activities					
3.1 *The following are the processes the students must follow in order to gain maximum benefits from make mobile-blended and inquiry-based learning.*					
3.1.1 Study mobile instructional content from teachers at home/dormitory, classroom and even while on the move.					
3.1.2 Students communicate with their teacher anytime anywhere for clarification on confusing concepts					
3.1.3 Students exchange ideas on the same content through mobile interaction – social constructivism					
3.1.4 Students search for related information on concepts online and write down questions that may arise which they present to the teacher either online via mobile devices or during class meeting					
3.1.5 Students attempt quizzes on mobile content from their teacher					
3.2 *The following are the processes the students*					

Factors and sub-factors	Strongly agree 5	Agree 4	Neutral	Disagree 2	Strongly disagree 1
must follow in order to enhance their critical thinking abilities during face-to-face classroom activities.					
3.2.1 Students ask questions on mobile instructional content they do not understand					
3.2.2 Students negotiate with teacher to generate ill-structured and work-related problems of which they can take ownership					
3.2.3 Students work collaboratively in groups to solve problems					
3.2.4 Students interact extensively to exchange information and perspective to solve problems					
3.2.5 Students analyze, evaluate and synthesize their knowledge to solve work-related problems					

APPENDIX M COPIES OF LETTERS OF INTRODUCTION FROM GRADUATE SCHOOL, NARESUAN UNIVERSITY TO EXPERTS FOR THE VALIDATION AND TRYOUT OF THE INSTRUCTIONAL MODEL BASED ON MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANCE CRITICAL THINKING ABILITIES FOR BUSINESS EDUCATION UNDERGRADUATE STUDENTS IN NIGERIA

NARESUAN UNIVERSITY
GRADUATE SCHOOL

NARESUAN UNIVERSITY
Graduate School
Phitsanulok, 65000
Thailand

December 30, 2020

Subject: Request to collect research data
RE # ศธ.0527.02/ว 3898

Dear Ajarn Chusri Wanthanee

Since **Mr.Augustine Agbi**, ID number 61031881, the graduate student of the Doctor of Philosophy Program in Educational Technology and Communications of the Graduate School Naresuan University has conducted the thesis title is **"Development of an Instructional Model with Mobile-Blended and Inquiry-based Learning to Enhance Critical Thinking Abilities for Business Education Undergraduate Students in Nigeria"**. Presently, he is at the stage to validate and try-out the model of his research.

Your efforts to validate the model, try-out the instructional plan with your students, and provide him with a brief report of the try-out will be highly appreciated.

Sincerely yours,

(Kanida Narattharaksa, Ph.D.)
Deputy Dean for Academic Affairs
For Dean of Naresuan University Graduate School

NARESUAN UNIVERSITY Graduate School, Phitsanulok, 65000, Thailand. Tel: (66-55) 968828 Fax: (66-55) 968826
http://www.graduate.nu.ac.th

NARESUAN UNIVERSITY
GRADUATE SCHOOL

NARESUAN UNIVERSITY
Graduate School
Phitsanulok, 65000
Thailand

December 30, 2020

Subject: Request to collect research data.
RE # ศธ.0527.02/ว 3898

Dear Ms.Amornrat Kreetatorn

Since **Mr.Augustine Agbi**, ID number 61031881, the graduate student of the Doctor of Philosophy Program in Educational Technology and Communications of the Graduate School Naresuan University has conducted the thesis title is **"Development of an Instructional Model with Mobile-Blended and Inquiry-based Learning to Enhance Critical Thinking Abilities for Business Education Undergraduate Students In Nigeria"**. Presently, he is at the stage to validate and try-out the model of his research.

Your efforts to validate the model, try-out the instructional plan with your students, and provide him with a brief report of the try-out will be highly appreciated.

Sincerely yours,

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NARESUAN UNIVERSITY Graduate School, Phitsanulok, 65000, Thailand. Tel: (66-55) 968828 Fax: (66-55) 968826
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NARESUAN UNIVERSITY

