ANALYSIS OF A MOBILE LEARNING ADOPTION MODEL FOR LEARNING IMPROVEMENT BASED ON STUDENTS' PERCEPTION

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ABSTRACT

Aim/Purpose	This identifies the factors that influence the application of mobile learning in order to improve the student learning process at universities in Indonesia based on the student's perspective regarding factors that affect mobile learning, which is still rarely done in the Indonesian context.
Background	The pandemic has had an impact on education in Indonesia so teaching and learning activities utilize online learning applications (online) to support the learning process (online teaching and learning). Although mobile learning is increasingly being used in universities in Indonesia, there have not been many studies on the factors that drive mobile learning adoption.
Methodology	The research method used was the quantitative method. Research based on the elaboration of the mobile learning adoption model was conducted based on students' perceptions of mobile learning adoption using the perceived interactivity of the mobile learning model and the Technology Acceptance Model (TAM) that has been modified to describe the adoption of mobile learning.
Contribution	This research contributes to knowledge in identifying and analyzing mobile learning adoption using three types of perceived interactivity; namely, perceived interactivity between users, perceived interactivity between users and mobile

learning applications, and perceived interactivity with mobile learning infrastructure, and evaluating the perceived interactivity impact of mobile learning adoption on perceived ease of use, satisfaction, and ongoing intention to use mobile learning. This study also evaluates the impact of mobile learning adoption on perceived usefulness, satisfaction, perceived enjoyment, and continuance intention to use mobile learning.

Findings	It was found that the factor in mobile learning based on the student's perspective became one of the components of the mobile learning interactivity model. The components are grouped into user-perceived interactivity (student-to-teacher, student-student, student-to-content), perceived interactivity within the application (perceived ease of use, perceived ubiquity, quality of learning content), and perceived interactivity in infrastructure (network quality, system quality).
Recommendations for Practitioners	The significant influence of adopting mobile learning in Indonesia is the Indonesian government which needs to provide a perception of quality interactivity and interesting and fun learning content so that users will feel comfortable when using mobile learning. The ease of use of mobile learning applications must also be adjusted to the needs of users and the learning content needed by users so that mobile learning can be better.
Recommendations for Researchers	This work confirms that nine of the twelve variables used have a significant influence on the adoption of mobile learning in universities in Indonesia. The nine variables are student-to-student interactivity, student-to-content interactivity, perceived ease of use, perceived ubiquity, quality of learning content, system quality, perceived enjoyment, perceived usefulness, and satisfaction.
Impact on Society	For universities, the development of mobile learning adoption in universities must be designed by considering interactivity in learning, learning content that is in accordance with user learning outcome targets set by the faculty, and user study programs, as well as taking into account aspects of learning technology, such as user information security and user interfaces that can provide convenience for mobile learning users, so that the quality of information, the quality of learning, and the learning system can be well received by users.
Future Research	Future studies will be able to cover all regions of Indonesia, represented by several public and private universities, by considering several additional factors, including user safety in using mobile learning.
Keywords	mobile learning, Indonesian higher education, student perspectives, Indonesia

INTRODUCTION

Since early March 2020, Indonesia has become one of the countries affected by the Coronavirus Disease 2019 (COVID-19) pandemic, which is caused by a coronavirus that can infect humans. Various policies have been adopted in Indonesia to reduce the effects of pandemics or public health emergencies due to COVID-19. The policies include the stipulation of Presidential Decree number 11 of 2020 concerning the Determination of Corona Virus Disease 2019 (COVID-19) Public Health Emergency on March 31, 2020. The pandemic has had an impact on education in Indonesia.

The entire educational process, from elementary to tertiary level in Indonesia, makes adjustments to the new condition. Teaching and learning activities, which were initially conducted face-to-face (offline) or by blended learning by utilizing online learning applications (online) to support the learning process (online teaching and learning), switched to using e-learning as a learning medium. The Ministry of Education and Culture of the Republic of Indonesia operates the Indonesian Online Learning

System or SPADA for universities that have not adopted e-learning in distance learning. E-learning is the result of collaboration between education and technology and has become a powerful medium for learning by utilizing internet technology (Al-Fraihat et al., 2020).

In early March 2020, the teaching and learning process in Indonesia began implementing distance learning using online learning media. All stakeholders in the education sector, from policymakers (namely, the government, teachers, or lecturers) to students, must be able to adapt to the sudden changes that have occurred due to the pandemic that has hit Indonesia. Based on the results of a survey conducted by Cyberthreat.id in February 2020, out of a total of 272.1 million Indonesians, the number of internet users reached 81.46% and the number of smartphones connected to the internet reached 353.2 million units or 85.05%, which is almost double the number of internet users. It means that almost all Indonesian people have more than one smartphone (Suud, 2020). Distance learning is conducted using learning applications that are widely accessed using a mobile device or mobile application. Students and teachers must be able to operate gadgets to be able to learn remotely, use applications for the implementation of learning, and monitor the learning process.

The current adaptation of e-learning technology can still be developed toward a mobile learning (also called m-learning) base to increase user interaction (Bernacki et al., 2020). The use of mobile learning increases the advantages of e-learning by utilizing handheld-wireless technology that allows students to interact via mobile devices wherever they are (Evans, 2008; Motiwalla, 2007). According to García-Martínez et al. (2019), several factors influence the success of mobile learning, including the ability of lecturers (in terms of pedagogy and use of mobile application technology), the convenience of use of mobile devices to develop self-efficacy with mobile technology, and infrastructure provided by the university to support interactive learning.

Unfortunately, although mobile learning is increasingly being used in universities in Indonesia, there have not been many studies on the factors that drive mobile learning adoption. Most of the existing studies are related to the adoption of e-learning (Kusdibyo & Leo, 2018; Suarta & Suwintana, 2012). There are only a few studies that discuss the context of mobile learning. For example, a study conducted by Sulisworo and Toifur (2016), explains that there has been a shift in the learning environment due to mobile technology so that students tend to learn in a more personal way. Learning design needs to activate mobile cooperative learning for individual learning convenience (Sulisworo & Toifur, 2016).

Research related to the adoption of mobile learning in universities, especially in Indonesia, has not been widely conducted. One of the research studies related to this topic is by Pramana (2018), which investigated the factors that influence student intentions to adopt mobile learning for their learning activities. This research discovered significant correlations and causal effects involving learning autonomy, perceived enjoyment, facilitating condition, perceived mobility, social influence, perceived usefulness, and perceived ease of use. Mobile learning meets the increasing need for communication and collaboration with the ability to obtain relevant information at the right time. Pramana (2018) has found that perceived enjoyment and perceived usefulness were the factors that most influence the adoption of mobile learning. However, Pramana (2018) did not discuss the relationship between perceived interactivity (of a user, in the application, and the infrastructure) and the adoption of mobile learning in Indonesia. Therefore, it is important to conduct research on the correlation between perceived interactivity and the adoption of mobile learning at universities in Indonesia.

Based on the statements above, this research aims to:

- Theoretically understand the adoption of mobile learning to improve the learning process at universities.

- Provide recommendations for higher education management so as to successfully implement mobile learning in universities.

- Explore the influence of perceived interactivity (of a user, in the application, and in the infrastructure) to identify factors for the adoption of mobile learning based on student perspectives.
- Analyze the influence of perceived interactivity, perceived usefulness, and perceived enjoyment on student satisfaction with mobile learning adoption and analyze the influence of perceived usefulness, perceived enjoyment, and satisfaction on continuance intention of mobile learning adoption.

The next section is a literature review that includes theories related to mobile learning adoption in Indonesia and perceived interactivity. The following section presents the research model, perceived interactivity attributes and their impact on perceived usefulness, and satisfaction, perceived usefulness, and perceived enjoyment and their impact on satisfaction, as well as perceived usefulness, perceived enjoyment, and satisfaction and their impact on continuance intention. Then there is a discussion about methodology, instruments, and data processing procedures. The final section of this paper is the results and discussion.

