Development of Mobile Learning English Web Application: Adoption of Technology in the Digital Teaching and Learning Framework

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ABSTRACT

E-learning has become an important part of distance education to comprehend students' skills and knowledge during the COVID-19 pandemic. The adoption of e-learning for kindergarten children is a challenging key for design and development that must be involved in parental care during the use of e-learning. This research aims to design and evaluate a digital learning English system based on a web application for kindergarten students who require additional attention from instructors and parents. The study investigates students' learning achievement and end-user perceptions based on the extended technology acceptance model. The results contribute and confirm a significant positive to technology adoption of the digital teaching and learning framework by offering real-time learning, assessments, achievement records, and learning session activities using web applications on mobile. Perceived ease of use, perceived usefulness, and attitude positively influence behavioral intention to use the proposed learning web application.

KEYWORDS

Digital Framework, Digital Learning, English Vocabulary, Learning English, Smart School, Technology Acceptance Model, Technology Adoption, User Perception, Web Application

INTRODUCTION

In many fields, the digital revolution has become a necessity for the transition from analog computation to digital technology (Leocadia, 2018). Distance education, also known as electronic learning (e-learning), has integrated education and technology systems (Gavrilovic et al., 2022). The e-learning system can be developed to support distance learning during the epidemic and disparities effectively. User requirements support an initiative for online software services that can be designed for use in a variety of educational systems (university, home, and workplace, among others), with various application options (Vasconcelos et al., 2020). By adopting information technology into the education system, e-learning

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has enabled students to acquire skills and knowledge through a variation of developments, including learning methodology (Kumar & Al-Besher, 2022; Lin et al., 2017; Nam et al., 2020), teaching technique (Farrow et al., 2019; Hardini et al., 2019), web and mobile learning platforms (Briz-Ponce et al., 2017; Cavus & Ibrahim, 2017; Hamidi & Jahanshaheefard, 2019), and new media interaction (Hsieh, 2016; Park et al., 2016; Pu & Zhong, 2018). Moreover, participation during a learning class is one of the most important aspects of distance education for young students, as the system can enhance the interactions between students, teachers, parents, media, and content regarding their intentions to use.

English proficiency is crucial for the education of today's children. English also is the second official language of Thailand. The Ministry of Education has established early childhood development policies and strategies (Siddoo et al., 2016). Thai students begin English instruction at a young age. With the advent of the digital age in the twenty-first century, the importance of English in Thai society has grown. The additional strategy for preparing children for the Association of Southeast Asian Nations (ASEAN) community emphasizes English as a means of communication with people of various cultural backgrounds. To increase competitiveness, English proficiency has become a required component of early childhood education (Hsieh, 2016; Lee et al., 2017). Birth to age six, the most formative years of a child's development, are ideal for learning because children quickly absorb, comprehend, and memorize information. The language processing and memory functions in children's brains are accurate and possess a large capacity for storage (Alnatour & Hijazi, 2018; Siddoo et al., 2016). Childhood is a crucial time and perspective for English acquisition (Jingjing & Xuelan, 2020). In addition, the challenging adaptation of e-learning can be applied to four learning English skills (speaking, writing, reading, and listening).

According to extensive research, English instruction should begin in early childhood, whereas the design, development, and implementation of e-learning should take into account the age-related learning limitations of individuals. For instance, teaching English in kindergarten necessitates the use of innovation or new media to maximize the time spent on the learning process (Kusuma, 2019). Participation and familiarity should be age-appropriate, taking into account each child's potential, preferences, comprehension, and desire to learn for enjoyment. Children in parental care may be expected to possess adequate English knowledge and skills. Consequently, parents must prepare their children for future changes and challenges. Parents should make English instruction a priority for their kindergartenaged children so that they can better increase their knowledge and develop their skills in the future.

The previous study proposed designing a digital framework for smart schools that would encompass the entire educational process (Phokajang & Netinant, 2021). The entire system was interconnected by end-users, administrators, and stakeholders using software architecture to connect a school to its digital information platform. The conceptual design of the smart digital school framework facilitated the adoption and evolution of technology. The framework for a smart school included digital learning media for teaching, learning, managing, and supporting school tasks. This research is motivated by adopting the digital smart school framework to propose an expanded system design and evaluation of the mobile learning web application. This article focuses on the collaboration and usage between teachers and parents who play an essential role in helping their children acquire English skills, knowledge, and behaviors, particularly during the COVID-19 pandemic. The pandemic has affected numerous school activities, including student learning, teaching, monitoring, and examining (Rukhiran et al., 2022b). E-learning is a remote instrument that plays a key role in this pandemic and enables schools and universities to facilitate student learning despite the closure of schools and universities (Subedi et al., 2020).

BACKGROUND

Children Learning English

Children can acquire languages more efficiently at a young age. The early years are critical for careful teaching because children are good at learning and remembering, and their brains are incredibly

flexible. From childhood on, children can develop their language skills. Language acquisition enables children to communicate effectively with their environment. As a result, children should begin developing language skills at a young age (Pu & Zhong, 2018; Siddoo et al., 2016; Sidi et al., 2017). People generally believe that children learn a second language more easily than adults. Numerous parents and families, particularly those with a high standard of living, encourage their children to begin learning foreign languages (typically English) as an early child (Nam et al., 2020). According to some researchers, early childhood learning English experiences positively affect later English success (Chen et al., 2020). Listening, speaking, reading, and writing are the four components of comprehensive English proficiency necessary for reading success. The development of a child's vocabulary is inextricably linked to the development of their grammar, as vocabulary is a critical component of the language learning process (Alnatour & Hijazi, 2018; Farrow et al., 2019). Utilizing the gaming concept, a mobile learning English game promotes the concept of self-learning (Chen, 2018). Children are interested and motivated to continue learning during gameplay. According to observations made in kindergarten, the most desired categories are numbers and pictures (He, 2019). Multimedia instructional materials can facilitate student learning and comprehension. A welldesigned learning English application is an excellent tool for promoting cognitive and communicative development in early childhood (Saputra et al., 2020; Widiartin et al., 2017).

