The Acceptance of Mobile Learning: A Case Study of 3D Simulation Android App for Learning Physics

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Abstract—This study explores the determinants that influence the acceptance of mobile learning, with a case study of a 3D simulation Android app, as an innovative tool for learning physics for high school students. The research model is developed based on prior studies in mobile learning acceptance, where Perceived Usefulness and Perceived Ease of Use are the two most popular determinants, with the addition of Perceived Enjoyment. Data are collected through questionnaires distributed to 50 high school students using Google Form. This study uses the structural equation modeling (SEM) technique to conduct the final analysis. The findings confirm that Perceived Enjoyment becomes the most influencing factor considered by high school students to use mobile learning, 3D simulation Android app, followed by Perceived Usefulness. However, the Perceived Ease of Use is an insignificant predictor that influences the acceptance of the 3D simulation Android app.

Keywords—m-learning, 3D-simulation, android

1 Introduction

Nowadays, mobile devices seem to become an inseparable part of human life. Mobile technology with internet connectivity has been evolved and increased convenience for its users due to its diverse functionality. A survey reported that in January 2021, there were 202.6 million (73.7% of the total population) internet users in Indonesia [1]. Furthermore, 96 percent of the internet users in Indonesia were using mobile phones [2]. Therefore, Indonesia has become one of the fastest-growing mobile app markets globally. Indonesian publishers had produced 47,573 mobile apps, which are prioritized on apps rather than game development, with the percentage of app and games are 89% and 11%, respectively [3].

The mobile phone functionalities are not only for communication but also for learning purposes, commonly referred to as mobile learning (m-learning). Mobile phones have become an essential device to create innovative learning methods, self-exploratory learning outside the classroom, problem-solving, and enhancing student's academic performance [4]. A recent study showed that incorporating multimedia and use of

touchscreens on mobile phones into learning can be performed to as early as kindergarten and primary school students to enhance their skills in an engaging environment, as well as increasing their motivation on the subject, compared to traditional teaching methods [5]. Thus, m-learning becomes an essential part of academic society. During the Covid-19 pandemic, students or learners have to switch their learning method from face-to-face to online learning using mobile devices as the main tools.

As a part of m-learning, mobile app usage has also been investigated as an innovative tool to achieve the student's cognitive level in physics learning [6]. The high school students can be categorized as Generation Z (Gen Z), that prefer to use the mobile phone to perform their daily activities [7]. Furthermore, Gen Z students are more attracted to multimedia, especially 3D simulation, when they learn something. This condition might happen because they are raised in a technology-savvy environment [8]. A prior study also argued that 3D simulation could produce a powerful immersive environment so learners can gain knowledge and create higher-level thinking skills [9]. Unfortunately, the adoption of m-learning in education is still considered slow [10]. There are also limited studies in m-learning acceptance that focused on the usage of 3D simulation mobile app. A literature review study conducted by Reisoğlu et al. found that the percentage of research in using the 3D virtual learning environment in science subjects is still less than ten percent [11].

Therefore, this study is expected to fill this gap by investigating the determinants that influence high school student's intention to adopt m-learning, specifically a 3D simulation Android app. The application is developed to create student's understanding of the concept in physics. The results provide the theoretical contribution due to the limited studies that explored the factors that significantly affect the adoption of 3D simulation mobile app in the education field, especially in science subjects. Furthermore, the findings can be used by mobile application developers as a guideline to develop a successful mobile app, especially in education fields using 3D technology.

2   Literature review

There are various definitions related to m-learning. In general, m-learning combines mobility with the electronic learning (e-learning) concept. Wang et al. [12] defined m-learning as using mobile devices to deliver learning materials to learners through wireless internet anytime, anywhere. Crompton [13] referred to m-learning in terms of accessibility and flexibility since learners can learn across multiple contexts using their personalized electronic devices. In this study, the definition of m-learning refers to student's ability to perform learning activities anytime, anywhere using their internet-enabled mobile devices through wireless technology.

The research in m-learning has increased in the last decade since the emergence of smartphones and other internet-enabled mobile devices. Mobile technology has supported the strategic goals in the education field by enhancing student's participation and achievements and improving the collaboration and interaction among students [14]. Some authors had examined the factors that influence m-learning adoption among students in various countries such as New Zealand [15], China [16], Jordan [17], and Sweden [18]. A study conducted in Greece showed that preschool teachers generally

welcome ICT usage, particularly m-learning, in their daily teaching, regardless of age and gender [19].