LITERATURE REVIEW

Teaching and learning activities that are usually conducted conventionally or face-to-face have become constrained due to the COVID-19 pandemic that has hit various countries in the world, including Indonesia. The learning activity process is forced to switch from face-to-face learning to online learning. Fortunately, current technological developments greatly support distance learning so that educational goals and processes can still be achieved.

Online learning is accessed using a mobile device (Korucu & Alkan, 2011). Based on research conducted by Sadikin and Hamidah (2020), students already have online learning facilities. Moreover, the implementation of online learning has flexibility, encourages independent learning, and motivates students to be more active in learning. There will be many challenges and opportunities that will be faced by lecturers in the application of distance technology and online education. One of these challenges is to ensure that technology is integrated effectively into distance learning and online education to allow for interaction and, ultimately, lead to individual satisfaction (Bailey, 2002).

MOBILE LEARNING ADOPTION

Mobile learning is very helpful in facilitating the distance or virtual learning process as an alternative to face-to-face learning during the COVID-19 pandemic. However, the use of mobile learning technology does not run smoothly because Indonesia has a unique and diverse ethnicity and culture in terms of technology acceptance, especially the use of information technology. Another obstacle is related to the facilities and infrastructure for developing mobile learning, especially the availability of internet networks and the skills of lecturers in operating devices and designing digital-based teaching materials properly.

The use of e-learning in Indonesia as a medium for distance learning can increase the effectiveness and efficiency of learning, improve skills in the field of information technology, improve self-discipline in completing assignments, and facilitate communication with educators in charge of related subjects (Sayekti, 2015). Mobile learning is the development of e-learning, which is a form of information and communication technology utilization. Mobile learning is very helpful for the interactivity of the learning process so that the learning process of students is expected to be more interesting and not bound by time and location (Yuliani, 2010).

According to Majid (2012), the process of mobile learning in Indonesia has three main functions, namely, as a supplement (where students have the freedom to use mobile learning or not), as a complement (where mobile learning is used as a complementary program for learning material that is taught to students in class or taught as reinforcement or remediation for students who have not been

able to meet competency standards), and as a substitute (where the learning activity model fully uses mobile learning). Mobile learning will have the aim of making students use their time flexibly in managing their college activities according to their daily schedule and activities (Majid, 2012).

The trend of using mobile service adoption for internet applications among teenagers is increasing and is a large enough opportunity to improve teaching and learning process services. The use of mobile technology to provide educational services will educate and save time and do many other activities, by not spending time on classroom-based education (Dolawattha et al., 2019). Mobile learning can be defined as the implementation of learning for students anytime and anywhere using wireless internet and mobile devices, including smartphones, tablets, laptops, and digital notebooks with wireless networks that enable mobility and mobile learning. Based on the definitions proposed by Wang et al. (2009) and Korucu and Alkan (2011), mobile learning in this research is interpreted as a process of learning activity or interaction between students, educators, and learning content that can be done anytime and anywhere using a mobile device connected to the internet or wireless network. This learning activity can be in the form of reading, listening, watching fun videos, answering questions in quizzes, or even participating in discussion forums with their peers and teachers (Pramana, 2018). Table 1 lists studies on mobile learning adoption.

Table 1. Summary of mobile learning adoption studies

Mobile Learning Adoption Theory	Project Focus	Reference
UTAUT	Solving the mystery of mobile learning adoption in higher education	Al-Adwan et al. (2018)
	Adoption and use of mobile learning in higher education: the UTAUT model	Mosunmola et al. (2018)
	For the sustainable application of mobile learning: an extended UTAUT model to examine the effect of technical factors on the usage of mobile devices as a learning tool	Alghazi et al. (2021)
TAM	Factors impacting teachers' adoption of mobile learning	Mac Callum and Jeffrey (2014)
	Factors influencing the adoption of mobile learning	Lu and Viehland (2008)
	Analysis of the essential factors for the adoption of mobile learning in higher education: a case study of students of the university of technology	Hamidi and Chavoshi (2018)
UTAUT and TAM	Determinants of the adoption of mobile learning systems among university students in Indonesia	Pramana (2018)

THE DEVELOPMENT OF MOBILE LEARNING IN INDONESIA

Indonesia has been facing the COVID-19 pandemic for a year and, during that period, learning activities have been mostly conducted via e-learning (Google Classroom, Moodle, Edmodo, Schoology, and university web learning), mobile learning applications (Whatsapp, Telegram, or Line), communication-based mobile applications for teleconferencing or video conferencing (Zoom Meetings, Google Classroom, Discord, and others), as well as applications for social media, entertainment, streaming, and others, such as Instagram, Facebook, YouTube, and TikTok. All of these mobile applications can be used in learning with innovations that have been widely applied to support the

learning process during the COVID-19 pandemic (Aditia, 2021). Mobile learning is a distance learning model designed to meet educational needs with the help of mobile devices so that independent learning opportunities, both in terms of time and location, will be realized (Korucu & Alkan, 2011). According to Mutlu et al. (2000), mobile learning can be used to support distance learning.

The application of mobile learning in Indonesia currently includes interactive video-based learning media content that will improve students' abilities, increase motivation, and encourage performance and behavior change of students to be more productive (Azizah, 2020). Mobile learning can be combined with video-based learning so that the learning process becomes more interactive. There are several combinations of video-based learning; for example, teaser videos to motivate students, conceptual videos, videos with interesting content, videos that can stimulate student initiative, and videos that are combined with SBL (scenario-based learning) that contain case studies and problem-solving (Azizah, 2020). Therefore, lecturers must be able to benefit from technological developments such as mobile applications and be able to innovate so that the learning process can be more interesting and easier and improve the learning quality of students (Aditia, 2021).

MOBILE LEARNING INTERACTIVITY MODEL

Perceived interactivity is the ability to facilitate both face-to-face interaction and online interaction via mobile learning so that two-way information is created in the process of exchanging information in an interpersonal connection. Perceived interactivity is very important in mobile learning research. This research identifies the components of perceived interactivity and investigates the impact of perceived interactivity on perceived ease of use, satisfaction, and continuance intention of mobile learning. Interactivity in mobile-based applications has several characteristics; for example, flexibility to be accessed anywhere by users via cell phones, always-on handset, and mobile devices that are connected to the internet, a mobile device that is frequently carried, and convenience of obtaining information using a handheld device (Kannan et al., 2001).

Mobile devices make it very easy for users to interact with each other and access learning materials anytime and anywhere (Liaw et al., 2010). Students can interact and exchange information with other students to collaborate and interact with lecturers in order to better understand the content of the material provided. Perceived interactivity in mobile learning will encourage more active teaching and learning activities. This is in accordance with research conducted by Almasri (2014), Dyson et al. (2009), and Alshalabi and Elleithy (2012), which discovered two types of interaction in the use of mobile learning, namely, human-system interaction (student to content) and interpersonal interaction (student to student, student to teacher).

The model in this research is the mobile learning model, which is a modification of the research model of perceived interactivity (user, application, and network) and the Technology Acceptance Model (TAM) by adding the variable of perceived enjoyment. This research proposes a mobile learning interactivity model that has three components, namely, student, educator, and content (Alshalabi & Elleithy, 2012). This research categorizes perceived interactivity into three: (i) the user (student-to-teacher, student-to-student, student-to-content), (ii) the application (perceived ease of use, perceived ubiquity, learning content quality), and (iii) infrastructure (network quality, system quality). In the context of this research, the interactivity perceived by students results in mobile learning user reactions to satisfaction, which in turn affects continuance intention.

The category of perceived interactivity for users consists of interactions between student and student, student and teacher, and student and content. This is in accordance with research conducted by Almasri (2014), Dyson et al. (2009), and Alshalabi and Elleithy (2012), who found two types of perceived interactions in using mobile learning, namely, human-system interaction (between student and content) and interpersonal interaction (between student and student, student and teacher).

Perceived interactivity in application consists of perceived ubiquity, perceived ease of use, and learning content quality. Perceived ubiquity is Ubiquity is the ability to allow mobile users to obtain information and conduct mobile transactions anyplace through Internet-enabled mobile devices (D. Kim & Hwang, 2006)). Mobile device features are increasingly functional, making them more useful so that perceived ubiquity has an impact on perceived usefulness (Nikou & Economides, 2017). Good-quality learning content provides learning material (equations, formulas, graphics, definitions, and videos) with easy access to information and inspires students to learn (Bekele 2010; Kamaruzaman & Zainol, 2012).