Children born during the globalization era grow up in an environment where citizens learn and are proficient in English. The world's current developments, such as in education and advanced technology, may cause children to require, comprehend, and learn English (Sidi et al., 2017). English education is critical for a child's future because it is required in various fields, including science and career. Indonesia and other countries in Asia encourage the strategies of learning English at an early age, like the possibility proposed for many kindergartens in China (Hardini et al., 2019; He, 2019; Nam et al., 2020). Additionally, Vietnam encourages the teaching of English as a foreign language. The national policy of English education attracts the public's attention. As a result, the English language is taught in schools and universities worldwide. Total physical response, abbreviated as TPR (Total Physical Response), is one of the most effective teaching methods for children (Alnatour & Hijazi, 2018; Nam et al., 2020; Sidi et al., 2017). By examining the significance of vocabulary, the authors intend to develop an English vocabulary web application for kindergarten students.

Digital Content

People are increasingly dependent on digital content in their daily lives. The digital information content is unquestionably faster, more convenient, and more environmentally friendly than paper content (Rukhiran et al., 2022a). To the benefit of the public, digital content can improve portability, take advantage of network distribution, and simplify downloading and reading (Gu et al., 2020). Digital content refers to digital information and innovative digital products, including e-books, e-journals, e-newspapers, digital music, digital online games, videos, and animations (Kim & Kim, 2017). Digital devices have evolved over time, and the evolution of such devices has resulted in the development of digital content (Park et al., 2016). Today, the majority of digital content on the Internet is distributed via websites. Approximately two million pieces of digital content have been distributed by multiple digital publication services. Each month, thousands of users can download and upload millions of files (Li et al., 2020). Digital content must enable the management of distinct rights for distinct individuals (Alnatour & Hijazi, 2018). Nowadays, academic organizations are populated with digital content (Erima et al., 2016).

Digital Learning

Digital learning is the delivery of skills and knowledge in digital formats widely used to promote learning, such as texts or images via the Internet and other essential technologies used to produce learning materials and course management systems. Learners can control the digital learning system's timers, locations, routes, and/or speeds. The development of a digital learning system enables students

to learn in various settings, including different locations, times, and ages, to enhance their learning ability and increase their knowledge, interest, and personal skills. Digital learning extends beyond the classroom. Other informal learning environments, such as at home and in the community, are also impacted. Digital learning positively affects learning motivation and outcomes, outperforming conventional instruction. Students concur that using digital learning aids in their coursework and accelerates their learning. Students utilizing a digital learning system can significantly enhance their learning effectiveness. Not only do students benefit from integrating digital learning into classroom instruction, but teachers also gain many advantages, such as the ability to record quizzes, monitor students' progress, and schedule tests. Numerous educational institutions have incorporated digital learning systems in and out of the classroom to allow students to learn and practice what they have learned, thereby promoting lifelong learning (Lin et al., 2017; Maria et al., 2019; Thongkoo et al., 2020; Zhuang et al., 2016).

Mobile Web Learning Contents

Mobile and wireless technology has increased the use of mobile devices in education and revolutionized learning methodologies. In addition, new terms, such as e-learning and mobile learning (m-learning), have been coined. In the past ten years, it has evolved from programmed instruction to computerassisted instruction, web-based learning, and mobile learning. M-learning for educational purposes has increased in popularity, attracting more researchers and educators (Briz-Ponce et al., 2017; Crompton & Burke, 2018; Hamidi & Chavoshi, 2018; Hamidi & Jahanshaheefard, 2019; Kim et al., 2017; Nikou & Economides, 2017). M-learning is an essential component of education that enables students to study whenever and wherever. While mobile learning is a valid point of contention, a comprehensive explanation has not yet been developed. According to Hamidi and Chavoshi (2018), the internet and technological advancements allow mobile learning to expand the online learning environment beyond what students can comprehend and interact with. According to Martin & Ertzberger (2013), mobile web learning is a supported technique in which students can access knowledge via mobile technology anytime and from any location, enabling them to share real-world interests while learning. Nikolopoulou (2019) has presented theoretical concerns and research findings on the following topics: (a) mobile device usage by young children (frequency of use, preferred device, popular activities), (b) mobile technologies and early learning (e.g., effects of mobile technologies on young children's learning of concepts, development of skills, motivation), (c) mobile educational applications that target preschool children (type of applications, design, ease of use), and (d) parents' and teachers' perceptions of mobile educational applications. Based on the findings, suggestions for future research are made, including teacher adoption of mobile learning, pedagogical support, and collaboration between parents and early childhood teachers. In the eyes of users, mobile learning offers the same benefits as other teaching methods, such as a large number of learning resources, quick access to knowledge, two-way interaction, and the elimination of time and geographical constraints (Crompton & Burke, 2018; Reeves et al., 2017).

Learning English Web Application

Mobile web applications refer to digital content-displaying applications for mobile devices that require a web browser. To aid young children in their English studies, a mobile e-learning web application was developed (Lin et al., 2017). The e-learning application for children was developed using the Construct2 software program. The Multimedia Development Life Cycle (MDLC) was implemented in the development process (Luther, 1994). ISO 9126 was utilized for application testing. The software usability test yielded a score of 91.11%. The summary highlighted the suitability of the learning English application's design as a tool for enhancing cognitive development and communication skills in young children. This development research was successfully designed and developed to introduce students learning English to the numbers 1 to 20 and the alphabet A to Z. Even more so in the age of Industry 4.0, using technology to create educational materials is a revolution in the digital education system.

Aqromi et al. (2017) proposed a game web application for action research with young children in the classroom. The game was created using Java as its programming language. The learning content was based on the kindergarten curriculum and aligned with the English language development areas of the kindergarten curriculum. Due to students' inherent interest in playing games, the game enhanced the atmosphere and environment of learning English. According to the findings of the interviews, every student enjoyed Learning English through games. Kindergarten students were observed as having fun and being challenged in class. They may unknowingly learn English in the class.