One popular model in adopting new innovative technology is TAM (Technology Acceptance Model), proposed by Davis [20]. TAM suggested two variables, Perceived Usefulness and Perceived Ease of Use, which determined the attitude toward using technology that affects the Behavioral Intention. Many prior studies used TAM in their theoretical model to explore user acceptance of m-learning [17], [21]. Several authors used extended TAM in their theoretical model by adding some essential determinants to increase the explanatory power of the research. Some studies confirmed that Perceived Enjoyment was another crucial predictor that significantly influences m-learning adoption [9], [22].

3 Methodology

This study is a quantitative research that uses a cross-sectional survey to obtain data based on the individual's experience using a 3D simulation Android app. A two-part self-administered questionnaire is then developed based on prior studies to maintain the content validity. The first part is related to the respondent's characteristics (age, gender, and education). The second part contains questions associate with each variable used in the research model. The instruments are adopted from the existing studies in m-learning adoption measured using a 5-point Likert scale, ranging the options from Strongly Disagree to Strongly Agree. The measuring instruments are listed in Table 1.

Table 1. Instruments of Variables

Variable [Ref]	Measuring instrument
Perceived Usefulness [14]	3D simulation Android app is useful in my learning
	3D simulation Android app enables me to perform learning activities more quickly
	3D simulation Android app increases my learning productivity
	3D simulation Android app will increase my chances to get a better grade
Perceived Ease of Use [23]	The interaction of 3D simulation Android app is clear and understandable
	It is easy to become skillful at using 3D simulation Android app
	3D simulation Android app is easy to use
	It is easy for me to learn how to operate 3D simulation Android app
Perceived Enjoyment [21]	I believe that using 3D simulation Android app will be interesting to me
	I believe that 3D simulation Android app will stimulate my curiosity
	I believe the use of 3D simulation Android app will fit well with the way I like to study
	I believe that using 3D simulation Android app can solve my problems
Behavioral Intention [14]	I intend to use 3D simulation Android app in the future
	Given the opportunity, I will use 3D simulation Android app
	I plan to use 3D simulation Android app in the future I predict I would use 3D simulation Android app in the future

Since the purposive sampling method is applied, the questionnaire was distributed to the targeted respondents from high schools located in two cities in Indonesia. Next, a preliminary analysis of the final data is addressed to examine the validity and reliability of the constructs. Component factor analysis is used to ensure the validity of all constructs, while the reliability of instruments is established using Cronbach's alpha coefficients. The final analysis is conducted by using structural equation modeling (SEM) developed in SmartPLS.

Meanwhile, the 3D simulation Android app is developed as a tool to support the study. All user interfaces are designed with the user-centered design principle proposed by Rogers et al. [24] to ensure the Android app will be user-friendly, intuitive, and interactive. The 3D simulation Android app is developed using Unity 5.6 and then packaged into an Android app.

4 The development of research model and hypotheses

A research model is developed based on existing studies in m-learning acceptance. Perceived Ease of Use was defined as the degree of difficulty when an individual uses m-learning [20]. The easier an m-learning application to be used by the students, the higher their intention to accept it. Many authors argued that Perceived Ease of Use effectively influences the Behavior Intention in adopting the m-learning [22], [25]. However, studies of Chao [26] and Hamidi [27] declared that the impact of Perceived Ease of Use on Behavior Intention was insignificant. Meanwhile, most studies in m-learning usage showed the high significance of Perceived Ease of Use on Perceived Usefulness, yet a study by Saroia and Gao [18] showed otherwise. Therefore, this study proposes the following hypotheses:

H1: Perceived Ease of Use significantly affects the Behavioral Intention to use m-learning (3D simulation Android app).
H2: Perceived Ease of Use significantly affects the Perceived Usefulness related to m-learning (3D simulation Android app usage).

Perceived Usefulness refers to an individual's belief that using m-learning would enhance his or her job performance [20]. Students have more willingness to accept m-learning if it offers some benefits for them. Usefulness was found to be the most significant predictor of a user's intention to use m-learning [14], [22], [25]. Another study reported there was no significant impact of Perceived Usefulness on Behavior Intention [27]. Thus, the following hypothesis is proposed:

H3: Perceived Usefulness significantly affects the Behavioral Intention to use m-learning (3D simulation Android app).