Perceived infrastructure relates to the availability of network quality and system quality. Network quality is an important dimension of interactivity for measuring the attributes of available communication channels and will greatly determine the quality of cellular communication services and user satisfaction (Downes & McMillan, 2000; McMillan & Hwang, 2002). The use of modern technology that is mediated by computer and network devices today greatly facilitates the distance learning process and can also facilitate user interaction, be it interactions between students, interactions between lecturers and students, and interactions between students and learning content. According to DeLone and McLean (2004), the quality of the system can be seen from the overall perceived activity of the entire system. The visual appeal of the mobile-based application display matters (Gao & Waechter, 2017; Silic & Ruf, 2018; Zhou, 2011, 2012).

CONSTRUCTS AND HYPOTHESES

Based on the literature review and previous research that focuses on the factors that influence the adoption of mobile learning on students, the model of this research consists of three dependent variables, namely, perceived usefulness, user satisfaction with mobile learning, and perceived convenience of using mobile learning. In addition to these dependent variables, there are eight independent variables that are grouped into perceived interactivity user (interaction between student and lecturer, the interaction between student and student, and interaction between student and material content provided by the lecturer), perceived interactivity in the application (perceived ubiquity, perceived ease of use, and quality of learning content), and perceived infrastructure (network quality and quality of mobile learning systems). The constructs and hypotheses are developed based on the relationship of the variables and are presented in the following section.

THE INFLUENCE OF PERCEIVED USER INTERACTIVITY ON THE PERCEIVED USEFULNESS OF MOBILE LEARNING AND SATISFACTION OF MOBILE LEARNING

The use of mobile learning greatly facilitates interaction between lecturer and students as well as interactions between students. Students easily ask questions to the lecturer without having to feel uncomfortable with other students. Students can also interact with other students to have discussions in order to solve problems presented by the lecturer. In this case, there is an interpersonal interaction where users can communicate or convey information to others via mobile learning, and other users can provide feedback and have discussions and dialogue. User interaction, both interaction between students and lecturer or interaction between students, is needed to understand the learning process online by referring to two-way and reciprocal communication between mobile learning users. Through interpersonal interactions, students gain knowledge and expertise that can increase knowledge and literacy in order to be able to understand the material provided by the lecturer. Human-to-human interaction can facilitate user outcome expectations of enhancing their self-competence (Lin & Chang, 2018).

Perceived interactivity of user (student-to-student, student-to-teacher, and student-to-content) will influence perceived ease of use and perceived benefit of the user, which in turn encourage continued

use, thereby affecting users' willingness to exchange information (Lee & Lee, 2019). Based on the arguments proposed, it is believed that there is a positive relationship between the perceived interactivity of user (student-to-student, student-to-teacher, student-to-content) and the perceived usefulness of mobile learning, which is formulated in the following hypotheses:

> H1a. Perceived interactivity of user (student-to-student) has a positive relationship with perceived usefulness of mobile learning (SS → PU)

> H1b. Perceived interactivity of user (student-to-teacher) has a positive relationship with perceived usefulness of mobile learning (ST → PU)

> H1c: Perceived interactivity of user (student-to-content) has a positive relationship with perceived usefulness of mobile learning (SC → PU)

The process of providing lecture material is conducted online by the lecturer every week. However, the material provided is not necessarily mastered and understood independently by students. Thus, the interaction between lecturer and students is needed so that students can better understand the learning material. The interaction between lecturer and students will certainly make students more satisfied with mobile learning. Collaboration between students to work on projects or assignments assigned by lecturers is also very much needed so that students can better understand the material provided along with the case studies. The interaction between lecturer and students and interaction between students are stimuli to increase student satisfaction. If the level of interaction between students and lecturer is high, then the level of student satisfaction will also be high. Conversely, if the level of interaction between students and lecturers is low, the level of student satisfaction will also be low (Bailey, 2002).

The level of student satisfaction with learning has become an integral part of individual success and students are ultimately responsible for determining whether distance learning is beneficial and satisfactory enough for them to complete distance learning activities (Hackman & Walker, 1990). Because each student is ultimately responsible for determining the effectiveness of the learning experience, it is important to understand the level of individual satisfaction with an activity (Bailey, 2002). Based on the explanation above, it is believed that the perceived interactivity of users (student-to-student, student-to-teacher, and student-to-content) has a positive relationship with the satisfaction of mobile learning. The hypotheses are formulated as follows:

> H1d. Perceived interactivity of user (student-to-teacher) has a positive relationship with satisfaction of mobile learning (SS → SA)

> H1e. Perceived interactivity of user (student-to-student) has a positive relationship with satisfaction of mobile learning (ST → SA)

> H1f. Perceived interactivity of user (student-to-content) has a positive relationship with satisfaction of mobile learning (SC → SA)

THE INFLUENCE OF PERCEIVED INTERACTIVITY IN APPLICATION ON THE PERCEIVED USEFULNESS OF MOBILE LEARNING AND SATISFACTION OF MOBILE LEARNING

In mobile learning, the mobile device is a platform for students to do various learning activities, including attending online classes, studying learning material provided by lecturers, uploading assignments, having discussions with lecturers or fellow students, having exams or quizzes, and other mobile learning feature functionality. Good mobile learning has instructions for use and the mobile learning administrator will update the user manual for users to learn the mobile learning interface. Instructions for using mobile learning that is always updated will make it easy for users, especially students, to use mobile learning. This is in line with Venkatesh et al. (2003) who found that students

will receive mobile learning if they believe the new technology will be easy to use. Studies conducted by Chung et al. (2015), Ali and Arshad (2016), and Chao (2019) discovered that the perceived ease of use of mobile learning had a positive direct influence on perceived usefulness, and the use of mobile learning improved student learning performance. Perceived ease of use of mobile learning will lead to more feelings of satisfaction with the quality of mobile learning. Based on the explanation above, the following hypotheses are proposed:

> H2a. Perceived interactivity in the application (perceived ease of use) has a positive relationship with the perceived usefulness of mobile learning (PEOU → PU)

> H2b. Perceived interactivity in the application (perceived ease of use) has a positive relationship with satisfaction with mobile learning (PEOU → SA)

Mobile learning technology provides time-spatial flexibility and makes it very easy for students to flexibly study the material provided by the lecturer according to the curriculum of the study program. The use of mobile learning that utilizes mobile devices increases interactivity, which allows users to exchange and search for information with time-spatial flexibility (Diehl & Karmasin, 2013). Perceived ubiquity refers to individual perceptions of the extent to which cellular technology provides personalized and uninterrupted connections and communication between individuals and other individuals and/or networks (S. Kim & Garrison, 2009). It is one of the most important characteristics of cellular service (Okazaki & Mendez, 2013). Perceived ubiquity is users' perception of the value of a mobile device when they use it in the mobile-based assessment (Nikou & Economides, 2017). It refers to students' confidence in using mobile learning services due to the provision of uninterrupted connections that can be accessed anytime and anywhere. The ubiquity feature of mobile devices enhances their functionalities and makes them more useful. Therefore, perceived ubiquity value has an impact on perceived usefulness (Nikou & Economides, 2017). The hypotheses proposed are:

> H2c. Perceived interactivity in the application (perceived ubiquity) has a positive relationship with the perceived usefulness of mobile learning.

> H2d. Perceived interactivity in the application (perceived ubiquity) has a positive relationship with satisfaction with mobile learning.

The learning materials provided by the lecturers must always be updated by keeping up with industrial development. Learning content in mobile learning has an attractive display, is easy to navigate, and provides teaching materials that help students to easily and quickly access information and understand learning content that includes necessary equations, formulas, graphs, definitions, and videos. This is in line with research conducted by Kutluk and Gülmez (2014), Bekele (2010), and Kamaruzaman and Zainol (2012), who found that learning content that is easy to navigate will make it easier for students to use mobile learning. When students get good quality content, they will be happy, satisfied, and more eager to learn (Bekele, 2010; Kamaruzaman & Zainol, 2012; G. M. Kim & Ong, 2005). Therefore, the following hypotheses are proposed:

> H2e. Perceived interactivity in the application (learning content quality) has a positive relationship with the perceived usefulness of mobile learning.