Hu et al. (2019) argued that a mobile application for learning English vocabulary could improve self-motivation and interest in language learning and promote lifelong learning. The research method analyzed the usability of existing applications for learning English vocabulary. The new version of the application for learning vocabulary through images and procedures had been released. Using a questionnaire, the exploratory comparison of usability issues was expressed. By comparing interfaces, images, and enjoyments, the researchers clearly understudied the visual experience requirements of individuals. In addition, the results demonstrated the correlation between learning experiences and improved performance. Cavus and Ibrahim (2017) discussed the creation of mobile applications that use children's stories to teach English as a second language. The vocabulary, pronunciation, listening, and comprehension of English learners improved without the assistance of teachers. Using mobile phone speech recognition tools to identify learners' speech to teach precise word pronunciation using a mobile-based interactive learning system was innovative. The results clearly demonstrated that the experimental group's English language learning skills improved statistically significantly more than the control groups. Presumably, the application's development can serve as a teaching tool for second-language English instruction. Enhancing one's English proficiency through the use of a mobile application is both enjoyable and advantageous.

METHODOLOGY

This section discusses the digital teaching and learning framework centered on end-users and mobile web application design and interfaces. Participants, experimental setting, vocabulary content, data collection, and testing of hypotheses will be described in the following section. The following research questions served as the study's research objectives:

- **Research Question One:** What are the practical outcomes of incorporating digital content learning English into the actual teaching and learning of kindergarten students?
- **Research Question Two:** What effect does the adoption of a mobile learning English web application for kindergarten students have on the perception of end users?
- **Research Question Three:** What effect do the age, gender, education, and occupation of end users have on their perception of the significance of adopting a mobile learning English web application?

Digital Teaching and Learning Framework

The conceptual design of the smart school digital framework consists of various operational systems. This article focuses on teaching and learning systems only. The framework can apply a digital English teaching and learning system for students in kindergarten level 3. There are many stakeholders known as end-users involved in the digital learning system. For authorized users, each user may have a different set of permissions. All end users must register the application in order for it to collect their responses.

Students can subsequently study the lesson from the fundamental to advanced levels, select the lesson as wanted, skip the lower levels, or repeat the same lessons. The seven vocabulary categories of lessons are two-letter words, three-letter words, four-letter words, color words, number words, day words, and colors of the day words. Besides this, the student can study based on the categories and learn vocabulary randomly from the vocabulary basket. The contents of each lesson include one

image for a vocabulary name. For a testing session, the student can take the pretest as needed. The test includes one image for three vocabulary name selections. There is only one correct answer. The student can select an answer to match the image question. When the student finishes the pretest, the outcome scores will be displayed immediately to establish a topic knowledge baseline. After the student learns from the lesson thoroughly, the student can take the posttest to measure their knowledge and comprehension. The application allows the students to access and compare the pretest-posttest scores.

Teachers have access to all lesson materials and a vocabulary basket through a process similar to students. Teachers can modify and update lesson plans and test questions. They can access and review lesson details and compare pretest-posttest scores for each student. The pretest-posttest results are critical in determining the quality of teaching and learning.

Parents can access the system to review content lessons' subject matter and specifics. Thus, parents can plan before monitoring their children's application usage. The parents can go over the categories and the vocabulary basket with their children. When reviewing their children's achievements, parents can access lesson details and overall scores and compare their children's pretest-posttest scores. Parents can observe their children's study behaviors and plan or improve their next lesson's learning methods.

The staff can review the total scores for various purposes, including reviewing all student scores and reviewing the previous semester's test scores, pretest scores, and posttest scores. Each student's improvement score can be reported for various beneficial purposes, including reporting students' grades and promoting a school.

According to the description of the user permission, integrating an adaptation of the teaching and learning system into the smart school can be beneficial. The school should recognize the contemporary preparation for a digital learning system incorporating multiple facets of human interaction. For instance, all students can enroll in the class from anywhere and anytime, maximizing the effectiveness and efficiency of learning. The teachers contribute to the ease of teaching. Parents can monitor their child's behavior in the classroom and review content to prepare for their child's learning and evaluation results via a camera. The staff performs tasks, such as reporting students' grades and promoting a school, more efficiently and comfortably. Finally, general users with interest in the digital learning system can review the application's entire process. The user authorization architectures for digital teaching and learning are depicted in Figure 1. Figure 2 presents a use case diagram illustrating the system's functions, operations, and users.

Proposed Mobile Learning English Web Application

The application is built on the Thunkable platform, a website for developing mobile applications. The program is being developed for Android and iOS (Thunkable, 2021). The application is divided into two sections: a lesson and a test. Figure 3 illustrates the Android operating system's user interfaces. The first page, show in Figure 3(a), is a login page that appears when the user clicks on the application's icon to open it.

Additionally, as illustrated in Figure 3(a), the new user can register as a member and log into the application. Following the authentication session, the program will navigate to the main application, as illustrated in Figure 3(b). This primary page contains numerous lesson menus. The learner may access the lessons in the order in which they are selected. The table of contents is divided into menus: two-letter words, three-letter words, four-letter words, color words, number words, day words, and colors of the day words; a vocabulary basket menu collecting all random vocabularies; a test menu; and a logout menu.

When the user selects a lesson from the menu, the lesson page displays the lesson's contents based on the user's selection. Figure 3(c) shows a four-letter word learning page. Every page is controlled by the next button and back button procedures, and the final menu of the next button can be used to return to the main application. Figure 3(d) is a page for learning about numbers. The lesson displays the number, associated spelling words, and a variety of visual flowers. Figure 3(e) is a coloring page with words associated with the colors of the day. The lesson includes information about color,





Figure 2. Use Case Diagram of Mobile Learning English Web Application



spelling words, and vocabulary. Figures 3(f) and 3(g) depict test pages comprised of a single image and three potential responses. The student may only select one response button. If they select the proper response, a green tab will display next to it, as shown in Figure 3(f). The red tab, on the other hand, indicates when an answer is incorrect, as shown in Figure 3(g). The application displays the next question after a two-second wait. A test consists of fifteen questions. After the students have completed the fifteen-question test, the application establishes a connection to the score page, depicted in Figure 3(h), to display the achievability. A link to the main program is presented via the home page button. By clicking the test again button, the student can retake the same test. Figure 3(i) illustrates a sample of pretest score histories.

