

Factors influencing students' attitude toward to use mobile learning applications using SEM-ANN hybrid approach

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ABSTRACT

Mobile learning application now is considered a powerful application for learning and was adopted in universities in the period of Covid-19. After Covid-19 pandemic, university students have been allowed to use mobile learning systems, it is needed to ensure students' intention to continuously use mobile learning for their learning activities or not. Thus, the purpose of this paper is to understand the main determinants that encourage the continuous use of mobile learning. To achieve that, we used the UTAUT-2 model to predict the main determinants of mobile learning acceptance. In our study, a quantitative technique was employed to collect the data. A hybrid approach SEM-ANN was applied to validate the research model. The findings indicated that performance expectancy and effort expectancy had a strong effect on students' attitudes towards mobile learning platforms. In addition, the results showed that performance expectancy and effort expectancy have a significant impact on students' continuous intention to use mobile learning platforms after Covid-19. In addition, hedonic motivation and habit had a positive effect on both students' attitudes and continuous intention to use mobile learning platforms. Moreover, Social influence factor and facilitating conditions had a significant effect on students' continuous intention to use mobile learning platforms after Covid-19.

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1. Introduction

Recently, the transformation towards mobile learning applications in higher education has received considerable attention (Almaiah et al., 2022). The usage of Mobile learning applications (MLA) has increased among university students (Meng & Li, 2024). Mobile learning applications are aimed for using mobile devices and mobile applications to enhance the learning process. Mobile learning applications offer many features including online classes, online learning materials, online meeting the teacher and access learning activities anytime and anywhere (Almaiah et al., 2019). This allows students to use mobile learning materials and sources at any location and any time. However, most universities in the world have adopted mobile learning systems to enhance teaching and student learning (Hameed et al., 2024). Recently, there is a growing trend of use of mobile learning in universities over the world (Ogata et al., 2024). Most universities now have converted their learning systems towards online learning tools like m-learning due to the rapid development in the field of mobile technologies (Almaiah et al., 2022). Mobile learning can be defined as a platform on which learners can obtain knowledge with the help of mobile devices. During Covid-19 period, mobile learning was noticed as a powerful learning tool, to assist learners' continuous learning process in Jordan (Almaiah et al., 2019). In addition, mobile learning has become an important platform to develop and support distance learning for both teachers

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and students (Hameed et al., 2024). Several previous studies indicated that mobile learning platform improved ability learning for students despite several advantages of mobile learning, after pandemic of Covid-19, several studies have recommended to shift from traditional learning method to mobile learning to enhance the learning process to students (Juera, 2024). According to Jiang et al. (2024), the use of mobile information systems was very important for students to perform their learning activities through mobile applications. The rapid development of mobile technologies has affected in a positive way in several fields, including higher education (Jiang et al., 2024). Many learners are encouraged to use mobile learning applications towards performing learning activities (Jiang et al., 2024). This leads universities to meet the rapidly increasing demand through the development of appropriate mobile learning platforms for both teachers and students (Jiang et al., 2024). In addition, universities' teachers also increasingly used mobile learning in the teaching process in post Covid-19. This proves that the mobile learning platform has increased the usefulness and its importance in the learning process before and after Covid-19 pandemic, which forced many universities in Jordan to transform and use mobile learning systems in the classrooms (Ogata et al., 2024). This indicates that several Jordanian universities used different online learning tools such as e-learning and mobile learning as learning platforms (Ogata et al., 2024). Based on that, the adoption of mobile learning is a challenge for Jordanian universities and teachers in Jordan (Almaiah et al., 2022). The role of mobile technologies in learning and education is more critical today than ever before (Ogata et al., 2024). Mobile technologies and applications developments can potentially transform education towards virtual learning. These enhancements make learning processes more efficient and offer student-centered, personalized learning opportunities (Jiang et al., 2024). Furthermore, mobile learning applications are essential to increase learning outcomes by providing students with content according to their learning needs. These applications allow learners to receive feedback anytime and continuously improve their learning processes. Mobile learning applications also offer significant opportunities for sustainable education practices. Regarding the investigation of mobile learning applications acceptance and usage, there have been several studies that have conducted in the literature (Meng & Li, 2024), which aiming for understanding the key factors related to the usage mobile learning applications, although the fact that the usage of mobile learning applications before Covid-19 is very different than after the Covid-19 pandemic. Hence, most studies now focus exclusively on this topic as well as the studies on mobile learning applications usage after Covid-19 pandemic are still very limited (Meng & Li, 2024).