Perceived Enjoyment was defined as the degree of an individual's perception that using m-learning will be enjoyable [14]. The more enjoyable mobile learning is, the higher student's willingness to use it. The significance of Perceived Enjoyment on the

intention of m-learning usage had been proved by several studies [14], [26]. Therefore, the following hypothesis is proposed:

H4: Perceived Enjoyment significantly affects the Behavioral Intention to use m-learning (3D simulation Android app).

Behavioral intention refers to the individual's intention to perform a specified behavior that has an effect on the actual usage [23]. Figure 1 depicts the research model used in this study which incorporates three determinants: Perceived Usefulness, Perceived Ease of Use, and Perceived Enjoyment, that may affect an individual's intention to adopt the 3D simulation Android app.
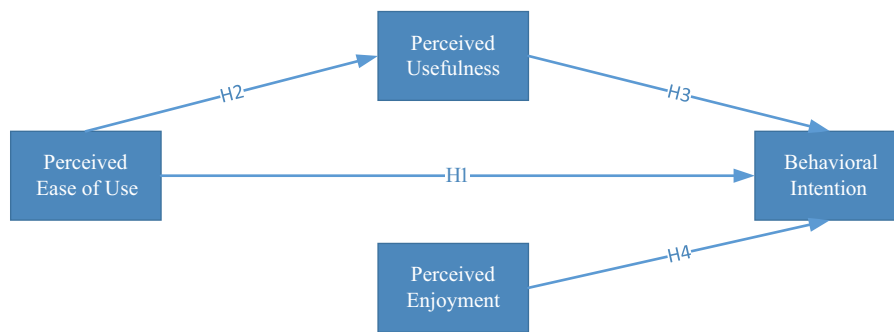
Fig. 1. Research model

5 Results and discussion

As the target respondents, high school students have to install the 3D simulation Android app on their smartphones. Students may interact with the Android app, play with the provided simulations, and immediately see the results. Next, they were given a set of tasks to perform in a certain period. After completing all tasks, they have to fill in the questionnaires through Google Forms. The total participants were 50 respondents, 32 males, and 18 females.

Table 2 shows that the validity of all constructs is satisfactory since all loading values are above 0.4, based on Straub et al. [28] guidelines. The Cronbach's alpha values of all variables also exceeded the acceptable value of 0.7, following the guidelines from George and Mallery [29]. In addition, both composite reliability (CR) and average variance extracted (AVE) are computed to check the composite reliability and convergent validity of each latent variable. The result shows that the values of CR are greater than the minimum threshold values of 0.7, and all AVE values for all the latent variables are also above 0.5, as suggested by Fornell and Larcker [30].

Table 2. Validity and reliability result

Variable	Indicator	Loading	Cronbach α	Result	CR	AVE (√AVE)
Perceived Enjoyment	PE2	0.857	0.890	Good	0.923	0.751 (0.866)
	PE1	0.852				
	PE4	0.885				
	PE3	0.871				
Perceived Usefulness	PU2	0.872	0.869	Good	0.911	0.718 (0.847)
	PU3	0.872				
	PU4	0.811				
	PU1	0.832				
Perceived Ease of Use	PEU3	0.824	0.834	Good	0.887	0.664 (0.815)
	PEU2	0.895				
	PEU4	0.796				
	PEU1	0.737				
Behavioral Intention	BI2	0.814	0.840	Good	0.891	0.671 (0.819)
	BI4	0.763				
	BI1	0.811				
	BI3	0.884				

Next, to ensure the model variables can be analyzed using SEM, this study performs the descriptive data analyses. Based on the results presented in Table 3, all variables are satisfactory since the values of the magnitudes of skewness and kurtosis for all indicators are within the acceptable limits of 3 and 7, respectively, following Kline [31] criteria.