Case Study of Student Participants and Setting

This experiment was conducted in Thailand at Siwalee School during the first semester of the academic year 2021, which spanned four out of sixteen weeks, or 25% of the semester. There were eight total learning sessions. This study's sample consisted of 30 kindergarten level 3 students, with 14 males (46%) and 16 females (54%) between the ages of five and six. Quota sampling is a method for selecting survey respondents who represent the same proportion of the population. The sample groups (seven males and eight females) consisted of a control group of fifteen students and an experimental group of fifteen students, as shown in Table 1. The English instructor for all classes was the same, and

Figure 3. Sample of Mobile Learning English Web Application Interfaces



Table 1. Sample groups of students in this research

Number of students	Control group u	sing the textbook	Experimental g applic	roup using the ation
	Male	Female	Male	Female
30	7	8	7	8

she had taught English for over a decade. The control group utilized a standard ABC1 textbook for kindergarten level 3 English language. The experimental group of students utilized the mobile learning English web application. The digital learning content of the application was similar to the English textbook studied by the control group. The teacher and parents administered an English vocabulary test on a mobile web application for a maximum of 20 minutes. Students could take as much time as they desired on the pretest-posttests. The test was expected to be completed under the supervision of a teacher or parent. Learning achievement in English language, particularly vocabulary, and attitudes toward mobile Learning English web applications were the dependent variables. Various teaching methods were independent variables.

Because this research took place for a quarter of the semester, a greater emphasis was given to receptive vocabulary and reading abilities. Throughout the book and digital content, lowercase English letters are used. The contents include learning vocabulary from one two-letter vocabulary, 37 three-letter vocabularies, 12 four-letter vocabularies, six color vocabularies, 10 number vocabularies, seven-day vocabularies, and seven colors vocabularies of the day.

Students' reading and vocabulary skills were assessed through learning performance evaluations. A quasi-experimental approach measures student achievement using two independent groups of pretest-posttest measurements. The research evaluation for both groups was the identical vocabulary questions of 15 vocabularies in 20 minutes for the pretest-posttest. The test for the control group was taken from a textbook. The test was obtained from the mobile application by the experimental group. The method of testing was to match words to visuals. Each question item has a single image and three-word answer options for students to choose from. A student chooses the answer vocabulary for the picture in the question item. The vocabularies in the test were chosen randomly from all 80 vocabularies in seven categories, which are not equal to difficulty levels. All of the categories are represented in the 15 quiz vocabularies. Table 2 summarizes English vocabulary for the learning and assessment categories.

DATA ANALYSIS

SmartPLS 4.0.8.3 was utilized for Partial Least Squares- Structural Equation Modeling (PLS-SEM) and can be applied for software engineering (Russo & Stol, 2021). In addition, PLS-SEM works well with advanced structures and imposes no limitations on sample size or data distribution. When there is little prior knowledge of the proposed hypotheses in developing the conceptual model, or when the attention is more on exploration than confirmation, PLS-SEM is considered an excellent aesthetic (Hair et al., 2014). Acceptance of PLS-SEM and its successful application in the information system, software design, and domain render PLS-SEM effective, primarily when used for theory development and exploratory research (Hair et al., 2017). Due to this study's exploratory nature and the hypotheses mentioned earlier, PLS-SEM is considered the appropriate method for this study's context. Therefore, the developed research model is validated in a two-step process. The first involves the evaluation of the outer measurement model, while the second involves evaluating the inner structural model development (Wieringa, 2014). Perception and hypotheses were developed using the steps suggested by DeVellis and Thorpe (2021). The

Content	2-letter words	3-letter words	4-letter words	Color words	Number words	Days words	Colors of the day words	Total Words
Learning	1	37	12	6	10	7	7	80
Testing	1	4	2	2	2	2	2	15

Table 2. Summarization of English Vocabulary Categories for Learning and Tests

proposed method establishes a list of components to evaluate, establishes items in each element, specifies the measuring scale, and tests the model's reliability and validity. Content validity, Cronbach's (1951) alpha (α), compound reliability (CR), convergent validity (AVE), and item analysis were employed as indications in the final step. Furthermore, an independent samples *t*-Test for genders of the participants was used to investigate end-user impressions, including a learning supervisor. Technology Acceptance Model (TAM) was proposed by Davis (1989) to investigate the elements that influence user adoption of new information technology. The TAM was used to create the experimental questionnaire (Rukhiran & Netinant, 2020).

Data Collection Instrument of Perception

There were two types of questionnaires used in this study. The first type contained sociodemographic information (gender, age, education levels, and occupations). The second type involved of a technology adoption model associated with four factors: perceived ease of use (five items), perceived usefulness (five items), attitude (four items), and behavioral intention (three items). The survey of a technology adoption assessed participants of each item on a 5-point Likert scale from 1 (strongly disagree) to 5 (agree strongly). To minimize possible bias in the answers, these items were placed in random order. Teachers and parents were polled for their opinions on the acceptance of the learning English web application in the study.

This study took a quantitative approach towards its methodology. Initially, a questionnaire was constructed to collect parent, teacher, and officer perceptions and test hypotheses based on the conceptual model proposed to evaluate the perception of using the mobile learning English web application. 40 users were requested to determine the end-user perception of the mobile learning English web application. There were forty responses, representing a 100% response rate. In addition, all study participants were given informed consent to ensure their participation was voluntary. Any information gathered was anonymized. The information provided was solely for the purpose of research. Justice, respect, autonomy, compassion, and confidentiality were all guaranteed as ethical values.