The emergence of mobile learning applications has brought great public interest and global concerns about the applications of mobile technologies in education (Jiang et al., 2024). These applications have created uncertainty for lectures and learners and hope for a better education (Juera, 2024). When the literature of mobile learning is investigated, few empirical studies to eliminate uncertainties, and limited information about the key factors that influence students on using or not exclusively mobile learning applications. A few empirical studies have examined the usage of mobile learning applications in different learning courses and grade levels. For example, existing mobile learning acceptance and adoption research, such as Almaiah et al., (2022) work on science education work on higher education, has examined how mobile learning systems can be used in terms of student learning and educator teaching. However, although previous research on mobile learning integration in early childhood education has demonstrated the usefulness and potential benefits of mobile learning in various aspects, studies on mobile learning usage and adoption have been limited. Therefore, this study aims to achieve the following objective:

- To investigate the primary elements that influence students on using m-learning applications.

2. Literature review

2.1 Mobile Learning in Higher education

Mobile learning applications' ability to provide personalized and responsive mobile devices support to students and teachers, such as providing instant feedback, answering questions, offering resources, evaluating assignments, and lesson planning, makes it an efficient application in higher education. Many researchers have confirmed that mobile learning has great potential for enhancing the education such as answering questions and generating text and has intelligent conversational capabilities in educational contexts Alfalah (2023) and Katayeva (2023). On the other hand, other researchers opposing views on the use of mobile learning in education emphasize the negative impacts on learning and teaching at all levels, such as the spread of misinformation and biased views, violation of academic integrity, job loss, and increased inequalities (Li & Liu, 2023). Mobile learning applications can provide equality in higher education by offering personalized learning experiences, which can form the basis of sustainable development Alfalah (2023). These applications can provide equal opportunities in education and create sustainable learning environments by responding to students' individual needs Katayeva (2023). The advantages offered by mobile learning in expanding educational opportunities and eliminating learning losses, especially for students living in disadvantaged regions, are remarkable (Meng & Li, 2024).

Consequently, the adoption of mobile learning applications at the higher education level offers the potential to transform learning and education by enhancing teachers' digital pedagogical skills and providing students with more equitable and sustainable learning opportunities. This study aims to investigate the primary elements that influence students on using m-learning applications in higher education.

2.2 Related works

Based on the literature, despite numerous studies offering some demonstration of which factors for improving the acceptance of mobile learning application (Almaiah et al., 2022), there is still limited evidence on how these factors could enhance the actual usage of mobile learning. Prior studies highlighted the technology acceptance models for mobile learning through investigating the important factors for promoting the actual usage of mobile learning among users (Li & Liu, 2023). For instance, Almaiah et al. (2022) found in his proposed model for mobile learning that quality aspects related to quality of content, quality of service and quality of system as the solutions for improving the acceptance of mobile learning application among students. The proposed model fundamentally works to guide how to enhance the quality of mobile learning systems and thus this will increase the usability and usage of mobile learning. Therefore, Almaiah et al. (2022) recommended that quality dimensions play a key role in enhancing the actual use of mobile learning and should be considered in the development of mobile learning applications in order to ensure the high-quality features in mobile learning applications. In the same way, Althunibat et al. (2022) confirmed that quality aspects such as service quality and content quality have a strong influence on fulfillment of students by the management systems of learning. In addition, Almaiah et al. (2020) proved that the quality of content and service are the elements that most influence satisfaction of students of mobile learning applications. Also, a study conducted by Sarrab et al. (2016) revealed three types of essential quality factors for the acceptance of mobile learning namely service quality, content, and functionality. Finally, Al-Emran (2020) found that perceived usefulness, ease of use and enjoyment are the most significant antecedents of mobile learning adoption. However, this work focuses to fill the above research gap by proposing a conceptual model by using the UTAUT-2 with technological factors to investigate the main drivers that influence students on using or not exclusively mobile learning applications in Jordan universities. This research aims to help the decision makers in universities in better understanding their students' needs and requirements with the aim of increasing the usage of mobile learning applications. Our study outcomes are expected to fill the research gap related to the limited investigation of mobile learning applications acceptance, through examining technological factors on actual use of mobile learning applications. Finally, our findings offer important recommendations and insights for decision makers in universities and academic research about the critical factors that encourage learners to use mobile learning applications after Covid-19 pandemic.

2.2 Theoretical model and hypothesis development

Based on the UTAUT2 model established by Venkatesh et al. (2012), this research used it as the theoretical foundation for establishing the proposed model. The UTAUT model has seven elements: facilitating conditions, hedonic motivation, performance expectancies and effort expectancies, price value, social influence, and habit affect behavioral intentions toward technology (Venkatesh et al., 2012). The UTAUT2 model has been extensively applied to examine many fields of IT/IS, including e-business systems (Dutta & Shivani, 2020), e-learning (Raman & Thannimalai, 2021) and healthcare domain (Thabet et al., 2023). According to previous studies, which found that UTAUT-2 is better than the original UTAUT in explaining the variance (R²) in usage behaviors. Therefore, this study used the UTAUT-2 as the theoretical foundation for establishing the proposed model as shown in Fig. 1.