GRADUATE SCHOOL

NARESUAN UNIVERSITY
Graduate School
Phitsanulok, 65000
Thailand

December 30, 2020

Subject: Request to collect research data.
RE # ศธ.0527.02/ว 3898

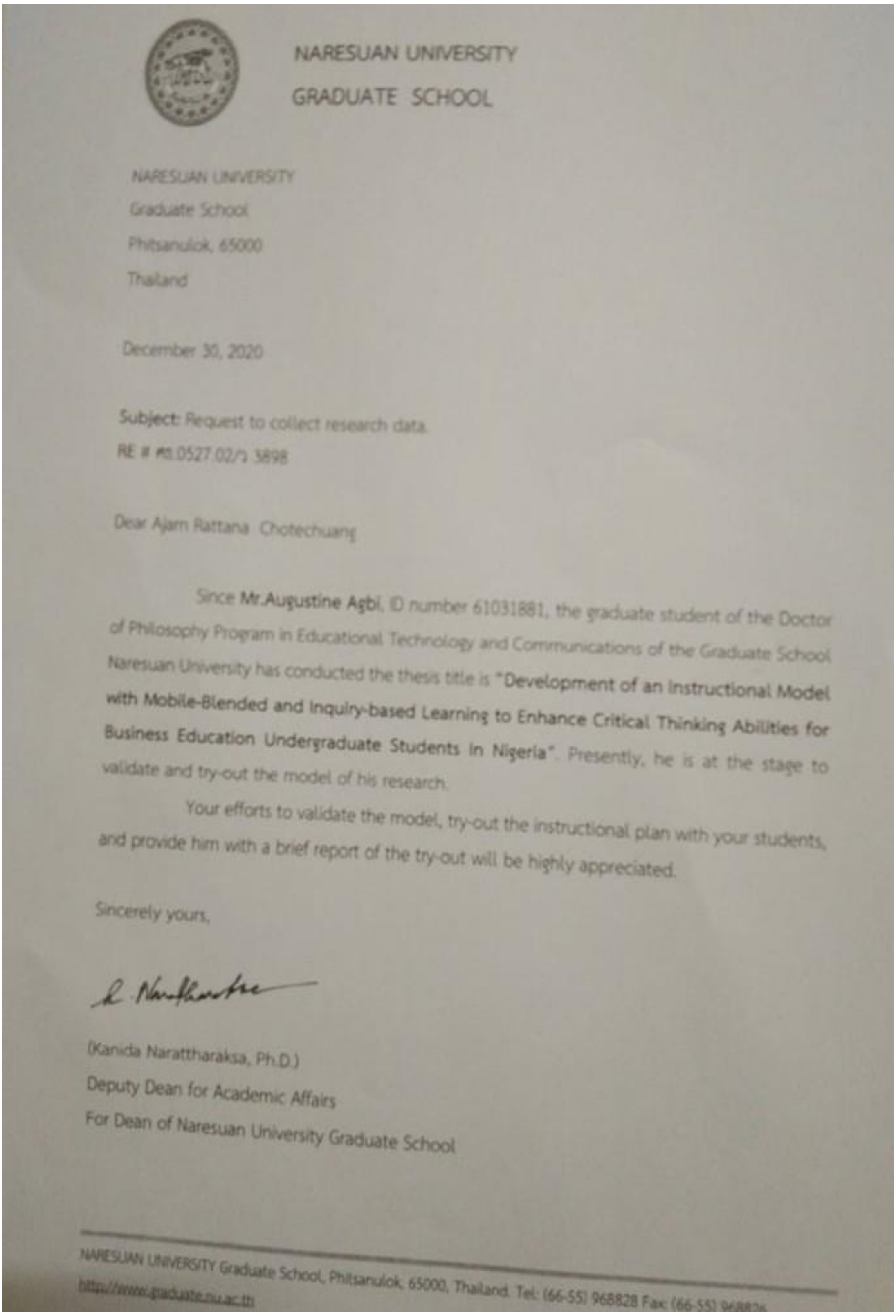
Dear Mr.Pramote Boonlerdlam

Since **Mr.Augustine Agbi**, ID number 61031881, the graduate student of the Doctor of Philosophy Program in Educational Technology and Communications of the Graduate School Naresuan University has conducted the thesis title is **"Development of an Instructional Model with Mobile-Blended and Inquiry-based Learning to Enhance Critical Thinking Abilities for Business Education Undergraduate Students In Nigeria"**. Presently, he is at the stage to validate and try-out the model of his research.

Your approval to allow him to perform these activities (model validation and tryout) in your school will be highly appreciated.