Conceptual Mobile Learning English Framework

This study utilized two primary research methods to examine student achievement and enduser characteristics. Children are responsible for learning achievement, and system participants (teachers, parents, administrators, and general users) have a responsibility to supervise and monitor their students' system use. As depicted in Figure 4, study of conceptual mobile learning English framework has been specified. The pretest-posttests of the digital learning method revealed that the mobile learning English web application assisted students in learning English more effectively and successfully than the conventional way. Based on the research objectives posed by this study, the hypotheses regarding the end-user perception of mobile learning English web applications are provided.

- **Hypothesis One (H1):** Perceived ease of use has significantly positive influences on the perceived usefulness of using mobile learning English web applications.
- **Hypothesis Two (H2):** Perceived usefulness has significantly positive influences on behavioral intention to use mobile learning English web applications.
- **Hypothesis Three (H3):** Perceived ease of use has significantly positive influences on behavioral intention to use mobile learning English web applications.
- **Hypothesis Four (H4):** Attitude has a significantly positive influence on behavioral intention to use mobile learning English web applications.
- **Hypothesis Five (H5):** Control variables of participants have significant influences on behavioral intention to use mobile learning English web applications.



Figure 4. Study of Conceptual Mobile Learning English Framework

RESULTS

Experiments were employed to obtain data on student learning achievement outcomes in various learning approaches. As part of student learning achievement methodology, the school utilizes digital English-language learning materials. As part of technology adaptation methodology, a survey of parents, administrators, and staff was employed to assess behavioral intension of learning English web application. In this study, students can study English using mobile learning English web applications from any Internet-connected location at any time. Four survey questionnaire sections were collected. The purpose of the first surveying portion was to collect information on the ease and usability of mobile learning English web applications. The second surveying section focused on the perceived usefulness of the mobile web application by the participants, the third surveying section addressed their attitude toward using a mobile web application for learning English, and the final surveying section addressed the behavioral intention to continue using a mobile web application for learning English.

Student Learning Achievement in Different Learning Approaches

The purpose of this study was to compare students' learning outcomes for traditional and digital learning methods using pretest-posttests. For analysis, quantitative and qualitative data were gathered. For achievement tests, descriptive statistics were used to determine the means (Mean), Standard Deviations (*SD*), *t*-values, *df*, and *p*-value. In terms of learning achievement, the effect of learning achievement was compared using a paired sample *t*-Test. To compare the final learning outcomes of different groups, an independent-samples *t*-Test was used. Table 3 displays descriptive statistics for the learning achievement of a control group, including Mean, *SD*, *t*-values, *df*, and *p*-values. The mean and standard deviation of the total score obtained in the control group's pre- and post-tests are reported. In four vocabulary tests, the paired sample *t*-Test revealed a statistical significance level of 0.001. Table 4 summarizes descriptive statistics by presenting the mean and standard deviation of the total score obtained in the experimental group's pretest-posttests. Additionally, the paired sample *t*-Test revealed a statistical significance level of 0.001 for all four tests.

	Control group $(N = 15)$								
Test	Pretest		Posttest			16			
	Mean	SD	Mean	SD		aj	р		
Vocabulary 1 (15)	3.87	1.06	6.40	1.40	-13.20	14	0.000		
Vocabulary 2 (15)	4.13	0.91	6.40	1.68	-7.18	14	0.000		
Vocabulary 3 (15)	5.87	1.69	8.33	1.40	-12.86	14	0.000		
Vocabulary 4 (15)	7.27	1.71	9.07	1.83	-8.09	14	0.000		
Pretest: Mean = 5.29 , $SD = 1.17$, Posttest: Mean = 7.55 , $SD = 1.46$									

Table 3. Descriptive Statistical Values of Paired Sample t-Test for the Control Group

Table 4. Descriptive Statistical Values of Paired Sample t-Test for the Experimental Group

	Control group $(N = 15)$								
Test	Pretest		Posttest		4	16			
	Mean	SD	Mean	SD		aj	р		
Vocabulary 1 (15)	3.87	1.19	8.20	1.86	-16.03	14	0.000		
Vocabulary 2 (15)	7.07	1.10	10.47	1.96	-13.36	14	0.000		
Vocabulary 3 (15)	9.47	1.25	12.00	1.56	-15.33	14	0.000		
Vocabulary 4 (15)	10.73	0.96	14.53	0.74	-19.00	14	0.000		
Pretest: Mean = 7.78, <i>SD</i> = 0.25, Posttest: Mean = 11.30, <i>SD</i> = 1.40									

The pretest-posttest scores of students learning through the English standard ABC1 textbook and mobile learning English web application are shown in Table 5. Both groups improved on every test. However, the independent sample *t*-Test results indicated a significant difference in learning achievement between the experimental and control groups on both pretest (t = -15.63, df = 14, p = 0.000) and posttest (t = -20.18, df = 14, p = 0.000). When examining the *t*-Test for independent samples, the statistical findings indicated that students who studied English using the digital content application achieved significantly higher pretest-posttest scores, with a significance level of 0.001.

Stakeholder Demographic Information Analysis

Females were the majority of participants (55.0%). Most participants were 36 to 40 years (32.5%). Most participants earned a bachelor's degree (45%). Most participants were government employees (45%). Table 6 shows the stakeholder demographic information of participants in this research.