> H2f. Perceived interactivity in the application (learning content quality) has a positive relationship with satisfaction with mobile learning.

THE INFLUENCE OF PERCEIVED INTERACTIVITY OF INFRASTRUCTURE ON THE PERCEIVED USEFULNESS OF MOBILE LEARNING AND SATISFACTION WITH MOBILE LEARNING

Students need functional components to actualize mobile learning application, including mobile devices with adequate memory, appropriate displays, and communication function that is necessary for mobile learning (Leung & Chan, 2003). Network quality (systematization of service delivery) refers to users' perception of the ability of a network to facilitate real-time interaction (M. Kim et al., 2015). A good-quality network makes the learning process optimally conducted. Mobile learning users need good network connectivity with high bandwidth whether they are using an internet data plan or wireless networks. Common and important wireless technology standards for mobile learning include GPRS, UMTS, HSPA, WiFi, WiMAX, or LTE) (Kitanov & Davcev, 2012). All mobile learning users access the University's Moodle Server Platform to provide the host the digital educational resources, download learning materials, and forward them to the HPC (High-Performance Computing) platform. HPC Data Centers provide hardware and software facilities, as well as infrastructure for cloud computing service providers. In an HPC Data Center, several servers are connected by a high-speed network to provide the services requested by the users, processing large amounts of data in a cloud computing environment (Kitanov & Davcev, 2012). Mobile devices and wireless networks can provide text, video, and mobile learning information services (Leung & Chan, 2003). Other studies suggest that time flexibility and feedback are parameters that can measure the attributes of communication channels that occur and important dimensions of interactivity (Downes & McMillan, 2000; McMillan & Hwang, 2002). Based on the explanation above, the following research hypotheses are proposed:

> H3a. Perceived interactivity in infrastructure (network quality) has a positive relationship with perceived usefulness of mobile learning

> H3b. Perceived interactivity in infrastructure (network quality) has a positive relationship with satisfaction with mobile learning

To support the smooth application of mobile learning as an online learning tool, the management of the University of Pembangunan Nasional Veteran, Jakarta, has established a special team to monitor the application of mobile learning in order to keep it stable and to evaluate the ongoing use of mobile learning. Easy access to mobile learning and easy-to-navigate mobile learning functions and features can increase customer satisfaction. The quality of the system reflects the speed of access, ease of use, navigation, visual attractiveness, and connection (Gao et al, 2015). According to DeLone and McLean (2004), the quality of a system can be seen from the overall perceived activity of the entire system. The visually appealing display of mobile-based applications is of great attractiveness (Gao & Waechter, 2017; Silic & Ruf, 2018). Users tend to be more confident in an application that has a good visual appearance, which makes them spend more time on the application. Based on the explanation above, we believe that perceived interactivity in infrastructure (system quality) has a positive relationship with perceived usefulness and satisfaction with mobile learning, which is formulated in the following hypotheses:

> H3c. Perceived interactivity in infrastructure (system quality) has a positive relationship with perceived usefulness of mobile learning

> H3d. Perceived interactivity in infrastructure (system quality) has a positive relationship with satisfaction with mobile learning

THE INFLUENCE OF PERCEIVED USEFULNESS AND PERCEIVED ENJOYMENT WITH MOBILE LEARNING

By using mobile learning, students can obtain learning materials via cell phones by using camera or video features and transfer files to lecturers or other students. The application of mobile learning is

very useful in the learning process, improves learning outcomes, and allows more access to information about the course material (Mtebe & Raisamo, 2014). Performance expectancy (perceived usefulness) describes that mobile learning tools help complete assignments faster than a computer (Iqbal & Qureshi, 2012).

The quiz at the end of the class is one of the methods used by the lecturer to evaluate student learning outcomes. The implementation of quizzes via mobile learning employs the principle of gamification to encourage students to compete for a position or ranking. With this kind of gamification, students will feel happy and compete to be in the top rank or succeed in achieving the desired target. The feeling of enjoyment when students use mobile learning to do quizzes will have a pleasant effect on the learning process. Students will adopt mobile learning if they find mobile learning technology is enjoyable and students will adopt mobile learning if they feel the course material is enjoyable (Ali & Arshad, 2016). Through mobile learning, students can combine education and enjoyment so that education will be more enjoyable and learning pressure will decrease (Ali & Arshad, 2016). Based on the explanation above, we believe that perceived usefulness and perceived enjoyment will have a positive relationship with satisfaction with mobile learning, which is formulated in the following hypotheses:

> H4a. Perceived usefulness has a positive relationship with satisfaction with mobile learning

> H4b. Perceived enjoyment has a positive relationship with satisfaction with mobile learning

THE INFLUENCE OF PERCEIVED USEFULNESS, PERCEIVED ENJOYMENT, AND SATISFACTION ON CONTINUANCE INTENTION OF MOBILE LEARNING

The perceived usefulness variable illustrates that students will accept mobile learning if they believe that the use of mobile learning will help them to improve their learning performance and get better grades (Wang et al., 2009). Research conducted by Abu-Al-Aish and Love (2013), Jambulingam (2013), Nassuora (2012), and Ali and Arshad (2016) showed that perceived usefulness had a positive effect on behavioral intention to use mobile learning.

The variable of perceived enjoyment in mobile learning is defined as to what extent a user feels comfortable using mobile learning (Ali & Arshad, 2016). Several studies have revealed that the enjoyment factor had a significant impact on users' intention to use mobile learning (Ali & Arshad, 2016; Huang et al., 2007; Wang et al., 2009). The enjoyment variable has a significant impact on behavioral intention to use mobile learning. Based on the explanation above, students may adopt mobile learning if they feel that using technology and the educational process will be enjoyable.

Several studies have revealed that the enjoyment factor has a significant impact on users' intention to use mobile learning (Ali & Arshad, 2016; Su & Cheng, 2015; Huang et al., 2007; Wang et al., 2009). In this research, the technology acceptance model (TAM) was modified by adding perceived interactivity and enjoyment variables. Enjoyment illustrates that the mobile learning application will have an enjoyment effect on the learning process. Students will adopt mobile learning if they find mobile learning technology is enjoyable and students will adopt mobile learning if they feel the course material will be enjoyable (Ali & Arshad, 2016).

Hence, the following hypotheses are proposed:

> H5a. Perceived usefulness has a positive relationship with continuance intention of mobile learning.

> H5b. Perceived enjoyment has a positive relationship with continuance intention of mobile learning.

> H5c. Satisfaction has a positive relationship with continuance intention of mobile learning.

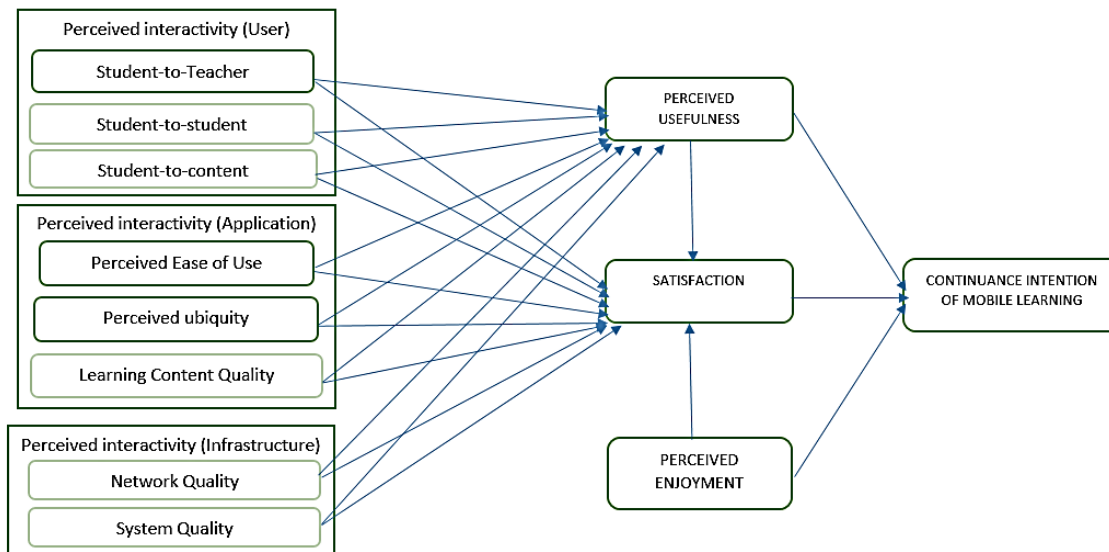The research model proposed in this research can be seen in Figure 1.