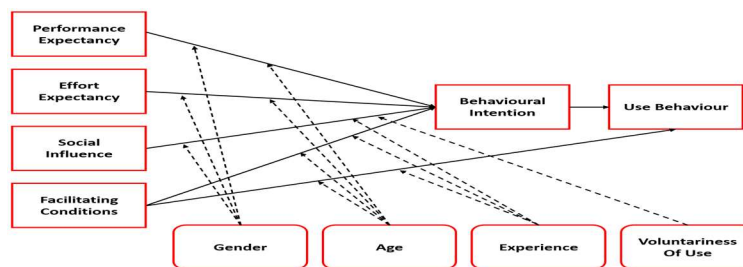


Fig. 1. UTAUT-2 framework

Performance expectancy (PE)

PE in mobile learning context refers to a learner believes that m-learning apps could improve their effectiveness and efficiency Venkatesh et al. (2012). It is also can be defined to a learner when using m-learning improves their learning performance and abilities in the post Covid-19. This indicated that learners need to have a positive perspective that the mobile learning platform has learning enhancement capabilities. In this regard, PE is significant factor when learners believe that mobile learning platform have the capability to enhance their learning outcomes in the post-Covid-19. For instance, learners used these tools during the Covid-19 and helped them in learning. Hence, the proposed model of this study hypothesized that:

H₁: PE has a significant impact on learners' attitudes to use m-learning apps.

H₂: PE has a significant impact on learners' continuous to use m-learning apps.

Effort expectancy (EE)

EE in mobile learning context refers to the learners' perception of the degree of difficulty to understand and use mobile learning technology Venkatesh et al. (2012). In another word, new technologies which simple to understand and make use of, are adopted more swiftly than technologies requiring development of new skills and understanding. This construct is similar to the perceived ease of use (PEOU) in the TAM model. It is also in agreement with previous studies by Almaiah et al (2022), they stated the more complex of mobile learning application and effort needed for adopting mobile learning, the less likely it is to be used and accepted. In addition, the perception of complexity involved in using mobile learning platform will vary depending on different learners and depending on their previous experience of using mobile learning platform. Hence, the proposed model of this study hypothesized that:

H3: *EE has a positive effect on learners' attitudes to use m-learning apps.*

H4: *EE has a positive effect on learners' continuous to use m-learning apps.*

Habit (HB)

In the literature, habit is considered one of the interesting constructs in the UTAUT-2 (Venkatesh et al., 2012). In previous studies, which indicated that the habit had significant effect on learners in different educational technologies context, towards the utilization of online learning systems (Venkatesh et al., 2012). In addition, habit construct was the key factor affecting the acceptance and usage of new educational platforms. This indicates that the habit of learners will increase their intention to use new technologies (Venkatesh et al., 2012). This result also confirmed by Hoang-Tung et al. (2017), they found intention behavior is transformed into a habit. Based on these facts, we proposed that habit factor could increase the learners' intention to use mobile learning platform in post Covid-19. Hence:

H5: *HB has a significant effect on students' attitude to use m-learning apps.*

H6: *HB has a significant effect on students' continuous intention to use m-learning apps.*

Hedonic motivation (HM)

HM in the mobile learning context refers to the pleasure gained from using mobile learning system, which effect on learners' intention to mobile learning platform (Venkatesh et al., 2012). Several studies in the literature argued that hedonic motivation predicted the users' intention to use for many educational technologies (Venkatesh et al., 2012). It is confirmed that hedonic motivation factor has great ability to explain the intention to use of mobile learning platform among students. In addition, the findings from previous studies confirmed that hedonic motivation felt by learners significantly affected the use of mobile learning (Sitar-Tăut, 2021), which leads to the suggestion that HM could influence on the continuous intention to use mobile learning platform in a post-Covid-19. In other words, the enjoyment gained from using mobile learning platform for learning also positively influences learners' continuous intention to use mobile learning platform even after Covid-19. Hence, the proposed model of this study hypothesized that:

H7: *HM affects students' attitudes towards m-learning apps.*

H8: *HM affects students' continuous intention to use m-learning apps.*

Social Influence (SI)

SI in the mobile learning context refers to the degree of social support towards to use new technologies like mobile learning technology. In other words, the degree to which learners believe that the social environment (their friends) leads to the use of mobile learning in their learning activities. Previous studies indicated that social influence among students had large impact on mobile learning utilization (Venkatesh et al., 2012). In addition, the intention to use of new technologies will be increased when user obtains social support for utilization Venkatesh et al. (2012). Furthermore, SI impacts the utilization of mobile learning platform even when unwanted (Sitar-Tăut, 2021). A study conducted by Sitar-Tăut (2021) found that SI construct had the highest effect on learners towards the use of mobile learning. Based on this discussion, in the same line with prior studies, we proposed that SI factor could influence on students' continuous intention to use mobile learning platform. Hence:

H9: *SI has a significant effect on students' continuous intention to use m-learning apps.*

Facilitating conditions (FC)

FC refers to offer the necessary technological infrastructure resources to facilitate the use of new technology among users Venkatesh et al. (2012). This indicates that supportive technical resources are very important for the utilization of mobile learning platform in effective way. Previous studies Hameed et al. (2024) and Alowayr (2022) reported that FC construct had a significant effect on the users' intention to use mobile learning. Based on that, we proposed in our model of this research that FC could have a strong effect on students' continuous intention to use mobile learning platform in the post-Covid-19. Hence:

H10: *FC have a strong effect on students' continuous intention to use m-learning apps.*

Attitudes towards mobile learning platform (ATT)

ATT in the context of this study measures the degree of students' interest and use of mobile learning platform. This means that when students' use the mobile learning platform and they find that this technology help them to learn in effective way after covid-19. In this case, their intention to use mobile learning will be increased. In the same line, previous studies confirmed that ATT has a positive correlation with intention to use educational technologies Hameed et al. (2024) and Alowayr (2022). This proved that ATT construct is very critical for measuring students' continuous intention to use mobile learning platform after Covid-19. Hence:

H₁₁: *ATT has a string effect on students' continuous intention to use m-learning apps.*

3. Methodology

3.1 A Hybrid SEM-ANN Approach

In our research, a hybrid approach SEM-ANN was employed to predict the main determinants that encourage students to continuous use of mobile learning. In the methodology of this study, we applied the same stages of a research method from research performed by Alhumaid et al. (2021). In several prior studies Al-Emran et al. (2021) and Alhumaid et al. (2021) used the SEM-ANN hybrid approach for predicting learners to adopt many types of technologies such as learning management system, m-learning and e-learning. Several previous studies indicated that SEM-ANN is a powerful data analysis technique to measure the structural models (Al-Emran et al., 2021; Alhumaid et al. (2021). In addition, many studies have been adopted this method to help in predicting the students' opinion towards to use new technologies in education. Moreover, SEM-ANN can be used to discover both linear and non-linear relationships between constructs in the proposed model (Al-Emran et al., 2021; Alhumaid et al., 2021). Based on the advantages in both methods, in this study we selected a hybrid approach SEM-ANN was employed to predict the main determinants that encourage students to continuous use of mobile learning.

3.2 Quantitative method for collecting the data

In our study, a quantitative technique was employed to collect the data. This technique is the most convenient for achieving the study's objective, to analyze the relationship between the factors that affect students' utilization of mobile learning applications. SEM was employed to test the study hypotheses in the proposed model. A hybrid approach SEM-ANN was applied to validate the research model.

3.3 Research participants

In this study, a questionnaire was distributed to undergraduate and postgraduate students at University of Jordan from Jordan. According to Kline (2023) the minimum sample size should be approximately 200 for the studies that use SEM method to analyze the research hypothesis. Kline (2023) recommended that 260 is acceptable sample size. Based on that, in this study, the data collected from 407 respondents, which is an acceptable sample size based on recommendation by Kline (2023).

Table 1

The Demographic Data

Category		Frequency	Percentage
Gender	Female	225	50.5%
	Male	200	49.5 %
Age	Between 18 to 29	381	85.6%
	Between 30 to 39	50	11.2%
	Between 40 to 49	14	3.2%
Education Level	Bachelor	355	79.8%
	Master	90	20.2%
	Doctorate	0	0%

3.4 Survey instrument

The survey instrument was divided into two parts. The first part collected background information on the participants, including their demographic characteristics, for example, their gender, age and education Level. The second section is concerned with measuring the constructs of the proposed model. The items of performance expectancy and effort expectancy have been adapted from a study conducted by Almaiah et al. (2022); constructs of habit and hedonic motivation have been used from Venkatesh et al. (2012); items of social Influence, facilitating conditions and attitude were adopted from a study performed by Venkatesh et al. (2012).

4. Data Analysis and Results

4.1 Reliability analysis

A pilot study was performed to assess the reliability items in the questionnaire survey. To conduct the pilot study, we selected 25 students from the College of Information Technology from University of Jordan. Those students are 10% of the total sample size in this study. We used Cronbach's alpha to analyze the data collected in the pilot study in order to test the internal reliability in the constructs of the proposed model. This step is important to help yield acceptable results for the measurement items. According to previous studies, if the value of Cronbach's alpha equal or above 0.70 is considered acceptable, (Taber, 2018). Table 2 provides the results of the pilot study and Cronbach's alpha values for all items in the proposed model.