Group	N	Mean	SD	t	df	p-value	Pairwise comparison
Experimental Group (pretest)	15	7.78	0.25	-15.63	14	0.000	E > C
Control Group (pretest)	15	5.29	1.17				
Experimental Group (posttest)	15	11.30	1.40	-20.18	14	0.000	E > C
Control Group (posttest)	15	7.55	1.46				

Table 5. Independent Sample t-Test Learning Achievement of Two Groups

Item	Description	Sample	%
Conden	Male	18	45.0
Gender	Female	22	55.0
	26-30	10	25.0
A	31-35	12	30.0
Age	36-40	13	32.5
	41-45	5	12.5
	Below Undergraduate	8	20.0
Education Level	Undergraduate	18	45.0
	Postgraduate	14	35.0
Occupation	Government Officer	18	45.0
	Private Company Officer	8	20.0
	Entrepreneur	14	35.0

Table 6. Stakeholder Demographic Information of Participants

Construct Reliability and Coefficient of Instrument

Five specialists determined the questionnaire's content validity for the measurement model. According to Hambleton (1984), Item Objective Congruence (IOC) index values range from 0.80 to 1.00. In addition, Confirmatory Factor Analysis (CFA) was used to validate the measurement model. Construct validity was defined by Hair et al. (2010) as the degree to which a set of observed variables accurately represents the latent variables to be measured theoretically. Using postulated criteria, they examined convergent and discriminant validity as well. The results validated a total of 17 items, such as perceived ease of use (five items), perceived usefulness (five items), attitude (five items), and behavioral intention (three items). Bagozzi and Yi (1988) suggested that no items were eliminated because the standardized item loading was greater than 0.5. The factor loading ranged from 0.595-0.902, which is greater than 0.50, indicating a high degree of dependability. Therefore, all constructs undergo reliability and validity analyses. To establish discriminant validity, Hair et al. (2017) stated that research studies must satisfy the Fornell-Larcker criterion (Fornell & Larcker, 1981) and investigate the cross-loadings for all indicators. The measurement model's internal consistency reliability, convergent validity, and discriminant validity were evaluated. Cronbach's Alpha and composite reliability (*rho* a and *rho* b) were used to assess the internal consistency of the employed measures, with values ranging from (0.821 to 0.910), (0.844 to 0.943), thus exceeding the 0.70 thresholds in every instance (Hair et al., 2017). In the case of convergent validity, factor loadings and Average Variance Extracted (AVE) of each item were assessed. All of the item loadings were greater than 0.7 (Hair et al., 2017), and the AVE for each construct was greater than 0.5. (Hair et al., 2017). All outcomes are displayed in Table 7, Table 8, and Figure 5. As shown in Table 7, all achieved and recommended measures and values demonstrated convergent validity acceptance (AVE > 0.5 and CR > 0.7). Based on Table 7, Table 8, and Figure 5, the study confirms the reliability of constructs.

In accordance with the Fornel-Larcker criterion, discriminant validity is established by comparing the correlation estimates between the constructs to the square root of the average variance extracted from the respective constructs. If correlation estimates among constructs do not exceed 0.85 and the square root of the AVE is greater than correlation estimates among other constructs, then discriminant validity is confirmed. As shown in Table 9, discriminant validity was established because the values of inter construct correlation were less than 0.85 and the square roots of AVE for each construct were greater than the values of off-diagonal correlation.

T.L.I. 7	^	V. P. P.			A
Table 7.	Convergent	validity	and Reliabl	lity of	Constructs

Item	Question	Factor loadings > 0.50	Cronbach's Alpha > 0.70	Composite reliability (rho_a) > 0.70	Composite reliability (rho_b) > 0.70	AVE > 0.50
Perceived	Ease of Use (PE)		0.821	0.844	0.878	0.597
PE1	The learning English digital content application is easy to use.	0.595				
PE2	The application is convenient to learn and gets the test results quickly.	0.766				
PE3	The application is convenient to learn English anywhere and anytime.	0.647				
PE4	The display template of the application is clear and easy to understand.	0.901				
PE5	It's easy for me to learn how to use the application.	0.902				
Perceived	Usefulness (PU)		0.863	0.880	0.901	0.647
PU1	The application is more useful for learning English.	0.807				
PU2	The application is useful for students to better understand the vocabularies.	0.884				
PU3	The application is a more versatile learning channel.	0.729				
PU4	The application can be used in conjunction with the study.	0.805				
PU5	The application gains equivalent knowledge to learn from the standard ABC1 English textbook with quality.	0.790				
Attitude (ATT)		0.876	0.911	0.914	0.726
ATT1	The application is one of modern study methods.	0.811				
ATT2	I am interested and ready to learn English from the application.	0.885				
ATT3	Learning via the application is convenient compared to the standard ABC1 English course book.	0.880				
ATT4	I would recommend of the application to others.	0.828				
Behavioral Intention (BI)			0.910	0.945	0.943	0.846
BI1	I would rather have kindergarten students learn English with the application than with the traditional way.	0.916				
BI2	I will use the mobile learning English web application to improve my students' English skills.	0.973				
BI3	I have confidence that the mobile learning English web application can be adopted in digital teaching and learning.	0.867				

	AT	BI	PE	PU
ATT2	0.811	0.159	-0.110	-0.114
ATT3	0.885	0.247	0.022	-0.006
ATT4	0.880	0.198	-0.005	-0.137
ATT1	0.828	0.152	0.009	-0.076
BI1	0.171	0.916	0.742	0.696
BI2	0.245	0.973	0.646	0.623
BI3	0.229	0.867	0.439	0.423
PE1	0.036	0.508	0.595	0.432
PE2	-0.069	0.467	0.766	0.659
PE3	0.075	0.473	0.647	0.509
PE4	-0.059	0.598	0.901	0.685
PE5	-0.025	0.584	0.902	0.680
PU1	-0.143	0.558	0.764	0.807
PU2	0.025	0.579	0.711	0.884
PU3	-0.026	0.451	0.414	0.729
PU4	-0.032	0.598	0.602	0.805
PU5	-0.202	0.385	0.560	0.790

Table 8. Cross Loading Among Constructs' Analysis

Figure 5. Path Coefficient/Direct Results



	AT	BI	PE	PU
AT	0.852			
BI	0.230	0.920		
PE	-0.018	0.683	0.773	
PU	-0.090	0.650	0.778	0.804

Table 9. Discriminant Validity - Fornell-Larcker Criterion

The Heterotrait-Monotrait ratio (HTMT) of correlations is a new criterion for evaluating the discriminant validity developed by Henseler et al. (2015). According to Table 10, the HTMT ratios obtained in this study indicated no correlation between the constructs. The highest inter-construct HTMT value was 0.848. As this value is less than 0.85, there was sufficient evidence of the constructs' discriminant validity (Kline, 2011).