Figure 1. Research model

METHODOLOGY

This research was conducted based on students' perceptions of mobile learning adoption using the perceived interactivity of the mobile learning model and the Technology Acceptance Model (TAM) that has been modified to describe the adoption of mobile learning. The variables, among others, are perceived interactivity of user (student-to-teacher, student-to-student, student-to-content), perceived interactivity in the application (perceived ease of use, perceived ubiquity, learning content quality), and perceived interactivity infrastructure (network quality, system quality), perceived usefulness, satisfaction, perceived enjoyment, and continuance intention.

INSTRUMENT DESIGN

The research method was the quantitative method. This research is based on the elaboration of the mobile learning adoption model. Each of the variables adopted was then used as the basis for a questionnaire that employed structured questions that represented each adopted variable. The instrument that was developed consisted of twelve latent variables and forty-three manifest variables. Respondents were asked to specify their level of agreement with statements on a 5-point Likert scale. The five points are: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). The indicators for questions that are distributed are in Indonesian. Before being distributed, the questionnaire was subjected to a legibility test by 30 respondents to ensure that the respondents did not experience difficulties and did not address ambiguity in understanding each statement in the questionnaire. The next process was to collect data from 264 e-learning users, which were students, as respondents through a questionnaire that had been developed. Questionnaire forms were created using Google Forms with a focus on respondents in one of the public universities in Indonesia. The questionnaire form consisted of instructions for completing the form, gender, year of study, and usage behavior, consisting of frequency of use and the average duration of use per login, which can be seen in Table 2.

This research used quantitative methods. Data collection was done by using a questionnaire. The number of male respondents was 147 (55.68%) and the number of female respondents was 117 (44.32%). The last part of the questionnaire, namely, users' perception, consists of questionnaire statements in Table 3, which aims to measure each variable based on a construct designed with a 5-point Likert scale.

Table 2. Respondent demographics

Factor	Frequency	Percentage (%)
Gender		
Male	147	55.68
Female	117	44.32
Year of study		
First	99	37.50
Second	85	32.20
Third	80	30.30
Frequency of use of mobile learning		
Everyday	127	48.10
Once a month	61	23.10
Once every two weeks	76	28.80
Duration of accessing mobile learning		
Less than 15 Minutes	6	2.30
15 minutes to less than 30 minutes	34	12.87
30 minutes to less than 1 hour	147	55.68
1 hour to less than 2 hours	75	28.40
More than 2 hours	2	0.75

Table 3. Questionnaire statement

Variable	Definition	Questionnaire Statement
Student-to-student	Students' perception: the use of mobile learning makes it easier for students to interact with other students to exchange information, knowledge, and thoughts or ideas about learning content, and to receive feedback or comments (Y.-C. Kuo, 2010).	SS1: I will easily communicate with other students using mobile learning (Keegan 2005) SS2: I will easily exchange opinions with other students using mobile learning (Lee & Lee, 2019) SS3: It will be easy for me to have (interpersonal) interactions with other students using mobile learning (Lee & Lee, 2019)
Student-to-teacher	Students' perception: they can use mobile learning to collaborate more easily with lecturers, increase interaction between lecturers and students, especially students who are not ready to raise their hands in class to ask questions for fear of saying something stupid (Rogers, 2011).	ST1: I can easily communicate with lecturers using mobile learning (Keegan, 2005) ST2: I can easily get feedback from lecturers using mobile learning (Lin & Chang, 2018) ST3: I can easily exchange opinions with lecturers via mobile learning (Lin & Chang, 2018)
Student-to-content	Students' perception: interacting with information or content (Marchionini, 2008; Zhao et al., 2012).	SC1: It is easy for me to obtain learning content using mobile learning (Keegan, 2005). SC2: My learning objectives can be achieved using mobile learning (Keegan, 2005). SC3: Evaluation and question and answer can be done effectively using mobile learning (Keegan, 2005)

Variable	Definition	Questionnaire Statement
Perceived ubiquity	Individual perceptions of the extent to which cellular technology provides personalized and uninterrupted connection and communication between individual and other individuals and/or network (S. Kim & Garrison 2009)	PU1: When I use mobile learning, I can do the learning process at any time (Johnson et al., 2018). PU2: When I use mobile learning, I can do the learning process from anywhere (Johnson et al., 2018) PU3: Mobile learning makes me more active in the learning process (Nikou & Economides, 2017) PU4: Mobile learning provides me with a personalized learning process (which is adjusted to my interests and learning style) (Nikou & Economides, 2017)
Learning Content Quality	Availability of materials and services that are directly related to and produce student learning (Theresiawati et al., 2020; Uppal et al, 2018).	LCQ1: Mobile learning content will provide more multimedia-based materials, tests, and assignments (Sharma & Kitchens, 2004; Theresiawati et al., 2020). LCQ2: Mobile learning will provide appropriate learning content (M. Kim et al., 2015). LCQ3: I can fully understand the content provided (M. Kim et al., 2015).
Network Quality	Users' perception of network's ability to facilitate real-time interaction (M. Kim et al., 2015)	NQ1: Telecommunication companies will provide reliable internet connection to access mobile learning (Y. F. Kuo et al., 2009) NQ2: Internet connection from gadget is stable to access mobile learning (Y. F. Kuo et al., 2009) NQ3: Mobile learning can be accessed properly at one-time access (Y. F. Kuo et al., 2009) NQ4: Mobile learning is well available 24 hours a day, 7 days a week (Y. F. Kuo et al., 2009).
System Quality	System quality reflects speed of access, ease of use, navigation, visual appeal, and connection (Gao et al., 2015)	SQ1: Mobile learning quickly loads all text and images (Gao et al., 2015). SQ2: Mobile learning is easy to use (Gao et al., 2015). SQ3: Mobile learning is easy to navigate (Gao et al., 2015).
Perceived ease of use	Users' perception of the perceived ease of use when they use mobile learning (Ali & Arshad, 2016; Chang et al., 2012; Chao 2019).	PEoU 1: Studying course material on cell phone saves time (Chung et al., 2015). PEoU 2: It will be easy for me to operate mobile learning learning system (Chang et al., 2012) PEoU3: It will be easy for me to become skilled in using mobile learning to do things related to learning (Gadabu, 2020) PEoU4: I will find the mobile learning system very flexible to interact with other lecturers and students (Chang et al., 2012).

