CrossMark

Mobile learning technology acceptance in Saudi Arabian higher education: an extended framework and A mixed-method study

Talal Alasmari[1] (iD) · Ke Zhang[2]

Abstract

This article reports a two-phase study with (1) an extended framework on mobile learning technology acceptance, and (2) a mixed-method research investigating college students on the use and embracement of mobile learning technology acceptance in Saudi Arabia. The research extended the Unified Theory of Acceptance and Use of Technology (UTAUT) framework with constructs particularly concerning mobile learning technology. The sequential mixed-method study investigated college students' mobile learning technology acceptance in Saudi Arabia, and also validated the extended framework with empirical data. A total of 1203 eligible college students, 591 male and 612 females, participated in the online survey, and 15 of them also participated in individual interviews afterward. A wide range of social media and social networking sites were used to recruit participants and collect data. The study found that variables like Learning Expectancy (LE), Effort Expectancy (EE), Social Influence (SI), and characteristics of mobile learning were significant predictors of students' intentions to use mobile learning technologies, regardless of the moderating effects of gender, age, and eLearning experience. Social influence was the only construct that was found as moderated by gender, where men showed a stronger behavioral intention to use mobile learning technology than women. Facilitating Conditions (FC) and Self-Management of Mobile Learning (SMML) in this study were not significant in predicting students' behavioral intention or their use behavior of mobile learning technology acceptance.

Keywords Mobile learning technology · Technology acceptance · Saudi Arabia · Higher education · Unified theory of acceptance and use of technology · Mixed-method · Technology acceptance model · Mobile learning acceptance

✉ Talal Alasmari
  talasmari@uj.edu.sa

Extended author information available on the last page of the article

⌀ Springer

In 2016, Prince Mohammed Bin Salman, the Crown Prince of Saudi Arabia, announced an ambitious national plan, *Saudi Vision 2030* (Salman 2016), which emphasized education as a key for the country. Accordingly, several initiatives were launched to promote mobile learning in Saudi universities (e.g., King Abdulaziz University 2014; Taif University 2016). However, for this to be successful, there was the need for students to embrace mobile learning technology and also raise the awareness of it as there was little research for its acceptance in Saudi higher education (Imtiaz and Maarop 2014). Related research in Saudi has been limited to either a single university (Alfarani 2014; Al-Hujran et al. 2014; Nassuora 2012), or without appropriate framework support (Narayanasamy and Mohamed 2013). There was also a need to show that significant studies assessing the effectiveness of mobile learning within Saudi Arabia higher education institutions are lacking the theoretical frameworks of UTAUT. The absence of studies reporting on existing mobile learning study reflects the limited penetration of this technology and associated pedagogies and a need to strengthen research in the field of mobile learning in the Kingdom of Saudi Arabia (Abdulrahman and Benkhelifa 2017).

Thus, this study was to achieve two major goals: (a) to extend the Unified Theory of Acceptance and Use of Technology model (UTAUT) with new and modified constructs focusing on mobile learning technology, and (b) to investigate Saudi college students' acceptance of mobile learning technology through a mixed-method study, which would also serve to test the extended framework of the UTAUT model.

1 Literature Review

Unified Theory of Acceptance and Use of Technology model (UTAUT) has been widely applied in technology acceptance research in various settings and countries. Figure 1 illustrates the key variables and their relationships as per UTAUT (Venkatesh et al. 2003, p.447).