Sincerely yours,

(Kanida Narattharaksa, Ph.D.)
Deputy Dean for Academic Affairs
For Dean of Naresuan University Graduate School



NARESUAN UNIVERSITY
GRADUATE SCHOOL

NARESUAN UNIVERSITY
Graduate School
Phitsanulok, 65000
Thailand

December 30, 2020

Subject: Request to collect research data
RE # ศธ.0527.02/ว 3898

Dear Ajarn Rattana Chotechuang

Since **Mr.Augustine Agbi**, ID number 61031881, the graduate student of the Doctor of Philosophy Program in Educational Technology and Communications of the Graduate School Naresuan University has conducted the thesis title is **"Development of an Instructional Model with Mobile-Blended and Inquiry-based Learning to Enhance Critical Thinking Abilities for Business Education Undergraduate Students in Nigeria"**. Presently, he is at the stage to validate and try-out the model of his research.

Your efforts to validate the model, try-out the instructional plan with your students, and provide him with a brief report of the try-out will be highly appreciated.

Sincerely yours,

(Kanida Narattharaksa, Ph.D.)
Deputy Dean for Academic Affairs
For Dean of Naresuan University Graduate School

NARESUAN UNIVERSITY Graduate School, Phitsanulok, 65000, Thailand. Tel: (66-55) 968828 Fax: (66-55) 968826
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NARESUAN UNIVERSITY

GRADUATE SCHOOL

NARESUAN UNIVERSITY
Graduate School
Phitsanulok, 65000
Thailand

December 30, 2020

Subject: Request to collect research data.

RE # ศธ.0527.02/ว 3898

Dear Ajarn Thitaree Chanthawat

Since **Mr.Augustine Agbi**, ID number 61031881, the graduate student of the Doctor of Philosophy Program in Educational Technology and Communications of the Graduate School Naresuan University has conducted the thesis title is **"Development of an Instructional Model with Mobile-Blended and Inquiry-based Learning to Enhance Critical Thinking Abilities for Business Education Undergraduate Students In Nigeria"**. Presently, he is at the stage to validate and try-out the model of his research.

Your efforts to validate the model, try-out the instructional plan with your students, and provide him with a brief report of the try-out will be highly appreciated.

Sincerely yours,

(Kanida Narattharaksa, Ph.D.)
Deputy Dean for Academic Affairs
For Dean of Naresuan University Graduate School

NARESUAN UNIVERSITY

GRADUATE SCHOOL

NARESUAN UNIVERSITY
Graduate School
Phitsanulok, 65000
Thailand

December 30, 2020

Subject: Request to collect research data

RE # ศธ.0527.02/ว 3898

Dear Ajarn Tippawan Klinkrud

Since **Mr.Augustine Agbi**, ID number 61031881, the graduate student of the Doctor of Philosophy Program in Educational Technology and Communications of the Graduate School Naresuan University has conducted the thesis title is **"Development of an Instructional Model with Mobile-Blended and Inquiry-based Learning to Enhance Critical Thinking Abilities for Business Education Undergraduate Students in Nigeria"**. Presently, he is at the stage to validate and try-out the model of his research.

Your efforts to validate the model, try-out the instructional plan with your students, and provide him with a brief report of the try-out will be highly appreciated.

Sincerely yours,

(Kanida Narattharaksa, Ph.D.)
Deputy Dean for Academic Affairs
For Dean of Naresuan University Graduate School

NARESUAN UNIVERSITY Graduate School, Phitsanulok, 65000, Thailand. Tel: (66-55) 968828 Fax: (66-55) 968826
http://www.graduate.nu.ac.th

APPENDIX N PHOTOGRAPHS SHOWING PART OF THE DRAFT INSTRUCTIONAL MODEL VALIDATION ACTIVITIES


THAILAND
INDONESIA


THAILAND
PHILIPPINES
INDONESIA
AUSTRALIA


EDUCATION

APPENDIX O INSTRUMENT FOR THE VALIDATION OF THE INSTRUCTIONAL MODEL TO ENHANCE STUDENTS' CRITICAL THINKING ABILITIES USING MOBILE-BLENDED WITH INQUIRY-BASED LEARNING

Please (tick) to indicate your agreement or disagreement and remarks where necessary on the relationship between the following items **and** the enhancement of critical thinking skills in business education undergraduate students with mobile-blended with Inquiry-based learning.