Table 2
Reliability analysis

Construct	Cronbach's Alpha
PE	0.881
EE	0.842
SI	0.843
FC	0.790
HM	0.852
CI	0.843
HB	0.896
ATT	0.901

Table 3
The Discriminant Validity Test

	FC	SI	HM	HB	EE	PE	ATT	CI
FC	.370							
SI	.400	.375						
HM	.543	.309	.325					
HB	.475	.343	.383	.673				
EE	.409	.366	.369	.507	.554			
PE	.275	.293	.311	.384	.360	.322		
ATT	.481	.233	.254	.322	.316	.249	.530	
CI	.425	.332	.356	.509	.449	.362	.282	.587

4.2 Discriminant validity

In this study, we conducted the discriminant validity for all constructs in the proposed model to assess the validity of all items. We applied the square root of the AVE to compute the values of discriminant validity and then compared them with the correlation coefficient values. Based on the results in Table 3 that presented the values of discriminant validity are accepted and higher than correlation coefficient values as suggested by Taber (2018).

4.3 ANN Analysis for validating the proposed model

In order to conduct ANN analysis for validating the proposed model, firstly, we must assign the dependent variable (output layer) and independent variables (input neurons) in the ANN analysis model as shown in Fig. 2. Based on that, in this study we have seven independent variables (FC, SI, HM, HB, EE, PE and ATT), which represent the number of predictors (input neurons) in the ANN analysis model. In addition, the output layer is the CI in the ANN analysis model, which means the number of output neurons is one. Regarding the hidden neurons (hidden layers) are computed automatically by using the Sigmoid Function. Based on that, the total number of hidden layers was computed using the activation function.

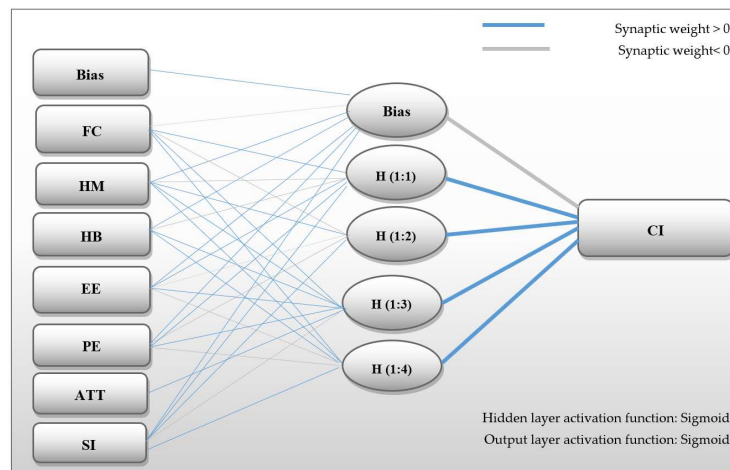


Fig. 2. ANN analysis model

In this paper, we applied the ANN analysis model using the original version 23.0 of SPSS software. For the training process in the ANN network model, a back propagation neural network algorithm was used. For checking the prediction accuracy of the

trained network, a ten-fold cross-validation was adopted in order to overcome the issue of model over-fitting. Therefore, a hybrid validation approach cross-validation-ten folds was selected to validate the prediction accuracy of our proposed model. Based on the hybrid approach, 85% of the data points were used for training dataset and 25% of them to test dataset in the network model. For measuring the accuracy prediction for the ANN analysis model, a root mean square error (RMSE) was applied. Zabukovšek et al. (2022) indicated that the value of RMSE can be computed two Eqs. (1-2) where SSE is the sum of squared error, and MSE is the mean squared prediction error as shown in Eq. (1) and Eq. (2).

$$MSE = \left[\frac{1}{N} \right] \times SSE \quad (1)$$

$$RMSE = \sqrt{MSE} \quad (2)$$

Based on the RMSE analysis in table 4, the values of RMSE were calculated for training datasets and testing datasets. These calculations have been used to validate the ANN analysis model for measuring the relationships between input predictors (FC, SI, HM, HB, EE, PE and ATT) and output variable (CI). When RMSE values are low this means higher predictive accuracy as well as better data fit as mentioned by Zabukovšek et al. (2022). The findings in Table 4 indicate that the average value of RMSE for the training model equals 0.295 and the average value of RMSE for the testing model is 0.902. Based on these results, which indicate that the ANN analysis model in this research is reliable for assessing the proposed hypotheses in the proposed model. Thus, the ANN approach is the appropriate method for predicting the main determinants that encourage students to continuous use of mobile learning effectively.