Variable	Definition	Questionnaire Statement
Perceived usefulness	Students' perception of the use of mobile learning will increase performance in, and satisfaction with, the learning process and have a major impact on increasing productivity, performance, effectiveness, and achieving satisfaction. (Alqahtani & Mohammad, 2015).	PU1: Using mobile learning will allow me to reach my college learning targets faster (Chang et al., 2012). PU2: Using mobile learning will improve my college learning performance (Chang et al., 2012). PU3: Using mobile learning will increase the productivity of my college activities (Chang et al., 2012). PU4: Using mobile learning will increase the effectiveness of my college activities (Chang et al., 2012). PU5: Using mobile learning will make it easier for me in the learning process (Chang et al., 2012).
Satisfaction	Individual perception of the extent to which they are satisfied with the use of mobile learning (Alqahtani & Mohammad, 2015).	SA1: In general, I am satisfied with the mobile learning application (Alqahtani & Mohammad, 2015). SA2: I like the mobile learning services provided (Alqahtani & Mohammad, 2015). SA3: Overall, my perception of mobile learning services is "satisfactory" (Alqahtani & Mohammad, 2015).
Perceived enjoyment	It is user trust that mobile learning will have an effect of enjoyment of the learning process. Enjoyment illustrates that the mobile learning application will have an enjoyable effect on the learning process, students will adopt mobile learning if they find mobile learning technology is enjoyable and course material will be enjoyable (Ali & Arshad, 2016).	PE1: I find the use of mobile learning is fun (Gadabu, 2020) PE2: I would love to use mobile learning (Huang et al., 2007). PE3: I will find that by using the mobile learning process, learning becomes fun. (Su & Cheng, 2015).
Continuance intention	It is a situation where the user feels satisfied and wants to use the system continuously (Kordina et al., 2019).	CI1: I am willing to use mobile learning to study course material (Chung et al., 2015). CI2: I will continue to use mobile learning in the future (Chung et al., 2015). CI3: Overall, I will study the course material via mobile learning (Chung et al., 2015). CI4: I would recommend other students to study via mobile learning (Chung et al., 2015).

DATA COLLECTION

UPNVJ is a university that has just utilized mobile learning to facilitate its learning activities. Before implementing mobile learning, UPNVJ only used web-based learning. The data were collected using questionnaires that were distributed to all students at UPNVJ. The questionnaire was distributed via an online link, which was distributed via student groups. The total data on the questionnaire that were entered were found to be from 264 respondents. The data were processed quantitatively using

SEM and SPSS to test their reliability and validity. The first step before data processing was to perform a test to identify common method biases (by conducting Harman's single-factor test) in order to avoid errors caused by method variance. After assessing the distribution of data, then Harman's single-factor test was conducted to identify common method bias. By performing the single-factor test, the entire research construct is included to determine whether the common variance can explain the majority of the variance. It is recommended that variance is not more than 50%. This research obtained 44.026% of the overall common variance.

DATA ANALYSIS

Data analysis was performed using multivariate structural equation modeling with the help of the SmartPLS 3.0 program to know the linkage among variables. The convenience obtained from using SmartPLS is that the data do not have to be normally distributed where indicators to interval and ratio can be used in the same model and the data sample size does not have to be large. The steps taken include making path diagrams and pre-formulated hypotheses and evaluating and testing models. This research applied a bootstrap test with 5,000 samples to assess the significance of path relations between exogenous latent constructs, namely, the user (student-to-teacher, student-to-student, student-to-content), application (perceived ease of use, perceived ubiquity, learning content quality), and infrastructure (network quality, system quality) and endogenous latent constructs (perceived usefulness, satisfaction, perceived enjoyment, and continuance intention). SmartPLS applies this bootstrap test for evaluating the significance of the relation between two variables by taking into account path coefficient (β), t-value, and p-value (Hair et al., 2016). The structural model was evaluated using the bootstrap method by considering the coefficient of determination (R^2) of endogenous latent variables and t-value.

RESULTS

VALIDITY AND RELIABILITY TEST

Data analysis was performed using multivariate structural equation modeling with the help of the SmartPLS 3.0 program to know the linkage among variables. The steps taken include making path diagrams and pre-formulated hypotheses and evaluating and testing models. This research applied a bootstrap test with 5,000 samples to assess the significance of path relations between exogenous latent constructs, namely, the user (student-to-teacher, student-to-student, student-to-content), application (perceived ease of use, perceived ubiquity, learning content quality), and infrastructure (network quality, system quality) and endogenous latent constructs (perceived useful-ness, satisfaction, perceived enjoyment, and continuance intention). SmartPLS applies this boot-strap test for evaluating the significance of the relation between two variables by taking into account path coefficient (β), t-value, and p-value (Hair et al., 2016). The structural model was evaluated using the bootstrap method by considering the coefficient of determination (R^2) of endogenous latent variables and t-value.

MEASUREMENT MODEL

Based on the results of data processing presented in Table 4, all latent variables had an AVE of more than 0.5, while three items had a loading factor value of less than 0.7 and therefore, three indicators, namely, PUQ1, PUQ2, and LCQ1, needed to be removed. The value of composite reliability was in the range of 0.839 to 0.947, exceeding the value of 0.80. The results of the test on Composite Reliability (CR) showed that the model had good reliability with the required minimum value limit. All variables had Cronbach's alpha range between 0.616 and 0.916 (see Table 4). If Cronbach's alpha (CA) value is higher than 0.60, the questionnaire declares reliability or consistency (Sujarweni, 2015).

Table 4. Result of test on measurement model - convergent validity

Construct	Item	Loading	AVE	CA	CR
Student-to-student (SS)	SS1	0.912	0.849	0.911	0.944
	SS2	0.939			
	SS3	0.913			
Student-to-teacher (ST)	ST1	0.906	0.816	0.887	0.930
	ST2	0.898			
	ST3	0.906			
Student-to-content (SC)	SC1	0.792	0.643	0.800	0.843
	SC2	0.893			
	Sc3	0.709			
Perceived ubiquity (PUQ)	PUQ1	0.612	0.785	0.727	0.880
	PUQ2	0.691			
	PUQ3	0.896			
	PUQ4	0.876			
Perceived ease of use (PEOU)	PEOU1	0.860	0.675	0.839	0.892
	PEOU2	0.802			
	PEOU3	0.799			
	PEOU4	0.823			
Learning content quality (LCQ)	LCQ1	0.521	0.723	0.616	0.839
	LCQ2	0.837			
	LCQ3	0.862			
Network quality (NQ)	NQ1	0.771	0.655	0.827	0.883
	NQ2	0.809			
	NQ3	0.875			
	NQ4	0.778			
System quality (SQ)	SQ1	0.777	0.715	0.800	0.882
	SQ2	0.892			
	SQ3	0.863			
Perceived usefulness (PU)	PU1	0.759	0.748	0.915	0.937
	PU2	0.912			
	PU3	0.889			
	PU4	0.883			
	PU5	0.873			
Satisfaction (SA)	SA1	0.878	0.783	0.862	0.916
	SA2	0.884			
	SA3	0.894			
Perceived enjoyment (PE)	PE1	0.935	0.857	0.916	0.947
	PE2	0.929			
	PE3	0.913			
Continuance intention (CI)	CI1	0.869	0.769	0.899	0.930
	CI2	0.845			
	CI3	0.893			
	CI4	0.899			

The Fornell-Larcker criterion was used to ensure discriminant validity by comparing the AVE of the construct itself and other constructs. The diagonal elements must be significantly larger than the off-diagonal elements in the appropriate rows and columns (Hulland, 1999). Based on the results of discriminant validity based on the Fornell-Larcker criterion in Table 5, the top figure (which is the square root of AVE) in any factor column is higher than the figure (correlation) below it. All criteria met both convergent validity and discriminant validity (Garson, 2016).

Table 5. Discriminant validity - Fornell-Larcker criterion

	CI	LCQ	NQ	PE	PEOU	PU	PUQ	SA	SC	SQ	SS	ST
CI	0.877											
LCQ	0.622	0.850										
NQ	0.418	0.544	0.809									
PE	0.859	0.588	0.411	0.926								
PEOU	0.651	0.591	0.469	0.614	0.821							
PU	0.817	0.718	0.465	0.817	0.659	0.865						
PUQ	0.654	0.692	0.442	0.661	0.592	0.795	0.886					
SA	0.728	0.642	0.444	0.750	0.754	0.723	0.631	0.885				
SC	0.728	0.609	0.418	0.640	0.661	0.731	0.699	0.664	0.802			
SQ	0.566	0.529	0.524	0.606	0.753	0.572	0.537	0.688	0.579	0.846		
SS	0.556	0.467	0.342	0.592	0.504	0.577	0.533	0.426	0.498	0.488	0.921	
ST	0.536	0.414	0.369	0.515	0.529	0.523	0.520	0.418	0.585	0.556	0.767	0.903

Note: Student-to-student (SS), Student-to-teacher (ST), Student-to-content (SC), Perceived ubiquity (PUQ), Perceived ease of use (PEOU), Learning Content Quality (LCQ), Network Quality (NQ), System Quality (SQ), Perceived usefulness (PU), Satisfaction (SA), Perceived enjoyment (PE), Continuance intention (CI)

"The off-diagonal entries are the correlations between the latent constructs and diagonals that are square values of AVEs."