Research's that applied the Unified Theory of Acceptance and Use of Technology model (UTAUT) on various technologies indicated that these different variables may have different effects on technology acceptance. Variables such as depending on the technology, user population and cultural settings. For example, it was noted in a research on having teachers embrace the usage of technology when it comes to
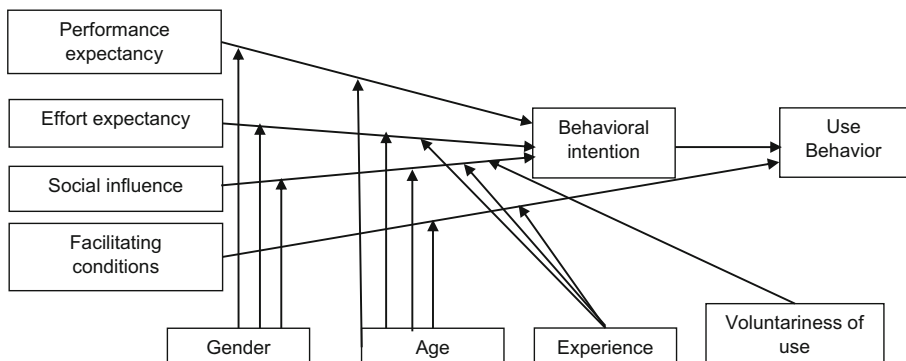

Fig. 1 UTAUT key constructs (Venkatesh et al. 2003, p.447)

teaching, that teachers tend to show high interest and got more involved in the usage of "Smart Board" technology when they saw the value and it's benefits as compared to the usage of traditional "White Boards" in the teaching of their student's (Wong et al. 2013). This also made the researchers to understand that the high level of Effort Expectancy (EE) will always result in a high Behavioral Intention (BI) among individuals to accept technology.

Another research found out that the main determiner towards the acceptance of student's embracing the use of technology in studies was the students' attitude, which is followed closely by Performance Expectancy (PE) which refers to the usefulness of the tool used by the student, Facilitating Conditions (FC) which refers to the technological support of where the student studied, Effort Expectancy (EE) which refers to the ease of use of the tool used by the student and Social Influence (SI) referring to the influence of social members of the student (El-Gayer et al. 2011). Moreover, a study that aimed to evaluate the intention of adopting a future mobile payment service from current Brazilian consumers of mobile phones, based on the UTAUT showed that the initial expectations of the consumers change with the experience of use of technology, considering the ease, usefulness, pleasure provided, confidence and the perception of a fair and reasonable price (de Sena Abrahão et al. 2016).

Likewise, studies on Moodle, a learning management system confirmed the influence of Performance Expectancy (PE) and Social Influence (SI) played a crucial role on the Behavioral Intention (BI) of a student's acceptance of technology, but results were inconsistent with other constructs of the Unified Theory of Acceptance and Use of Technology model (UTAUT) with different participants, moderators, such as age and experiences, contributing to the inconsistent results in these research's (Hsu 2012, Raman et al. 2014a, 2014b).

Inconsistency was found in studies' findings based on user population and cultural settings. For example, after conducting studies using the Theory of Acceptance and Use of Technology model (UTAUT) with university teaching personnel in two African countries, Nigerian teaching personnel had a positive influence on behavioral intentions (Oye et al. 2014) while Ghanaian teaching personnel found that Effort Expectancy (EE) was the only construct showing positive influence on behavioral intentions (Attuquayefio and Addo 2014).

A cross-cultural study of educational technology acceptance was also conducted in three European countries: Germany, Romania, and Turkey. This study extended Unified Theory of Acceptance and Use of Technology model (UTAUT) with two additional constructs: computer literacy and computer anxiety, and found that Performance Expectancy (PE) was moderated by gender (Nistor et al. 2013).

Most of the studies initially were focused on behavioral intentions however, a study conducted by (Attuquayefio and Addo 2014) examined all hypotheses according to the Unified Theory of Acceptance and Use of Technology model (UTAUT) mode, including both the behavioral intention and the actual use of behavioral determinants. In this sense, only three constructs: Performance Expectancy (PE), Effort Expectancy (EE) and Social Influence (SI), directly influenced the intentions of an individual embracing technology while the fourth construct, Facilitating Condition (FC), only influenced the user behavior.

2 UTAUT & Mobile Technology

Unified Theory of Acceptance and Use of Technology model (UTAUT) being very popular and widely used to predict behavioral intention for the adoption of technology was easy to fuse with mobile technology so as to influence students, precisely college students in Saudi Arabia to embrace and conform to a new experience of the usage of mobile technology in learning. There have been many applications and replications of the entire model or part of the model in organizational settings that have contributed to fortifying its generalizability (Neufeld et al. 2007).