Gender: Male [ ] Female [ ]

Highest Academic Qualification: Bachelor's degree [ ] Master's degree [ ]

Ph.D. [ ] Academic position ………………………

	Agree	**Disagree**	**Remarks**
1. Philosophy of the model			
The standard of the Nigerian educational system has continued to witness a decline over the years at all levels, contributing to the disturbingly high rate of unemployment among graduates in the country. Most classrooms in the country are still fraught with the old-fashioned instructional approaches. These methods only focus on equipping students with knowledge of concepts that do not sufficiently avail them with the required abilities to solve real-life problems in contemporary society. Modern jobs require skills that are focused on what individuals can accomplish with their acquired knowledge through analysis, evaluation and reorganization of information to solve problems. To achieve this, students need to be engaged in active learning that encourages the use of their cognitive process, in order to sufficiently prepare them for the demands of present-day jobs. Cognitive development requires that learning should not just consist of repetitive accumulation			

	Agree	Disagree	Remarks
of facts and knowledge, but must also encompass effective deep conceptual change in order to support life-long learning. It is against this background that this model finds its relevance to adequately empower the teachers with the required instructional approach, which will facilitate the enhancement of the critical thinking skills of business education undergraduates for global competitiveness. Mobile-blended learning with an inquiry-based approach, allows teachers sufficient time during its face-to-face components to effectively engage learners with problem-solving tasks that encourage their cognitive development, rather than exposing them to learning experiences that are fraught with a repetitive accumulation of facts and knowledge of concepts only.			
2. Concept of the model This instructional model is based on the following: *Constructivist's theory* This model is based on Piaget's constructivist theory, which emphasized the exposure of students to learning environments that inspire and empower them to construct their knowledge to promote their thinking skills (Piaget, 1977). Authentic learning, according to the social constructivist's perspective, makes learners active researchers, enables them to generate knowledge via investigation and actively experiencing reality. When students work collectively, they are encouraged to share ideas on their inquiry activities through collaboration and interactions. This encourages them to reflect on their previous knowledge, which results in the development of their creative thinking which better equips them for lifelong learning. *Blended learning*			

	Agree	Disagree	Remarks
The availability and utilization of digital facilities, have led to increased deployment of ICT-mediated instructional elements into the conventional learning environment. Blended learning is a combination of two instructional models that incorporates both the traditional face-to-face classroom system, and an online learning platform (Liu, Peng, Zhang, Hu, Li &Yan, 2016; Han & Ellis, 2019) that employs a mix of asynchronous and synchronous interactions (Wu, Tennyson & Hsia, 2010). This practice affords educators the opportunity to help their students acquire the information and terms associated with the course before class starts, which allows them the time to carry out their collaborative problem-solving tasks that engage their cognitive processes (Couch, 2014; Clark, 2015; Lee & Lai, 2017). When students are sent learning materials to study via an online platform before class, it ensures a more collaborative and engaging environment in the classroom, which affords them adequate time to evaluate and reconceptualize the contents for problem solving in real life situations. Higher education institutions are embracing this approach, because the traditional method of instruction mainly encourages the lower levels of Bloom's taxonomy of memorizing and the recalling of information (Bloom, Englehart, Furst, Hill & Krathwohl, 1956) and does not effectively promote the development of the cognitive process in students. Conversely, the engagement of students in real-time inquiry tasks, enables them to analyse, evaluate, synthesize content and apply learnt knowledge to new situations through reflection and reconceptualization of ideas (Graham, 2004; Fu and Hwang, 2018; Jantakoon & Piriyasurawong, 2018). In			

	Agree	Disagree	Remarks
blended learning, teachers acquire a greater amount of class time to engage students in collaborative inquiry-based learning tasks that enhances their critical thinking abilities. *Mobile learning* Mobile learning experiences offer valuable opportunities that supplement or replace aspects of face-to-face traditional lectures, and textbook-based approaches. It is a type of educational experience that occurs with the aid of portable technological devices like laptops, Personal Digital Assistants (PDAs), tablets, and smart phones (Giousmpasoglou & Marinakou 2013; Alwraikat & Al Tokhaim 2014) or learning "on the move" with no classroom restrictions (Brown & Mbati, 2015). The pervasiveness and utilization of these devices have led to increased deployment of mobile-technology-mediated instructional elements into the conventional educational environment. Blended learning in association with mobile technology affords educators the opportunities to help their students acquire the relevant information and terms associated with the course before class starts, which provides sufficient class time to carry out collaborative problem-solving tasks that engage their cognitive processes (Couch, 2014; Clark, 2015; Lee & Lai, 2017). Students can watch, pause and repeat the learning materials on their mobile devices, which allows them to gain a clearer understanding of the content before class (Herreid & Schiller 2013; Lee & Lai, 2017). This technology facilitates more individualized and independent learning, as well as making it possible to access all content at will. In any e-learning scenario, students are expected to exercise self-efficacy and regulative skills, while the teachers should be responsive			