Having validated and analyzed the measurement model, Table 11 presents the findings of testing hypotheses concerning students' learning outcomes using pretest-posttest methodologies for traditional and learning English methods. The results of the *t*-Test indicated a statistically significant difference in achievement between the experimental and control groups. When the pretest-posttests were compared, the result showed that the mobile Learning English web application had a significant effect on an achievement of learning English.

As outlined in Hair et al. (2017), a bootstrapping procedure employing 5000 bootstrap samples via SmartPLS 4.0 was employed to determine the significance of the developed hypotheses. Correspondingly, the proposed essential criteria for evaluating the structural model in PLS-SEM should include testing path coefficients. Figure 5 depicts the outcome of implementing the proposed model with PLS-SEM. Table 12 illustrates end-user characteristics of usage learning English web applications as technology adoption and the direct results of testing the hypotheses. PE was found to be significantly and positively associated with PU, as the *p*-value is 0.000 and the *t*-value is greater than 1.96, confirming the significance of the effect (p < 0.001). Since the path coefficient value was 0.778, indicating a positive sign, PE had a significant positive effect on PU. Similarly, for the second

	AT	BI	PE	PU
AT				
BI	0.252			
РЕ	0.131	0.771		
PU	0.164	0.701	0.848	

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Table 11. Summary of Result for Digital Learning Outcomes from Hypotheses Testing

Relationship	Types	Value	<i>p</i> -value	Results
Pretest of Digital Learning → Digital Learning Achievement	t-Test	-15.63	0.000	Accepted***
Posttest of Digital Learning → Digital Learning Achievement	t-Test	-20.18	0.000	Accepted***

*** p< 0.001

Hypotheses	Relationship	Original sample (<i>O</i>)	Sample mean (M)	Standard deviation (STDEV)	T-statistics (\O/ STDEV\)	<i>p</i> -value	Results
H1	$PE \rightarrow PU$	0.778	0.791	0.058	13.483	0.000	Accepted***
H2	$PU \rightarrow BI$	0.352	0.387	0.202	1.740	0.082	Accepted*
Н3	$PE \rightarrow BI$	0.413	0.369	0.216	1.911	0.056	Accepted*
H4	$AT \rightarrow BI$	0.269	0.269	0.112	2.399	0.016	Accepted**

Table 12. Path Coefficient/Direct Effect Results

*** p< 0.001, ** p < 0.05, * p < 0.1

hypothesis (H2), PU was found to be significantly related to BI, as the *p*-value was less than 0.1 and the *t*-value was greater than 1.740, confirming the significance of the relationship (p < 0.1). PE was found to be significantly related to BI, as evidenced by the *p*-value of 0.056, which is less than 0.1, and the *t*-value of 1.911, which confirmed the significance of the relationship (p < 0.1). In addition, the final hypothesis (H4) AT was significantly associated with BI, as the *p*-value was 0.016 less than 0.05. The *t*-value of 2.399 confirms the significance of the effect (p < 0.05), given that the path coefficient values were 0.202, 0.216, and 0.112, indicating that PU, PE, and AT have a significant positive effect on BI. Consequently, H1, H2, H3, and H4 were approved.

The results of the moderation analysis are presented in Table 13 and Figure 6, which reveals that the values fell within the range mentioned by Hair et al. (2017). As *p*-values were less than 0.05 and *t*-values were greater than 1.96, the methodology section describes all results. According to the *p*-value of 0.01 and the *t*-value of 2.56, there was a statistically significant positive correlation between the moderation of Education and BI. The *p*-value and *t*-value for the relationship between the moderation of Education and PE were 0.04 and 2.057, respectively. The interaction between Gender and AT, and BI exhibited a significant positive direction, as indicated by the p-value of 0.043 and the *t*-value of 2.023. The *p*-value was 0.083, and the *t*-value was 1.732, indicating that the relationship between

Hypotheses	Relationship	Original sample (<i>O</i>)	Sample mean (M)	Standard deviation (STDEV)	T-statistics (\0/ STDEV\)	<i>p</i> -value	Results
H1	$\rm PE \rightarrow PU$	0.749	0.766	0.070	10.682	0.000	Accepted***
H4	$AT \rightarrow BI$	0.612	0.618	0.192	3.187	0.001	Accepted**
H2	$\mathrm{PU} \to \mathrm{BI}$	0.377	0.416	0.199	1.896	0.058	Accepted*
H3	$PE \rightarrow BI$	0.460	0.407	0.214	2.148	0.032	Accepted**
H5-1	$Age \rightarrow AT$	-0.272	-0.291	0.147	1.846	0.065	Accepted*
H5-2	Gender x AT → BI	-0.477	-0.473	0.236	2.023	0.043	Accepted**
Н5-3	Gender \rightarrow BI	0.043	0.034	0.215	0.202	0.840	Not accepted
H5-4	$\begin{array}{c} \text{Occupation} \\ \rightarrow \text{PE} \end{array}$	0.243	0.256	0.141	1.732	0.083	Accepted*
H5-5	Education \rightarrow BI	0.266	0.254	0.104	2.565	0.010	Accepted**
H5-6	Education \rightarrow PE	-0.270	-0.266	0.131	2.057	0.040	Accepted**
H5-7	Education \rightarrow PU	-0.103	-0.092	0.111	0.930	0.353	Not accepted

Table 13. Path Coefficient/Direct Effect Results and Moderation Effect Results

*** p< 0.001, ** p < 0.05, * p < 0.1





Moderation of Occupation and PE was significant at the p < 0.1 level. As the *p*-value was 0.065, the *t*-value was 1.846, and the result was significant at p < 0.1, there was a statistically significant negative relationship between Age and AT moderation. Similarly, the *p*-value of 0.043 and the *t*-value of 2.0 indicated a significant direction for the interaction of Gender with AT and BI. However, a significant interaction between Gender and the relationship between AT and BI was found to be negative. H5-4 and H5-5 were significantly positive, while H5-1, H5-2, and H5-6 were significantly negative.