Unified Theory of Acceptance and Use of Technology model (UTAUT) has four key constructs (i.e., performance expectancy, effort expectancy, social influence, and facilitating conditions) that influence behavioral intention to use a technology and/or technology use (Venkatesh et al. 2012). Models employed in most studies are named as acceptance models, such as Technology Acceptance Model (TAM) with the focus of such studies however, often being the acceptance (or adoption) of mobile learning, rather than mobile learning technology (Nassuora 2012; Seliaman and Al-Turki 2012).

Given the drastic differences of mobile learning technology from information and communication technology, which Unified Theory of Acceptance and Use of Technology model (UTAUT) was originally focusing on, modifications were infused in the model in recent studies to fit the demand and for the understanding of the usage of mobile technology as a learning tool. For example, two additional constructs were suggested to modify the UTAUT model so as understand more on how individuals will adjust to mobile learning. The two newly proposed model construct: Perceived Playfulness (PP) and Self-Management of Mobile Learning (S-MML) were found significant in predicting individual's intentions to take part in mobile learning, and they were stronger predictors than the conventional UTAUT constructs. Thus, making these new models evidently playing a unique characteristic in predicting acceptance of mobile technology among learners in different cultures and contexts (Liew et al. 2013; Wang et al. 2009).

Other researches argued that the original UTAUT model may be reconsidered from the light of other constructs that may explain adoption and usage behaviors of individuals. The four exogenous constructs in the UTAUT model may be viewed as representing technology attributes (i.e., performance expectancy and effort expectancy) and contextual factors (i.e., facilitating conditions and social influence) even when they may be viewed as perceptions held by individuals regarding the technology and the context. Despite the evidence that these four constructs explain a significant proportion of variance in the adoption and usage behaviors, a key element missing from the UTAUT model is the "individual" engaging in the behavior—i.e., individual characteristics that describe the dispositions of the users may be influential in explaining their behaviors (Dwivedi et al. 2017).

A new proposed construct into the UTAUT model: Personal Innovativeness (PI) from a recent study in a specific technology, found that Personal Innovativeness affected mobile learning acceptance in Canada, a developed country, more than it did in Turkey, a developing country. Such a difference might have been because users in developed countries, like Canada, were more likely to accept new ideas and thus would try them at early stages than a developing country like Turkey. Interestingly, though, Social Influence (SI) had more effects on an individuals' intention to use mobile

learning technology in developing countries than it did in developed countries (Arpaci 2015; Iqbal and Qureshi 2012). Therefore, a country's social economic status, together with cultural differences may have played a significant role in predicting mobile learning technology acceptance in various countries. For instance, Turkey has a more collectivist culture, while Canadian culture is more individualistic. So, variables like self-reliance and Personal Innovativeness (PI), might be applicable in Canada-like contexts, while constructs like Social Influence (SI) and collaborative variables might be more relevant in cultures like in Turkey.

Similar to the Turkish collectivist culture, research has found that Saudi Arabian students' intention to use mobile learning technology is influenced by social factors, such as peers' and faculty opinions, families, and by the general factor of easiness one derives in mobile learning experiences (Al-Hujran et al. 2014; Nassuora 2012). In fact, a recent research done by Norton showed more than half of parents in Saudi Arabia said they believe mobile technology and mobile devices can help foster children's problem solving and learning skills (60%), among the highest, with 64% saying that children being in charge of their own devices teaches them responsibility (Arabian Business 2018). However, the Gulf Cooperation Council countries, including Saudi Arabia, revealed that peers of students had a significant influence on a student intends to practice mobile learning (Shorfuzzaman and Alhussein 2016). Furthermore, Facilitating Condition (FC) from the model of Unified Theory of Acceptance and Use of Technology (UTAUT), was also used and found out that infrastructure and all other facilitating conditions insignificantly influenced learners' use of mobile learning technology in, Saudi Arabia and Pakistan (Iqbal and Qureshi 2012).