	Agree	Disagree	Remarks
to the interactions of the learners on the platform to achieve the desired objectives. *Inquiry-based learning* Inquiry-based learning is an approach that encourages learners to explore problems of interest through social interactions to create shared understanding (Piaget, 1959; Vygotsky, 1978; Suáre, Specht, Prinsen, Kalz, & Ternier, 2018). It enables students to develop skills to work in complicated situations, while enhancing their critical thinking abilities. This approach enables students to exercise their inquiry abilities to discover knowledge while promoting their active participation and responsibility in learning (Jong & Joolingen, 1998; Pedaste, & Sarapuu, 2006). As students engage in self-directed learning, teachers guide them to discover new knowledge through cautious and well-planned scaffolding, such as timely and inspiring questions, demonstrations or promoting the formulation of their hypotheses for explanation (Kuhlthau, Caspari, & Maniotes, 2007; Moran 2007). In the discovery of knowledge, such scaffolding is necessary for students to be able to investigate complex situations without subjecting them to extreme cognitive load (Hmelo-Silver, Duncan & Chinn, 2007). It is a learning environment where students are collaboratively engaged in real-time inquiry tasks, which encourages and facilitates their abilities to analyse, evaluate, synthesize, and apply knowledge through reflection and reconceptualization of ideas. This enables them to effectively transfer their knowledge across courses and apply it to unfamiliar situations (Piaget, 1977). Interactions and collaboration engage them in their learning, because as they exercise their minds to find			

	Agree	Disagree	Remarks
feasible solutions to problems, their responses to their peer's questions improve their higher-order tendencies. Such social interactions enable them to share perspectives, reflect and reorganize their knowledge, and ultimately leads to the development of their critical thinking abilities. *Collaboration* Collaborative learning refers to the instructional method that offers students the opportunity to learn in a group with positive interdependence, team accountability and interactions as well as assist others to accomplish specific targets (Johnson & Johnson, 1975; Slavin, 2014; Fu, & Hwang, 2018). The effectiveness of interactivity and collaboration in building and nurturing critical thinking skills is well documented in various studies (Chuang, Chiang, Yang, & Tsai, 2012; Lan, Tsai, Yang & Hung, 2012; Hwang, Hung, Chen & Liu, 2014; Yang, Gamble, Hung & Lin, 2014; Chen & Chiu, 2016). A collaborative learning environment is an effective strategy that enables students to interact among themselves by exchanging views and ideas in order to effectively accomplish their objectives (Morrison, Morrison, & Lowther, 2009; Osman, Duffy, Chang & Lee, 2011; Hwang, Lai, Liang, Chu, & Tsai, 2017). Interactive and collaborative environments empower learners to exercise their minds to find solutions to problems while developing their critical thinking tendencies, as they respond to their peer's questions in more complex and confident ways (Davis, 1993; Hunkins, 1995; Arends, 2004). Learners need interaction and reflection on what they were previously exposed to, and what they are currently experiencing in both external (social) and internal (reflective) contexts in order to gain new knowledge (Brierton, Wilson, Kistler, Flowers & David, 2016).			

	Agree	Disagree	Remarks
Piaget believed that reflection on the elements of lower-level knowledge, directly leads to the attainment of higher order thinking (Bruner, 1996). Collaborative inquiry-based learning tasks facilitate students' discovery of new knowledge through the resolution of previous information while promoting their thinking skills (Gurses, Acikyildiz, Dogar & Sozbilir, 2007; Kumar & Natarajan, 2007). In an environment where education is student-centered, learning is considered as knowledge constructing activities where learners collaboratively obtain, reorganize and use the information acquired for analyzing and solving problems (Gonza´lez-Marcos, Alba-Elı´as, Navaridas-Nalda, & Ordieres-Mere, 2016). The constructivist theory averred that student are required to be exposed to learning experiences that inspire and empower them to construct their own knowledge while promoting their cognitive skills (Driver, Asoko, Leach, Mortimer, & Scott, 1994). When students engage in social interactions with peers in real world contexts, their ability to reflect on previous exposure and knowledge is facilitated, and such reflection is necessary in the enhancement of their cognitive processes. *Critical thinking skills* As nations across the world have become a global enclave with the generation of technologies, human productive activities have become collaborative, knowledge-based and mobile (Dunning, 2000; Black, 2009). This creates the demand for employees to possess digital, analytical and effective communication skills (Levy & Murnane 2012) as machines are taking over human productive activities that require repetitive routine operations (Chu, Reynolds, Tavares, Notari, & Lee, 2021).			