Table 3. Descriptive statistics

Indicator	Mean	Median	Min	Max	Stand Dev	Kurtosis	Skewness
PE1	4.020	4.000	2.000	5.000	0.707	0.132	−0.380
PE2	4.180	4.000	3.000	5.000	0.517	0.296	0.221
PE3	3.900	4.000	3.000	5.000	0.640	−0.525	0.094
PE4	4.040	4.000	3.000	5.000	0.599	−0.114	−0.015
PU1	4.400	4.000	4.000	5.000	0.490	−1.900	0.421
PU2	4.220	4.000	3.000	5.000	0.642	−0.623	−0.243
PU3	3.980	4.000	3.000	5.000	0.678	−0.783	0.025
PU4	3.860	4.000	3.000	5.000	0.600	−0.249	0.067
PEU1	4.020	4.000	3.000	5.000	0.510	1.065	0.034
PEU2	3.880	4.000	3.000	5.000	0.621	−0.389	0.088
PEU3	4.020	4.000	2.000	5.000	0.648	1.016	−0.475
PEU4	4.000	4.000	3.000	5.000	0.600	−0.116	0.000
BI1	4.420	4.000	3.000	5.000	0.533	−1.156	−0.078
BI2	4.080	4.000	3.000	5.000	0.523	0.729	0.100
BI3	4.260	4.000	3.000	5.000	0.482	−0.371	0.563
BI4	4.260	4.000	3.000	5.000	0.522	−0.300	0.217

T-tests are used to investigate whether there are significant differences between the mean values of a latent variable and the *neutral* value of 3. The result indicates that all mean values are above the *neutral* value of 3 at a level of 0.05 or less. Furthermore, the fit statistics of the research model show that the variance of the intention to adopt a 3D simulation mobile app is 48.5% that indicates good explanatory power.

Table 4 presents the result of the hypotheses. The shaded cells correspond with the three supported hypotheses. Perceived Enjoyment significantly influences the student's intention at a level of 0.001 (***). It means that students are willing to use the 3D simulation Android app only if they enjoy using it. This finding aligns with a study conducted by Pramana [14] and Chao [26]. Perceived Usefulness also significantly influences the intention to use the 3D simulation Android app at a level of 0.05 (*), which supports several prior studies [14], [22], [25]. Surprisingly, Perceived Ease of Use does not significantly impact the Behavioral Intention at a level of 0.05 or less. This means that high school students place less importance on Perceived Ease of Use as a motivation for accepting 3D simulation Android app. One factor that we argue might influence this result is the behavior of Generation Z students, which are already familiar with technologies from their youth days [7], so they can use complex Android app. This result fits with Chao's and Hamidi's studies [26], [27]. However, the outcome might be different if the 3D simulation Android app users are more general, not limited to Generation Z students only. Another finding proves the influence of Perceived Ease of Use on Perceived Usefulness at a level of 0.01 (**) as many other studies have proven this hypothesis.

Table 4. Hypotheses test

Hypothesis		Original Sample	Sample Mean	Stand Dev	T Statistics	P Values	Decision
H1	PEU→BI	−0,155	−0,149	0,155	0,997	0,319	Rejected
H2	PEU→PU	0,345	0,366	0,116	2,961	0,003	Accepted
H3	PU→BI	0,308	0,310	0,122	2,523	0,012	Accepted
H4	PE→BI	0,529	0,530	0,109	4,837	0,000	Accepted

6 Conclusion

The study finds that Perceived Enjoyment is the strongest factor influencing the student's intention to use the 3D simulation Android app, followed by Perceived Usefulness. Surprisingly, the Perceived Ease of Use factor does not significantly affect the acceptance of the 3D simulation Android app. This study concludes that high school students are willing to adopt the 3D simulation Android app since it can help them in learning physics (Usefulness) by working on the problems and playing with the simulations (enjoyment). Besides having theoretical contribution, this study is expected to have a practical contribution to mobile app developers (especially Android app) who want to develop an educational app for mobile learning. They have to provide the students with useful mobile app content and 3D simulation to make an enjoyable mobile app for students to complement their studies.

7   Limitations and future research

There are some limitations to this study. This study is conducted in Indonesia with all respondents from Indonesia, so the findings may not apply to other countries nor education in general. Due to the limited number of respondents (50 respondents), further study may be needed with more respondents and different groups of respondents, which can yield different results. Future research may add some other constructs in the theoretical model to increase the explanatory power.