3 UTAUT2

Unified Theory of Acceptance and Use of Technology model (UTAUT) has gone through many extensions in various studies, one of those is the proposed UTAUT2 by Venkatesh and colleagues (Venkatesh et al. 2012) which was widely applied in the context of consumer use, to study the acceptance of technology. The proposed UTAUT2 has three new constructs: (a) hedonic motivation, (b) price value, and (c) habit, and deletes the voluntariness of use as a moderator, because the consumer use of technology is always voluntary. Attuquayefio and Addo (2014) also have argued the importance of choosing appropriate combination of variables when applying UTAUT in different cultures. With these constraint in mind, we come up with a two-phase study proposing an extension of UTAUT to include variables concerning mobile technology in educational contexts, based on critical review of collective empirical evidence of related mobile learning technology research.

4 The Two-Phase Research: methods & Procedures

4.1 Phase 1: extending UTAUT with MLT constructs

We propose to add two new constructs to the Unified Theory of Acceptance and Use of Technology mode (UTAUT) which are: (a) Mobile Learning Technology Characteristics,

and (b) Self-Management of Mobile Learning, as well as modify two other constructs. In the following, we will provide detail rationales and explanations on the specific constructs, both existing and new, as particularly related to mobile learning technology acceptance.

New construct: Mobile learning technology characteristics (MLTC) Mobile learning technology characteristics focus on mobile technology's capacity to support learning. This construct is theoretically based on Goodhue and Thompson's (1995) Task-Technology Fit model (TTF), where the underlying concept is that technology leads individual performance through a utilization process. Similarly, in Technology Acceptance Model (TAM 3) of Venkatesh and Bala (2008) proposed that system characteristics as determinants of technology acceptance. As the use of mobile learning has become more common in educational settings, research in the effectiveness of mobile learning in relation to student learning outcomes grows in importance. There is a manifest lack of research related to results of effective implementation of mobile learning methods in different educational contexts and this appears to be a vicious cycle. Although some progress is slowly taking place, teachers and students have difficulties finding information on this topic that they can use and adapt, and this inevitably contributes to extend the problem (Pedro et al. 2018).

Platzer and Petrovic (2010) critically reviewed seventy-three studies on mobile technology acceptance and found that technology characteristics was a strong predictor in influencing mobile technology acceptance. Likewise, Oliveira et al. (2014) found technology characteristics significantly influenced performance expectancy, and technology characteristics contributed in predicting the overall behavioral acceptance in mobile banking.

All these constructs were characteristics of the technology systems significantly influencing the acceptance behaviors of individuals. Thus, we propose an extension of the Unified Theory of Acceptance and Use of Technology (UTAUT) mode with mobile learning technology characteristics (MLTC) as a construct and acting as potential influencers in behavioral intention to use mobile learning technology.

New construct: Self-Management of Mobile Learning (SMML) We also propose a new construct, self-management of mobile learning (SMML). This refers to the degree that a learner is self-regulated with the ability to engage in learning autonomously (Smith et al. 2003). In mobile learning environments, students must have a high level of self-management to succeed, including tasks like developing critical thinking, setting up learning objectives, evaluating learning resources, and conducting self-evaluation (Liew et al. 2013; Wang et al. 2009). Whatever form online education may take, educators and administrators generally rely upon some kind of learning management system to develop and assign course content, track student progress, and measure and report student outcomes (Fenton 2018).

Modified construct: Learning expectancy (LE) Performance Expectancy in UTAUT refers to the personal belief that the intended technology use will result in better performance in job tasks, and it is moderated by the one's gender and age. In this extension, we propose to modify it into Learning Expectancy (LE) for educational contexts. Learning Expectancy (LE) includes cognitive expectancy and perceived usefulness as represented in the UTAUT model of Wen-Hong et al. (2010) with

cognitive expectancy referring to the individual's perception that using mobile learning technology benefits his/her cognitive domain. As Stakkestad and Fladvad Størdal (2017) proposed for further research, in addition, it would be interesting to examine whether there are more students that choose technology-oriented study fields as a result of being introduced to technology in upper secondary school. If the students obtain high digital competence before choosing higher education, the share of students applying for more technological study programs is likely to increase.