	Agree	Disagree	Remarks
This development is making educational institutions emphasize on learning experiences that facilitate analysis, evaluation and synthesis of knowledge to develop skills for problem-solving through interpretation, creativity and generalization. These learning experiences promote reproductive thinking rather than productive reasoning. Thomas &Thorne (2009) stressed that critical thinking ability is a level that is beyond memorization of information or quoting facts back to an individual in exactly the same manner as they were previously expressed. It is the use of critical and creative thought that enables an individual to solve complex problems through analysis, evaluation and synthesis of knowledge (Yeung, 2012; Lee & Lai, 2017). Critical thinking is observed when an individual receives and stores new knowledge, while interrelating and applying such information to address unfamiliar situations. It is the ability of individuals to achieve a complex and logical thinking process that allows them to interpret, evaluate and manipulate previous experiences, in order to confront present life challenges.			
3. The objective of the model The objective of this instructional model is as stated below: To provide Business education teachers in Nigeria with an instructional model that will enable them to enhance the critical thinking skills of their undergraduate students, by using mobile-blended learning with inquiry-based approach.			
4. Model factors The activities of the teachers and their students in this model are divided in two (mobile and face-to-face roles). The following factors enable them to perform their			

	Agree	Disagree	Remarks
activities effectively to accomplish the intended objective: (a) Teachers' participation in the decision-making process. They need to be part of the decision-making process to introduce mobile-blended learning. When they are allowed to be part of the decision-making process, they become empowered and motivated to implement the new teaching approaches in their classes. Their participation enables the management to glean information on the possible barriers that will affect implementation, and find ways to circumvent them. (b) Mobile-blended learning orientation. The orientation offers an opportunity to introduce the teachers and students to their various roles, appropriate hardware/software sensitization, setup their devices/accounts, and expose them to the relevant school policies, regarding the innovation. The orientation also provides a forum to explain to the teachers and students how and where they can seek support for effective participation, and the incentives for the teachers that will motivate them to embrace and be dedicated to the innovation. (c) Competencies. Teachers require abilities to appropriately blend both the mobile and face-to-face components, to achieve the desired outcome. In addition, their ability to design and deliver mobile content in suitable formats is very important. Their skills to appropriately guide students in these learning contexts, and keep them on track to achieve their learning goals. Teachers require regular training to enhance their competence on how to redesign online instruction and manipulate the learning management system proficiently. Such training initiatives are directed towards achieving a proper blend of both components.			

	Agree	Disagree	Remarks
(d) Support for teachers and students. The support for Teachers is crucial in the implementation of blended learning. This can be in the forms of teaching assistants, technical support, and exposure to successful blended learning prototypes. Such forms of support could be accessed through collaboration, experienced teachers serving as mentors to beginners, and the establishment of a technical support unit, to ensure smooth functionality of the devices across the entire innovation. This will boost their confidence and allay any anxiety they may have in embracing the innovation. Adequate support for them is a mandatory requirement, as they are the focus of the activities with regards to the innovation. When learners get support, their sense of belonging and social ties are enhanced, which in turn strengthen their participation in online learning. Technical support is crucial to promote their effective interaction with technology-mediated instructional materials, because it helps to eliminate any anxiety associated with it, and closes the digital gap among students. Prior to implementation, the need to put in place a robust blended learning lifeline for the students cannot be overemphasized, because it helps to dispel their uneasiness and promote their confidence to leverage on the benefits provided by technology, as learning tools.			
5. Teachers' activities Teachers' activities are divided into mobile and face-to-face activities *A. Mobile activities* Mobile activities refer to the online activities of the teachers via mobile technology. These mobile activities include: i. Design mobile content.			