Table 4

Results of RMSE values for ANN model validation

Input: FC, SI, HM, HB, EE, PE and ATT				
Output: CI				
Neural network	Training dataset (75% of data sample 3000, N=2250)		Testing dataset (25% of data sample 3000, N=750)	
	SSE	RMSE	SSE	RMSE
ANN1	0.131	0.325	0.121	0.920
ANN2	0.129	0.311	0.127	0.950
ANN3	0.130	0.325	0.168	0.908
ANN4	0.125	0.317	0.108	0.866
ANN5	0.126	0.315	0.112	0.888
ANN6	0.115	0.301	0.120	0.920
ANN7	0.114	0.230	0.119	0.909
ANN8	0.110	0.290	0.115	0.910
ANN9	0.113	0.295	0.101	0.832
ANN10	0.112	0.297	0.114	0.915
	Mean	0.305	Mean	0.901

4.4 Sensitivity Analysis

Sensitivity analysis has been calculated by applying the average of the importance of the independent variables that help in predicting the dependent variable Zabukovšek et al. (2022). The findings indicated that all seven independent variables are significant in all 10 neural networks in ANN model analysis. In addition, the results showed that the facilitating condition factor was the most important predictor for mobile learning adoption with importance value (0.315) as shown in Table 5.

Table 5

Results of Independent Variables Importance

Independent Variables	Importance	Normalized Importance
FC	.315	100.0
SI	.227	66.2
HM	.205	58.6
HB	.199	62.0
EE	.231	71.3
PE	.215	61.1
ATT	.131	36.4

4.4 Structural model and Hypothesis test

To analyze the proposed model in this study, a structural equation model was applied that aims to understand students' continuous Intention to use mobile learning systems as shown in Fig. 3.

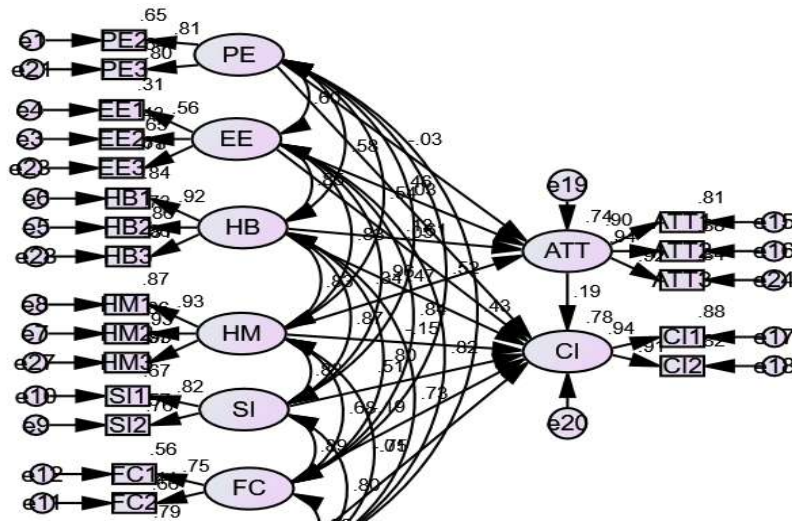


Fig. 3. The Analysis SEM for the proposed model

5. Discussion

In this work, a conceptual model was proposed based on eight constructs from the UTAUT-2 model namely; effort expectancy, performance expectancy, hedonic motivation, habit, facilitating conditions, social Influence and attitude to examine their effect on continuous intention to use mobile learning platform after Covid-19. The findings indicated that performance expectancy and effort expectancy had a strong effect on students' attitudes towards mobile learning platforms. In addition, the results showed that performance expectancy and effort expectancy have a significant impact on students' continuous intention to use mobile learning platforms after Covid-19. This indicates that students have a positive perspective towards the learning through mobile learning platform and did not require a big effort to use it. Also, this indicated that students found mobile learning as an easy tool to use, thus; their attitude and continuous intention to use mobile learning will be increased. These findings are in line with prior study conducted by Hameed et al. (2024) and Ogata et al. (2024), who found that both performance expectancy and effort expectancy affected attitude and intention to use educational technologies significantly.

In addition, the findings showed that hedonic motivation has a positive effect on students' attitudes towards mobile learning platforms. Also, the results showed that hedonic motivation had a significant impact on students' continuous intention to use mobile learning platforms after Covid-19. This indicates that students observed the mobile learning platform to be fun and exciting when learning and performing learning activities. This means hedonic motivation has the ability to change students' perception of the difficulties and boringness of learning through using mobile learning platforms. Also, this indicated that students found mobile learning as an enjoyable tool, and thus; their attitude and continuous intention to use mobile learning will be increased. This finding is in line with prior study, who found that hedonic motivation affected students' attitude and intention to use e-learning significantly.