DISCUSSION

Incorporating mobile technology into digital English-learning strategies for students is effective research. The results are consistent with those of recent studies reported by Lee et al. (2017). This study investigated the application of digital content and determined its value in terms of positive learning outcomes and perceptions in digital English learning contexts. The findings indicate that

digital content for learning English on mobile devices helps students comprehend vocabulary anywhere and anytime. In this study, the experimental group outperformed the control group regarding vocabulary and reading development among children. Using mobile technology to learn English digitally confirms the findings of several earlier studies concerning the success of English learners. On multiple platforms, both groups had equal access to the same resources. In addition, the students shared a teacher who planned lessons meticulously to meet course requirements. However, the experimental group performed well when the instructor evaluated student achievement. In accordance with the research findings of Hsieh (2016) and Lee et al. (2017), integrating digital learning into a mobile web application can increase motivation and influence learning behaviors. The concentration and interactivity of the content provided by the mobile web applications aided the control group's vocabulary comprehension. As shown in Figures 3(a) - 3(i), the digital content application demonstrates the distinction between interactive learning English in terms of vocabulary content as illustrated in Figures 3(b) - 3(e), vocabulary tests as depicted in Figures 3(f) - 3(g), and test results as displayed in Figures 3(h) - 3(i).

The authors return to the initial research questions to discuss the significant findings and their implications for the practical outcomes of integrating mobile learning web applications into the actual teaching and learning of kindergarten students. The first research question investigated the relationship between teaching fidelity and student achievement when using digital content to study English vocabulary. Taking into account descriptive statistics for the variables of interest (see Tables 3–5 and 11), the experimental group had a higher mean value than the control group. The results indicate that the pretest-posttest of digital content learning English has a significant impact on achievement. This finding confirms that the mobile learning English web application developed in accordance with the proposed English teaching and learning framework has a significant impact on the English learning outcomes of students. This result is also consistent with previous research indicating the importance of student learning (Aqromi et al., 2017; Cavus & Ibrahim, 2017; Hu et al., 2019).

The results of this study indicate that end-user perceptions, including those of parents, teachers, and staff, are influenced by satisfaction. These findings represent the second research question regarding the mobile learning web application for kindergarten students. The results indicate that the perceived usability, perceived usefulness, and attitude of end users have a significant positive effect on their behavioral intention to use mobile learning English web applications. As shown in Table 12, the results supported the second hypothesis that perceived ease of use (H1 and H3) is significantly and positively associated with perceived usefulness (p < 0.001) and behavioral intention (p < 0.1), perceived usefulness (H2) is significantly and positively associated with behavioral intention (p < 0.05). Thus, H1, H2, H3, and H4 were accepted. This result is consistent with prior research indicating that perceived ease of use and usefulness are influenced (Mo, 2021; Vanduhe et al., 2020).

The findings from this study regarding the third research question concern the relationship between moderation effects (age, gender, education, and occupation) and perceived ease of use, perceived usefulness, attitude, and behavioral intention. Age (H5-1) (p < 0.05) had a significant effect on attitude. Gender interaction of attitude (H5-2) (p < 0.05) had a significant effect on behavioral intention. The results corroborate prior research (Chung et al., 2010), demonstrating that age and gender have no bearing on perceived ease of use and usefulness. Education (H5-5 and H5-6) (p < 0.001) had a significant effect on perceived ease of use and behavioral intention. Occupation (H5-4) (p < 0.05) had a significant positive effect on perceived ease of use. Education and occupation had the most significant effect on one external variable's perceived ease of use. They significantly impacted English digital content in perceived ease of use and behavioral intention. Their characteristics contribute significantly to their children's success in digital learning English. Parents, teachers, and staff are also impacted by educational changes and the integration of technology adoption into teaching and learning. It influences their children's digital learning approach based on their education and career (Starkey, 2020; Stevenson, 2011). A longitudinal study could be conducted by manipulating the release of extended digital learning content for mobile learning English web applications, which may act as a stimulant for perceived ease of use and usefulness. Simultaneously, the findings of this study contribute to the TAM literature and substantiate future research in the field of mobile learning English web applications.

CONCLUSION

Distance education is digital learning for eradicating pandemics and addressing disparities in opportunity. E-learning is one of the distance education solutions that can help learners achieve skills and knowledge in various educational settings, including K-12, higher education, and training. In this study, the authors designed and developed mobile learning web applications for kindergarteners to learn English vocabulary. By developing the web application, the stakeholders, such as teachers, parents, and staff, enable certain participants to review, utilize, and monitor their students constantly. In addition, adopting web applications on mobile devices enables real-time learning, assessments, achievement records, and learning session activities.

Furthermore, the proposed research model can demonstrate two preliminary evaluations: students' digital learning outcomes and stakeholders' behavioral intention to use mobile learning on web applications. The learning outcomes of students in the experimental group who utilized mobile learning on a web application may have been significantly superior to those of students in the control group who studied from a textbook. The authors extended the Technology Acceptance Model (TAM) based on perceived ease of use, perceived usefulness, and attitude to ensure that the factors positively influence behavioral intention when using mobile English-learning web applications. Consequently, based on the acceptance results, the developed model represents the relationship structure of all significant factors.

Future research can experiment with the longer study period by implementing a variety of vocabulary categories and creating lessons and tests for four fundamental language skills (listening, speaking, reading, and writing). Therefore, teacher participation in the design of learning activities is crucial. It is possible to investigate a larger number of students, parents, and teachers to improve kindergarten children's technological adoption performance in various locations. By maintaining the web application, the artificial intelligence of pronunciation detection can evolve to aid English language learners' pronunciation.

COMPETING INTERESTS

The authors declare that they have no conflict of interest.

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