Effort expectancy (EE) The second construct is effort expectancy which refers to the level of ease of using the intended technology. This construct is mentioned in many other acceptance models under different names such as perceived ease of use in Technology Acceptance Model (TAM) and TAM2 or complexity in Model of PC Utilization (MPCU) (Davis et al. 1989; Davis and Venkatesh, 2000; Venkatesh et al. 2003). Effort expectancy is moderated by gender, age, and experience. As further described in Ma (2019) this can be explained by noting that if the system is easy to use, a user may find the system more useful, and hence, has a motivation to use it, so that in the end, actual usage behavior happens as an indirect result of ease of use.

Social influence (SI) Social influence refers to the level of influences from one's peers and other social connections, and is also known as subjective norms in Technology Acceptance Model (TAM) or social factors in Model of PC Utilization (MPCU). SI is moderated by gender, age, experience, and voluntariness. Previous studies have found that SI has a strong influence on behavioral intention. The interaction between user and technology, in turn, determines the extent of social influence as technology evolves from a tool level to a social level (Lorenz and Buhtz 2017).

Facilitating conditions (FC) Facilitating conditions refers to the extent an individual believes that the available infrastructure in one's organization that supports their use of technology. This construct influences use behavior directly rather than behavioral intention unlike in the other constructs. Moreover, the facilitating conditions construct is moderated by age and experience, and that means, according to the UTAUT hypothesis, facilitating conditions construct has a significant influence on user behavior among older workers especially with advanced level of experience (Venkatesh et al. 2003). The paradigm thereby makes facilitating conditions (infrastructure) to remain as technological solutions deployed and maintained by trusted organizations which guarantee their sustainability and quality of the services offered to the users (Hamzat and Mabawonku 2018). The facilitating conditions construct was found to be an insignificant construct in predicting behavioral intention to use technology among studies; however, by adding privacy and security items, it is assumed that facilitating conditions will influence the behavior of Saudi high students' in the use of mobile learning technology (Rao and Troshani 2007).

Moderating variables In accordance with Unified Theory of Acceptance and Use of Technology (UTAUT), this extension also proposes that gender and age are moderating variables of the relationship between the six constructs and learners' behavioral intentions (or actual use behavior of mobile learning technology). However, experience and voluntariness of use are the two moderating variables that have been dropped due

to their irrelevance in educational contexts. Instead, we propose eLearning experience as a moderator in its place, where the frequent use of eLearning technologies (e.g. internet applications) would increase learners' awareness towards mobile learning technology (Zhao and Zhu 2010). Mobile devices allow on-the-move contact with mentors, tutors, or other learners; mobile phones are considered an acceptable way for learners to receive reminders and chasers, and to manage their time; bite-sized (just in time) e-learning resources can be delivered e.g., to basic skills learners, or work-based learners; abstract (representations) and concrete (environmentally situated) knowledge can be integrated, connecting field or workplace learning with classroom learning; peer-to-peer networks make mobile learning inherently more learner-centered (Vrana 2018). Thus, gender, age and eLearning experience are the proposed moderating variables in this extension of with Unified Theory of Acceptance and Use of Technology in mobile learning environments, as illustrated in Fig. 2 below.

Based on this extension of Unified Theory of Acceptance and Use of Technology (UTAUT) for mobile learning technology, the following hypotheses are developed and tested in the following empirical study:

> H1: Mobile Learning Technology Characteristics have a significant effect on students' behavioral intention to use mobile learning technology, moderated by eLearning experience, such that the effect will be stronger for students with high eLearning experience.
> H2: Self-Management of Mobile Learning has a significant effect on students' behavioral intention to use mobile learning technology moderated by eLearning experience, such that the effect will be stronger for students with high eLearning experience.
> H3: Learning Expectancy has a significant effect on students' behavioral intention to use mobile learning technology moderated by gender, age, and eLearning experience such that the effect will be stronger for men, particularly younger men with high experience in eLearning.
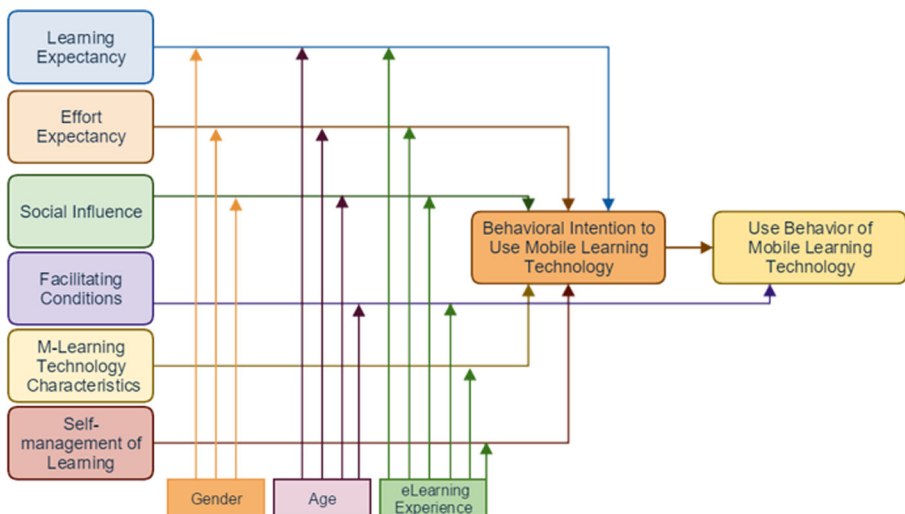

Fig. 2 Authors proposed extension of UTAUT for MLT

H4: Effort Expectancy has a significant effect on students' behavioral intention to use mobile learning technology moderated by gender, age, and eLearning experience, such that the effect will be stronger for women, particularly younger women, with low experience in eLearning.

H5: Social Influence has a significant effect on students' behavioral intention to use mobile learning technology moderated by gender, age, and eLearning experience, such that the effect will be stronger for women, particularly older women, with low experience in eLearning.

H6: Facilitating Conditions have a significant effect on students' use behavior of mobile learning technology moderated by age, and eLearning experience, such that the effect will be stronger for older students with high experience in eLearning.

4.2 Phase 2: a sequential mixed-method study

The phase-2 of this project was a sequential mixed-method empirical study, including both quantitative and qualitative data analyses. This study employed an explanatory sequential mixed method where the quantitative method was initially employed followed by the qualitative method to explain the findings of the quantitative method in more details (Creswell 2014). More specifically, a questionnaire collected quantitative data with closed-ended questions while interviews collected qualitative data through open-ended questions.

The population of this study is the Saudi higher education students enrolled in all of the twenty-eight public universities in Saudi Arabia, with an estimated total of 1,323,692 students (Ministry Deputyship for Planning and Information 2016). 3% of the population are pursuing associate degrees, 92.3% are pursuing bachelor degrees, while 4.7% of the students are pursuing graduate degrees. In respect to gender, 47.7% of the population are male students while 52.3% are female students.

This study drew its sample from social networking sites by employing two sampling techniques: river and network samplings. The river sampling technique is used when participants are recruited through many social networking sites while network sampling (also called snowball sampling) is used when participants are asked to recruit other participants in the study.

Much empirical evidence supports the use of social networking sites in recruiting participants in the Saudi context for this study purpose. This was so, because of the high rate of today's youth engagement in the various social media platforms. The intellectual influence of Twitter on its young Arab users has become greater than that of 'traditional' intellectuals, 'old elites' or even traditional media, especially in the Gulf, Levant and Iraq. The predominant use of Twitter is in the Gulf region, especially since the social medium became available in Arabic in 2012. The Gulf countries occupy the top five rates of Twitter use in the Arab World. According to Dick Costolo (as cited in Aissani and Dheyab 2018), the chief executive of the social network, the use of Twitter in the Arab World is more prevalent among the youth; that is, it is preferred by those under the age of thirty who represent the majority of the population of the region. In fact, according to Statista.com (n.d.), in Saudi Arabia, social media and technology is

increasingly popular, mostly due to the low average age of the country's population. As of the third quarter of 2017 in Saudi Arabia, the most popular social network was mobile messenger WhatsApp with a 71% penetration rate. During the same period, 75% of the total population were active social media.