Furthermore, our results showed that habit factor had a significant effect on students' attitudes towards mobile learning platforms. Also, the results showed that this habit had a significant impact on students' continuous intention to use mobile learning platforms after Covid-19. This is because the utilization of the mobile learning platform has become a habit during the Covid-19, for approximately 2 years. In this case, students were found to often use mobile learning platforms to attend classes, download materials and others. The results also indicated that students also liked recording lectures and performing their homework through mobile learning platforms. Thus, students are found to continuously use mobile learning platforms when it has become a habit. This means that intention behavior is transformed into a habit. Habit construct is the key factor affecting the acceptance and use of new educational platforms. This finding is in line with previous studies, which indicated that the habit had significant effect on learners in different educational technologies contexts, towards the utilization of online learning systems (Hameed et al., 2024; Ogata et al., 2024).

Social influence factor also had a significant effect on students' continuous intention to use mobile learning platforms after Covid-19. This indicated that the social support had a high impact towards continuous intention to use mobile learning platforms. In addition, the intention to use mobile learning platforms will be increased when students obtain social support for utilization. This means that when students obtain social support from family and friends towards the use of new technology, the degree to use it

will be increased. This finding is in line with previous studies, which found that social influence among students had a large impact on mobile learning utilization (Hameed et al., 2024; Ogata et al., 2024).

The findings showed that facilitating conditions had a significant effect on students' continuous intention to use mobile learning platforms after Covid-19. This indicated that offering the necessary technological infrastructure resources to facilitate the use of new technology will lead to enhancing the students' continuous intention to use mobile learning platforms. This indicates that supportive technical resources are very important for the utilization of mobile learning platforms in an effective way. This finding is in line with previous studies, which indicated that facilitating conditions construct had a significant effect on the users' intention to use mobile learning (Hameed et al., 2024; Ogata et al., 2024).

Finally, the attitude toward use also had a strong effect on students' continuous intention to use mobile learning platforms after the covid-19. This was in line with other previous study, where attitude was the key factor to predict the influencing the intention to use educational technologies (Hameed et al., 2024; Ogata et al., 2024). This means that when students' use the mobile learning platform and find this technology helps them to learn in an effective way after covid-19; their intention to use mobile learning will be increased. This finding is in line with previous studies, which found that ATT has a positive correlation with intention to use educational technologies (Hameed et al., 2024; Ogata et al., 2024). This proves that the ATT factor is very critical for measuring students' continuous intention to use mobile learning platforms after Covid-19.

7. Conclusion

This research was conducted to explore the main determinants that encourage students to continuous use of mobile learning. To achieve this objective, we used the second version of the Unified Theory of Acceptance and Use of Technology (UTAUT-2). A hybrid approach SEM-ANN was applied to validate the research model. The findings indicated that performance expectancy and effort expectancy had a strong effect on students' attitudes towards mobile learning platforms. In addition, the results showed that performance expectancy and effort expectancy have a significant impact on students' continuous intention to use mobile learning platforms after Covid-19. In addition, hedonic motivation and habit had a positive effect on both students' attitudes and continuous intention to use mobile learning platforms. Moreover, Social influence factor and facilitating conditions had a significant effect on students' continuous intention to use mobile learning platforms after Covid-19. The findings indicated that all proposed factors in the research model of this study had a significant effect on students' continuous intention to use mobile learning platforms. This work contributes to the body of knowledge on mobile learning adoption practices. Likewise, it may help to increase the continuous usage of mobile learning among students in Saudi universities after Covid-19.

8. Limitation and Future works

First, the research is limited to the university level in Saudi Arabia context, to deeply understanding the continuous intention to use mobile learning platform in post Covid-19. Second, our findings could not be generalized to primary educational level. Third, other models like TAM can be considered in the future studies. Fourth, teachers' perspectives towards the continuous intention to use mobile learning platforms in post Covid-19 is also very important, which should be investigated in the future studies. Finally, this study used only the quantitative approach, thus, in future studies, there is need to use a mixed-method approach in order to deeper understand the factors influencing the continuous intention to use mobile learning platform in post Covid-19.

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References

- Al-Emran, M. (2020). Mobile learning during the era of COVID-19. *Revista Virtual Universidad Católica del Norte*, 61, 1-2.
- Al-Emran, M., Abbasi, G. A., & Mezhuyev, V. (2021). Evaluating the impact of knowledge management factors on M-learning adoption: A deep learning-based hybrid SEM-ANN approach. In *Recent advances in technology acceptance models and theories* (pp. 159-172). Cham: Springer International Publishing.
- Alfalah, A. A. (2023). Factors influencing students' adoption and use of mobile learning management systems (m-LMSs): A quantitative study of Saudi Arabia. *International Journal of Information Management Data Insights*, 3(1), 100143.
- Alhumaid, K., Habes, M., & Salloum, S. A. (2021). Examining the factors influencing the mobile learning usage during COVID-19 Pandemic: An Integrated SEM-ANN Method. *IEEE Access*, 9, 102567-102578.