STRUCTURAL MODEL

The interpretation of the R^2 value is the same as the interpretation of the linear regression of R^2, that is, the amount of variability of the endogenous variable that can be explained by the exogenous variable. The R^2 results for the endogenous latent variables in the structural model indicated that the model was substantial. The values of R^2 obtained by using the bootstrap method, based on Table 6 on the results of research on R^2 of students' perception, resulted in a continuance intention (CI) value of 0.785, satisfaction (SA) value of 0.746, and perceived usefulness (PU) value of 0.746. Based on Chin (1998) and Höck and Ringle (2006), the results of the cut-off value of R^2 above are above 0.67, so it can be stated as substantial.

Table 6. R^2 values

Construct	R^2
Continuance intention (CI)	0.785
Perceived usefulness (PU)	0.746
Satisfaction (SA)	0.746

The level of significance of the path coefficient is obtained by running the bootstrap algorithm to produce the t-value. As shown in Table 7, this research used a significance value of 10% so that the hypothesis is supported if each pathway has a t-value greater than 1.65 and a path coefficient greater

than 0.1. A path coefficient that is in the range of -0.1 to 0.1 is considered insignificant (Hair et al., 2016). Path coefficients that had a value greater than 0.1 and a t-value greater than 1.65 were student-to-student interactivity with perceived usefulness (SS→PU), student-to-content interactivity with perceived usefulness (SC→PU), student-to-content interactivity with satisfaction (SC→SA), perceived ease of use with perceived usefulness (PEOU→PU), perceived ease of use with satisfaction (PEOU→SA), perceived ubiquity with perceived usefulness (PUQ→PU), learning content quality with perceived usefulness (LCQ→PU), learning content quality with satisfaction (LCQ→SA), system quality with satisfaction (SQ→SA), perceived enjoyment with satisfaction (PE→SA), perceived usefulness with continuance intention (PU→CI), perceived enjoyment with continuance intention (PE→CI), and satisfaction with continuance intention (SA→CI). The results showed support for 13 of 21 hypotheses, namely, H1a, H1c, H1f, H2a, H2b, H2c, H2e, H2f, H3d, H4b, H5a, H5b, and H5c.

Table 7. Hypothesis testing results

Hypothesis	Path	Path Coefficient	Standard Error	t-value	p-values	Decision
H1a	SS → PU	0.174	0.054	3.197	$p<0.001$	Supported
H1b	ST→ PU	-0.091	0.062	1.470	0.142	Not Supported
H1c	SC → PU	0.228	0.058	3.923	$p<0.001$	Supported
H1d	SS → SA	-0.111	0.063	1.747	0.081	Not Supported
H1e	ST→ SA	-0.098	0.076	1.289	0.198	Not Supported
H1f	SC → SA	0.108	0.053	2.038	$p<0.001$	Supported
H2a	PEOU→PU	0.126	0.060	2.096	$p<0.001$	Supported
H2b	PEOU→SA	0.329	0.058	5.675	$p<0.001$	Supported
H2c	PUQ →PU	0.376	0.061	6.146	$p<0.001$	Supported
H2d	PUQ → SA	0.018	0.064	0.279	*0.780*	Not Supported
H2e	LCQ → PU	0.194	0.045	4.343	$p<0.001$	Supported
H2f	LCQ → SA	0.141	0.052	2.734	$p<0.001$	Supported
H3a	NQ → PU	0.014	0.050	0.274	*0.785*	Not Supported
H3b	NQ → SA	-0.023	0.051	0.447	*0.655*	Not Supported
H3c	SQ → PU	-0.001	0.060	0.012	*0.990*	Not Supported
H3d	SQ → SA	0.163	0.058	2.812	$p<0.001$	Supported
H4a	PU → SA	0.024	0.095	0.249	*0.804*	Not Supported
H4b	PE → SA	0.392	0.082	4.795	$p<0.001$	Supported
H5a	PU → CI	0.303	0.063	4.799	$p<0.001$	Supported
H5b	PE → CI	0.509	0.071	7.217	$p<0.001$	Supported
H5c	SA→ CI	0.136	0.056	2.414	$p<0.001$	Supported

The mobile learning variable was influenced by student-to-student interactivity, student-to-content interactivity, perceived ease of use, perceived ubiquity, learning content quality, system quality, perceived enjoyment, perceived usefulness, and satisfaction. The perceived usefulness variable was influenced by student-to-student interactivity, student-to-content interactivity, perceived ease of use, perceived ubiquity dan learning content quality. The satisfaction variable was influenced by student-to-content interactivity, perceived ease of use, learning content quality, system quality, and perceived enjoyment. The continuance intention of mobile learning was influenced by perceived usefulness (30.3%), perceived enjoyment (50.9%), and satisfaction (13.6%).

DISCUSSION AND IMPLICATION

The process of learning activities has undergone several evolutions, including face-to-face learning, distance learning, e-learning, and mobile learning. Mobile learning is one of the information technology innovations in education that functions to ensure that the learning process of students can run well individually, personally, and independently. The teacher acts as an advisor or counselor, has knowledge of mobile device technology, and is able to integrate pedagogical knowledge to promote the teaching and learning process (Evans, 2008; Gallagher et al, 2019; García-Martínez et al. 2019).

This research identifies and analyzes the adoption of mobile learning by using three types of perceived interactivity, namely, perceived interactivity between users, perceived interactivity between users and mobile learning applications, and perceived interactivity with mobile learning infrastructure. This research also evaluates the impact of the perceived interactivity of mobile learning adoption on perceived ease of use, satisfaction, and continuance intention to use mobile learning.

This research contributes to knowledge in the field of information systems, especially mobile learning. Research on the adoption of mobile learning provides information on indicators of mobile learning adoption so that it will contribute to the successful development and implementation of mobile learning and can increase the intention of users to continue using mobile learning. Most of the research on mobile learning employs the Technology Acceptance Model (TAM) or Unified Theory of Acceptance and Use of Technology (UTAUT) to measure the context of adoption or the factor of user acceptance for technology in mobile learning. Meanwhile, this research involved many aspects as components of mobile learning adoption, among others, including perceived interactivity, which consisted of user interactivity, perceived interactivity application, perceived interactivity infrastructure, and perceived enjoyment, so that the proposed model combined various aspects to become integrative.

The perception of interactivity perceived by mobile learning users was significantly influenced by perceived interactivity. Interactivity is the ability to facilitate interactions manifested by communicators (Rafaeli, 1988). This is in line with research conducted by Krishanan et al. (2016), which was related to perceived interactivity in which consumer attitudes towards cellular use were significantly influenced by perceived interactivity. Research conducted by Wu (1999) also discovered that perceived interactivity had a significant influence on user attitudes. Perception of interactivity will affect the perception of ease of use and perceived benefits of the user, which in turn will encourage continued use and thus, affect users' willingness to exchange information (Lee & Lee, 2019).

Research on mobile learning is expected to have implications for the realization of a new reference for analyzing the variables of mobile learning adoption to support learning methods in higher education based on students' perceptions. This research has shown that perceived interactivity of user (student-to-content) and perceived interactivity in the application (perceived ease of use, perceived ubiquity, learning content quality) had a significant influence on perceived usefulness and satisfaction in using mobile learning based on students' perceptions. However, student-to-teacher interactivity and network quality had no significant influence on perceived usefulness and satisfaction with mobile learning.

Variables that greatly influenced the satisfaction of using mobile learning were perceived interactivity of users (student-to-content) and perceived interactivity in applications (perceived ease of use, learning content quality, and perceived enjoyment). For this reason, it is necessary to analyze and evaluate the functional needs of mobile learning so that the learning content becomes attractive and easy for students to understand. It will create a sense of enjoyment for students when they use mobile learning, which can be realized by gamification or interactivity between the user and the learning application. There is also a need for the ease of using mobile learning so that mobile learning can be a better learning tool.