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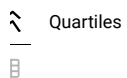
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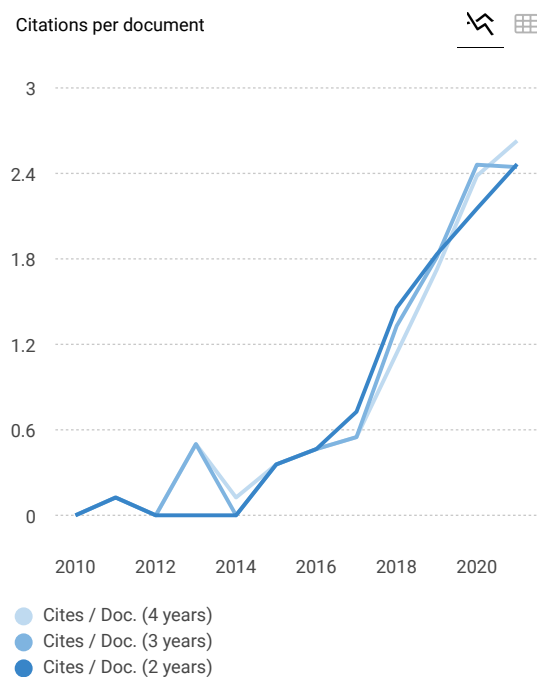| 1	2	3	4
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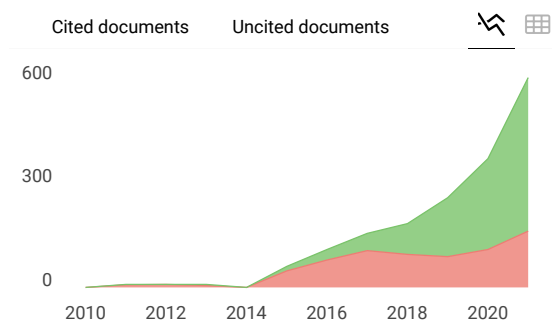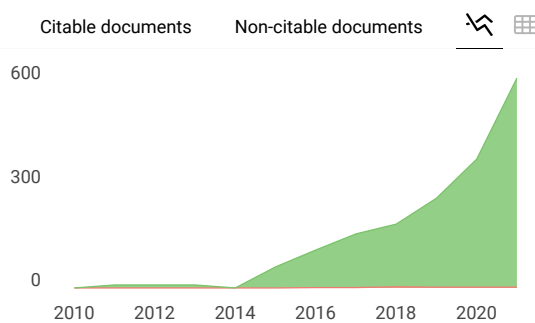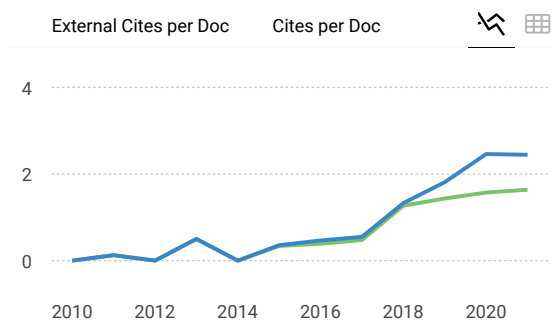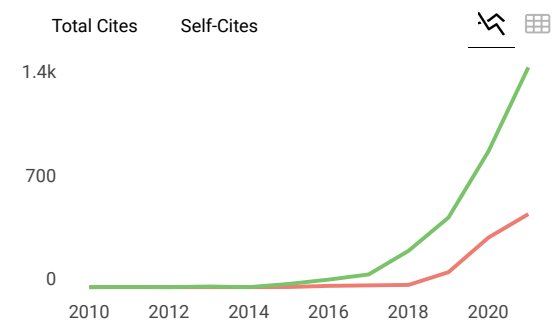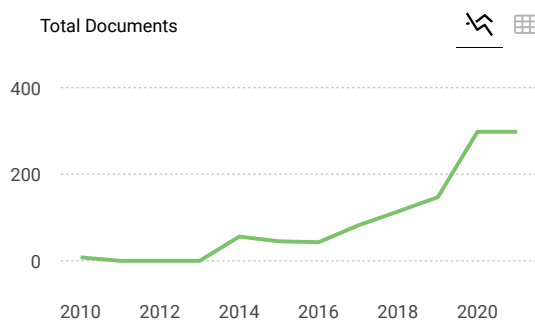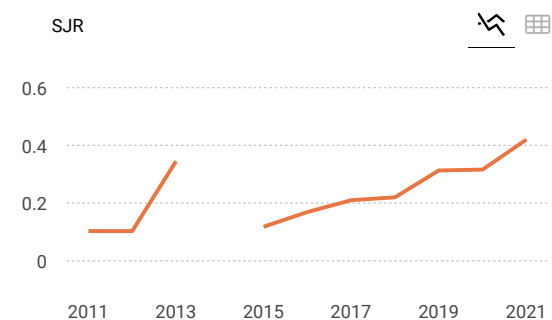
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