	Agree	Disagree	Remarks
Depending on the nature of content, the teachers should design the content in appropriate media formats (text, images or videos). The media format should promote students' understanding of the content. ii. Deliver mobile content to students. The content should be delivered in chunks, this is to ensure the content do not overwhelm the students. iii. Explain complex concepts of the content to students. In order to facilitate students' understanding and to avoid their misconception of the content, the teacher should explain the complex terms of the content to the students, by providing them with additional information. iv. Evaluate students' mobile learning. To determine the students' level of understanding of the mobile content, the teacher should ask students questions on the content. This enables the teacher to ascertain whether or not the students understand the content, and to provide clarification where necessary. This is to sufficiently prepare the students for the classroom context. *B. Face-to-face activities* These are the activities of the teachers in the classroom context. i. Recap the mobile content. At the beginning of the face-to-face context, the teacher provides the students with a summary of the mobile content. This to refresh the students' memories and to sufficiently prepare them for inquiry-based tasks in the classroom. ii. Generate work-related ill-structured problems. This is to trigger their reasoning ability and engages their critical thinking processes. This is where the teachers			

	Agree	Disagree	Remarks
link the mobile content to the classroom activities to achieve a suitable blend of both contexts of blended learning. To achieve this, the problems should be related to the mobile content, to encourage the students to analyse, evaluate and synthesize the content in their inquiry activities, to proffer possible solutions to the problems. iii. Divide the students into heterogenous groups. This is to reflect the various backgrounds of the students regarding their knowledge domains, to encourage their ability to share robust perspectives and offer alternative solutions in their inquiry activities. iv. Facilitate elaborate interactions among the students The teacher should encourage the students to engage in discussions, to helps them to share ideas, which results in reflection and reorganization of their knowledge in their inquiry learning activities. This promotes the students' ability to reconceptualize their previous knowledge with the perspectives of their peers to solve problems. v. Scaffold students' knowledge. While the students engage in their collaborative inquiry learning tasks, teachers play the role of a guardian and facilitator, by scaffolding their knowledge with questions that encourage them to exercise their minds to resolve unfamiliar problems. vi. Evaluate students' critical thinking skills To do this, the teachers need to develop critical thinking assessment check list to evaluate the students' critical thinking skills in the following: a. Ability to separate fact-based information from inferences in the mobile content			

	Agree	Disagree	Remarks
b. Ability to analyse the mobile content and separate relevant from irrelevant information c. Ability to relate fact-based information in the mobile content to new situations d. Ability to identify new information that support the solutions in their inquiry activities e. Ability to identify alternative interpretations of the content f. Ability to reorganize relevant information to solve problem g. Ability to reason logically in the application of content in a new situation h. Ability to communicate ideas clearly and effectively			
6. Students' activities The students' activities are divided into mobile and face-to-face contexts. *A. Mobile activities* Students perform these activities via mobile technology i. Access and study mobile content from their teacher. The students access and study mobile content from the teacher in their various locations via their mobile devices. ii. Ask their teachers questions on confusing and complex concepts of the content. This enables them to attain greater understanding of the content. iii. Answer mobile quizzes from their teachers. While the students answer quizzes from the teachers via their mobile devices, they develop the ability to apply the content. iv. Search and study other related online materials. This promotes students' deeper understanding of the			

	Agree	Disagree	Remarks
mobile content as they are exposed to other similar content by other educators. *B. Face-to-face activities* The face-to-face context is where the teachers lead their students through inquiry tasks with the focus to develop their critical thinking skills. Below are the roles of students in this context. i. Listen actively as their teacher summarizes the mobile content. ii. Ask their teachers questions on the mobile content. iii. Answer questions from their teacher on mobile content. iv. Partner with their teachers to generate work-related problems in line with the mobile content. v. Identify their various inquiry groups. vi. Students interact and collaborate with their group members to analyse the problem and the mobile content. vii. Use teacher's questioning to analyse and evaluate their knowledge of the mobile content. viii. Reorganize their knowledge of mobile content to resolve the problem. ix. Evaluation of the processes. The students should be given anonymous and structured questionnaire to elicit responses regarding their level of satisfaction with the processes, the design, the amount of work, motivation, learning gains, as well as the teacher's attributes, using the five-point Likert-scale. This is to provide information that will determine the modifications required for making the project more effective.			
7. **The mobile context** To ensure maximum benefits from the mobile context, the following are necessary:			

	Agree	Disagree	Remarks
i. Both teachers and students must possess ICT hardware such as mobile devices ii. Teachers and students must be proficient in the manipulation of their mobile devices as teaching and learning tools respectively iii. The mobile devices must be internet enabled iv. There must be application software installed in the devices that will assist the teachers and students to deliver and access mobile instructional content respectively, example of such software can be WhatsApp, Line, Facebook messenger or any other preferred learning management system. v. There should be a learning community of the student where students can interact and collaborate while studying the mobile instructional content			