As seen in Figure 2, this research provides evidence that 39.2% of perceived enjoyment and 32.9% of perceived ease of use of mobile learning have influenced mobile learning adoption satisfaction. In addition, 50.9% of perceived enjoyment and 30.3% of perceived usefulness influenced students' continuance intention to use mobile learning. Therefore, further research must consider perceived enjoyment, perceived usefulness, and content quality as important indicators that may influence the adoption of mobile learning.
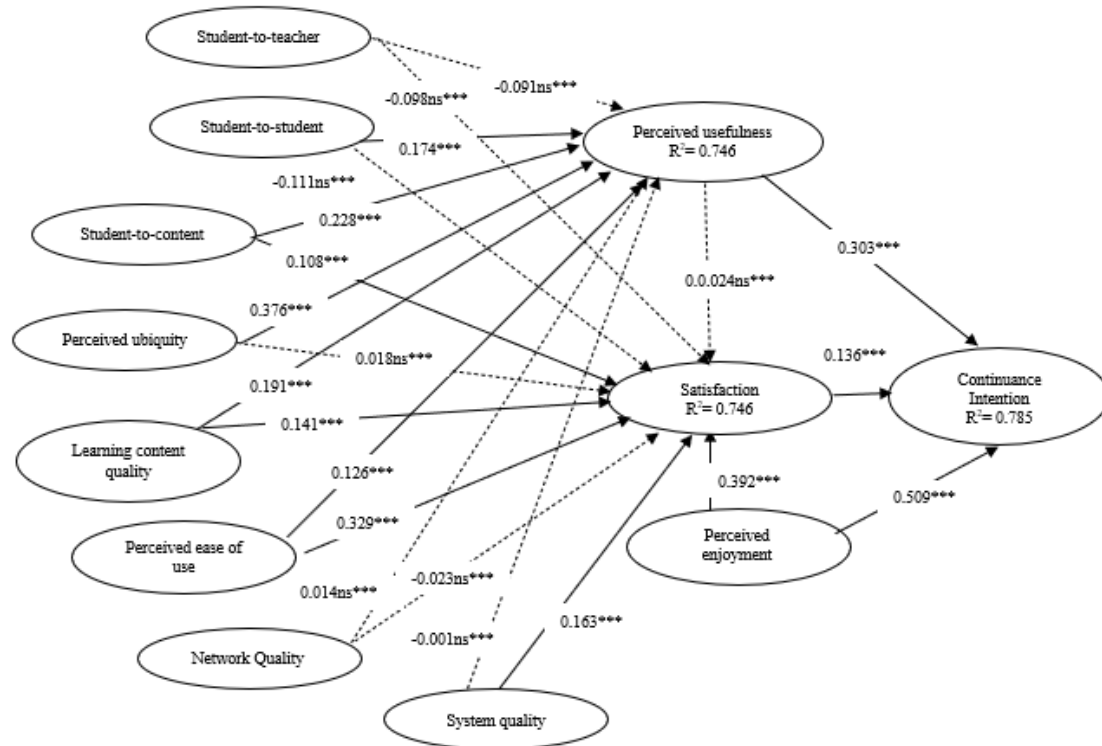
Notes: Dotted arrows indicate rejected hypotheses; solid arrows indicate significant relationships.
***p<0.001

Figure 2. Final research model

Based on the research results, several recommendations can be proposed for the adoption of mobile learning. For example, management should focus more on variables that will affect content quality, ease of use, and the sense of enjoyment when students use mobile learning. Students gain experience by using mobile learning to collaborate, for example, in solving problems, and then they can immediately see the results of the evaluation of the problem solving and discuss it so as to increase interaction with the teacher. This process makes students feel collaborative both with fellow students and with teachers in the teaching and learning process. Collaboration in work on assignments can be assisted by additional mobile learning tools that facilitate assessment for programming languages. Good quality content is a must in mobile learning. This is because students learn more individually, personally, and independently so content attractiveness, for example, impressive content opening and communication media in the form of videos or animations, or images, makes students more interested in the content presented.

Meanwhile, the lecturer will act as an advisor or counselor with the ability to integrate pedagogical knowledge to encourage students to engage in teaching and learning activities. After students are interested and perceive the ease of interaction, then they will feel comfortable using mobile learning. Mobile learning needs to be improved, for example, by searching for collaborative tools that can be used together with mobile learning, so that the current content can be more attractive to students.

The convenience of students as users can be supported by providing notifications on mobile learning, but it should be limited to using notifications that support learning so that notification does not become a nuisance.

CONCLUSION

This research identifies and analyzes factors in mobile learning based on the perspective of students as one of the higher education stakeholders in order to improve the student learning process in higher education institutions. This research contributes to knowledge in the field of information systems, especially the adoption of mobile learning. The research model was three components of mobile learning interactivity, which were grouped into perceived interactivity of users (student-to-teacher, student-to-student, student-to-content), perceived interactivity in the application (perceived ease of use, perceived ubiquity, learning content quality), and perceived interactivity in infrastructure (network quality, system quality). This research also evaluates the impact of mobile learning adoption on perceived usefulness, satisfaction, perceived enjoyment, and continuance intention to use mobile learning, and evaluates the perceived interactivity impact of mobile learning adoption on perceived ease of use, satisfaction, and ongoing intention to use mobile learning.

Based on Figure 2, student satisfaction in adopting mobile learning in the learning process was strongly influenced by perceived enjoyment, which was equal to 0.392. It has proved that students in Indonesia need convenience in using mobile learning. Perceived enjoyment is a user's perception that the use of mobile learning will have a pleasant effect on the learning process. After feeling comfortable when they use mobile learning and experience fun course material, students will eventually adopt mobile learning.

The research model showed that perceived enjoyment (0.392) had the strongest influence on satisfaction, followed by perceived ease of use (0.329), perceived interactivity in the application (learning content quality) (0.141), perceived interactivity of user (student-to-content) (0.108), and perceived interactivity in infrastructure (system quality) (0.163). Perceived interactivity in the application, namely, perceived ubiquity, had the strongest influence on perceived usefulness (0.376), followed by perceived interactivity of user (student to content) of 0.228 and 0.174 (student-to-student), and perceived interactivity in the application (learning content quality), which was 0.191.

These findings imply that perceived interactivity in the application (perceived ubiquity, learning content quality), perceived interactivity of users (student-to-student and student-to-content), and perceived interactivity in infrastructure (system quality) are important aspects in adopting mobile learning for teaching and learning process at the higher education level. These findings also imply that the application of mobile learning requires interaction between users, especially students, and interaction between students and interactive learning content so that it can improve mastery of learning material and the quality of learning for students. Individual perception of mobile learning requires cellular technology that will provide personalized connectedness or communication for each student and uninterrupted connectedness between students and other students and/or networks.

The results of this research have confirmed that nine of the twelve variables had a significant influence on the adoption of mobile learning in higher education in Indonesia. The nine variables were student-to-student interactivity, student-to-content interactivity, perceived ease of use, perceived ubiquity, learning content quality, system quality, perceived enjoyment, perceived usefulness, and satisfaction. The development of mobile learning adoption in universities should be designed by considering interactivity in learning, learning content that is in accordance with the target learning outcomes of users that are set by the faculty, and study programs of the users and by paying attention to aspects in technology, such as user information security and user interfaces that can provide convenience for mobile learning users, so that the quality of information, quality of learning, and learning systems can be well accepted by users. Therefore, to adopt mobile learning in Indonesia, the Indone-

sian government needs to provide good-quality perceived interactivity and interesting and fun learning content so that users will feel comfortable when they use mobile learning. The ease of use of the mobile learning application should be also adjusted to the needs of users and the learning content that users need so that mobile learning can be better.

This research is limited to mobile learning at one university in Indonesia. For further research, it is expected that the research will be able to cover all regions of Indonesia, represented by several public and private universities by considering several additional factors, including user safety in using mobile learning.

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