- Almaiah, M. A., Alamri, M. M., & Al-Rahmi, W. M. (2019). Analysis the effect of different factors on the development of Mobile learning applications at different stages of usage. *IEEE Access*, 8, 16139-16154.
- Almaiah, M. A., Ayouni, S., Hajje, F., Lutfi, A., Almomani, O., & Awad, A. B. (2022). Smart mobile learning success model for higher educational institutions in the context of the COVID-19 pandemic. *Electronics*, 11(8), 1278.
- Alowayr, A. (2022). Determinants of mobile learning adoption: extending the unified theory of acceptance and use of technology (UTAUT). *The International Journal of Information and Learning Technology*, 39(1), 1-12.
- Althunibat, A., Altarawneh, F., Dawood, R., & Almaiah, M. A. (2022). Propose a New Quality Model for M-Learning Application in Light of COVID-19. *Mobile Information Systems*, 2022(1), 3174692.
- Dutta, S., & Shivani, S. (2020). Modified utaut2 to determine intention and use of e-commerce technology among micro & small women entrepreneurs in jharkhand, india. In Re-imagining Diffusion and Adoption of Information Technology and Systems: A Continuing Conversation: IFIP WG 8.6 International Conference on Transfer and Diffusion of IT, TDIT 2020, Tiruchirappalli, India, December 18–19, 2020, Proceedings, Part II (pp. 688-701). Springer International Publishing.
- Hameed, F., Qayyum, A., & Khan, F. A. (2024). A new trend of learning and teaching: Behavioral intention towards mobile learning. *Journal of Computers in Education*, 11(1), 149-180.
- Hoang-Tung, N., Kojima, A., & Kubota, H. (2017). Transformation from intentions to habits in travel behavior: An awareness of a mediated form of intention. *Transportation Research Part F: Traffic Psychology and Behaviour*, 49, 226-235.
- Jiang, T., Luo, G., Wang, Z., & Yu, W. (2024). Research into influencing factors in user experiences of university mobile libraries based on mobile learning mode. *Library Hi Tech*, 42(2), 564-579.
- Juera, L. C. (2024). Digitalizing skills development using simulation-based mobile (SiM) learning application. *Journal of Computers in Education*, 11(1), 29-50.
- Katayeva, M. (2023). Analysis And Recommendations On Mobile Learning In The Educational Process. *Farg'ona davlat universiteti*, 3, 40-40.
- Kline, R. B. (2023). Principles and practice of structural equation modeling. Guilford publications.
- Li, M., & Liu, L. (2023). Students' perceptions of augmented reality integrated into a mobile learning environment. *Library Hi Tech*, 41(5), 1498-1523.
- Meng, Z., & Li, R. (2024). Understanding Chinese teachers' informal online learning continuance in a mobile learning community: an intrinsic–extrinsic motivation perspective. *Journal of Computing in Higher Education*, 36(2), 275-297.
- Ogata, H., Majumdar, R., Flanagan, B., & Kuromiya, H. (2024). Learning analytics and evidence-based K12 education in Japan: usage of data-driven services for mobile learning across two years. *International Journal of Mobile Learning and Organisation*, 18(1), 15-48.
- Raman, A., & Thannimalai, R. (2021). Factors Impacting the Behavioural Intention to Use E-learning at Higher Education amid the Covid-19 Pandemic: UTAUT2 Model. *Psychological Science & Education*, 26(3).
- Sarrab, M., Elbasir, M., & Alnaeli, S. (2016). Towards a quality model of technical aspects for mobile learning services: An empirical investigation. *Computers in Human Behavior*, 55, 100-112.
- Sitar-Tăut, D. A. (2021). Mobile learning acceptance in social distancing during the COVID-19 outbreak: The mediation effect of hedonic motivation. *Human Behavior and Emerging Technologies*, 3(3), 366-378.
- Sternad Zabukovšek, S., Bobek, S., Zabukovšek, U., Kalinić, Z., & Tominc, P. (2022). Enhancing PLS-SEM-enabled research with ANN and IPMA: Research study of enterprise resource planning (ERP) systems' acceptance based on the technology acceptance model (TAM). *Mathematics*, 10(9), 1379.
- Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in science education*, 48, 1273-1296.
- Thabet, Z., Albashtawi, S., Ansari, H., Al-Emran, M., Al-Sharafi, M. A., & AlQudah, A. A. (2023). Exploring the factors affecting telemedicine adoption by integrating UTAUT2 and IS success model: a hybrid SEM–ANN approach. *IEEE Transactions on Engineering Management*.