APPENDIX P PHOTOGRAPHS SHOWING ACTIVITIES OF THE TRYOUT AT PHITSANULOK VOCATIONAL COLLEGE

APPENDIX Q TEACHERS' QUESTIONNAIRE FOR THE EVALUATION OF THE TRYOUT OF THE PROCESSES OF THE REVISED INSTRUCTIONAL MODEL WITH MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANCE CRITICAL THINKING SKILLS OF BUSINESS EDUCATION STUDENTS

Please (tick) to indicate your degree of agreement or disagreement on the relationship between the following items **and** the enhancement of critical thinking skills in business education undergraduate students with mobile-blended with Inquiry-based learning.

Gender: Male [ ] Female [ ]

Highest Academic Qualification: Bachelor's degree [ ] Master's degree [ ]

Ph.D. [ ] Academic position ………………………

Items (Processes)	Strongly agree 5	Agree 4	Neutral 3	Disagree 2	Strongly disagree 1
1. Practicability of the processes					
1.1. I was able to implement the online components of instructional plan generated from the processes of the instructional model					
1.2. I was able to implement the face-to-face components of instructional plan generated from the processes of the instructional model					
1.3. My students were active					

Items (Processes)	Strongly agree 5	Agree 4	Neutral 3	Disagree 2	Strongly disagree 1
during mobile context.					
1.4 My students were active during the face-to-face session.					
Remark:					
2. Time allocation					
2.1. The time allocated to the online activities was adequate.					
2.2. The time allocated to the face-to-face sessions was adequate.					
Remarks					
3. Workload					
3.1. The activities in the mobile context did not overwhelm me					
3.2. The activities in the face-to-face context did not overwhelm me					
3.3. The activities in the mobile context were sufficient enough for the learning objectives.					
3.4. The activities in the face-to-face context were					

Items (Processes)	**Strongly agree 5**	**Agree 4**	**Neutral 3**	**Disagree 2**	**Strongly disagree 1**
sufficient enough for the learning objectives					
Remark					
4. Evaluation					
3.1. The activities in the mobile context were effective enough to achieve the mobile context objectives					
3.2. The activities in the face-to-face context were effective enough achieve the learning objectives					
3.4. The general performance of the students in the mobile context was satisfactory					
The general performance of the students in the face-to-face session was satisfactory					
Remarks					

APPENDIX R STUDENTS' QUESTIONNAIRE FOR THE EVALUATION OF THE TRYOUT OF THE PROCESSES OF THE REVISED INSTRUCTIONAL MODEL WITH MOBILE-BLENDED AND INQUIRY-BASED LEARNING TO ENHANCE CRITICAL THINKING SKILLS OF BUSINESS EDUCATION STUDENTS

Please tick to indicate your degree of agreement or disagreement on the relationship between the following items **and** the enhancement of critical thinking skills in business education undergraduate students with mobile-blended with Inquiry-based learning.

Gender: Male [ ] Female [ ]

Items (Processes)	**Strongly agree 5**	**Agree 4**	**Neutral 3**	**Disagree 2**	**Strongly disagree 1**
1. Practicability of the processes					
1. The mobile content my teacher delivered to me was designed in appropriate format(s)					
2. I understood the mobile content my teacher delivered to me to study					
3. My teacher was always online to answer my questions on the mobile content					
4. My peers were always online to share their ideas on the mobile content					
5. The mobile platform was user-friendly					

Items (Processes)	Strongly agree 5	Agree 4	Neutral 3	Disagree 2	Strongly disagree 1
6. The mobile content was available synchronously and asynchronously					
7. I was able to interact and share ideas with my group members during the class session					
8. As the teacher scaffolds our knowledge with questions in the class, we were able gain an in-depth knowledge of the problems and greater understanding to link the knowledge gained from the mobile content to solve the problems she presented to us					
9. During the face-to-face context, my group members were able to create knowledge to solve the problems given to us by our teacher.					
10. The activities in both the mobile and classroom contexts triggered my critical thinking process through reflection and sharing of ideas that leads to creation of knowledge to solve problems					

Items (Processes)	**Strongly agree 5**	**Agree 4**	**Neutral 3**	**Disagree 2**	**Strongly disagree 1**
11. The attitude of my teacher in the online context was satisfactory					
12. The attitude of my teacher in the face-to-face context was satisfactory					
General remarks					

BIOGRAPHY