The dominant age of social media users in Saudi Arabia is 18–30 recording 56% where 7.6 million use Facebook on their mobile devices. The extreme heavy usage of social media by young Saudis is well reported in research's where YouTube, Facebook, Twitter, and WhatsApp are the top most used applications (Aifan 2015; Askool 2013; Dimitrios and Alali 2014; Kutbi 2015; The Social Clinic 2015).

Mirabeau et al. (2013) assert potential benefits of social networking sites on survey research where there is non-response bias, large sampling frame, and monitoring responses and adjusting the data pace. To this end, this study used Facebook, Twitter, WhatsApp, and Email applications to optimize the sampling process.

Instruments validity and reliability A series of three-principle component analysis were used to validate the questionnaire items where items of Learning Expectancy (LE), Effort Expectancy (EE), Mobile Learning Technology, and Self-Management of Mobile Learning (SMML) were loading positively and uniquely on their factors. Item-Total analysis was established for the two remaining unvalidated construct; Social Influence (SI) and Facilitating Conditions (FC), which identifies items detracting reliability from each subscale. This made loading uniquely and positively. Regarding reliability, Cronbach's alpha values of all items exceeded .70, and thus were acceptable (Kline 2000). Content and face validity were established for both the questionnaire and interview protocol, and member checking was conducted to further establish trustworthiness of the qualitative inquiry.

Participants profile A total of 1203 eligible students participated in the online questionnaire. G*Power software (Faul et al. 2007) was used to perform an a priori power analyses to estimate the levels of statistical power that were provided by the available sample of 1203 cases in evaluating: (a) the overall significance of R^2 (i.e., using all independent variables) and, (b) the significance of each of the three independent variables in the analyses (including the antecedent x moderator interaction term). In evaluating the significance of the overall R^2 value the analysis estimated that a sample of the available size, $N = 1203$, would provide statistical power $(1 - \beta)$ of about 96% to detect even a small population effect (Cohen's $f^2 = .02$) as statistically significant ($\alpha = .01$). In evaluating the significance of a single regression coefficient, the analysis estimated that the sample would provide statistical power $(1 - \beta)$ of over 99% to detect even a small population effect (Cohen's $f^2 = .02$) effect as statistically significant ($\alpha = .01$).

The participants in this study were of 591 males and 612 females, who were placed in three age groups: Ages 18–22 ($n = 794$), Ages 23–72 ($n = 331$), and Age 28 and older ($n = 123$). The majority of participants (69%) had 0–3 years of eLearning experiences and 31% reportedly with more than three years of experience in eLearning. Over 90% of participants were enrolled on-campus, and less than 10% of them were distance education students. Responses were from a wide range of social media and technology, specifically, via Twitter (68%), WhatsApp (22%), Facebook (6%), and Email (4%). Fifteen participants (8 male and 7 female) volunteered to participate in the interview.

5 Results

As shown in Table 1, all moderators (gender, age, eLearning experience) have insignificant influence on the interactions between Learning Expectancy (LE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Mobile Learning Technology Characteristics (MLTC), Self-Management of Mobile Learning (SMML)

Table 1 Regression coefficients for BI & UB on LE, EE, SI, FC, MLTC, and SML

Construct	Moderator	B	SE	β	t	Sig.	H Testing Results
Mobile Learning Technology Characteristics (MLTC)	Without moderator	.799	.128	.471	6.259	.000**	H1 Not Supported
	MLTC x eLearning experience	.075	.095	.208	.785	.433	
Self-Management of Mobile Learning (SMML)	Without moderator	.154	.086	.153	1.787	.074	H2 Not Supported
	SML x eLearning experience	.084	.065	.229	1.290	.197	
Learning Expectancy (LE)	Without moderator	.765	.044	.577	17.358	.000**	H3 Not Supported
	LE x Gender	.022	.063	.059	.345	.730	
	Without moderator	.730	.079	.547	9.266	.000**	
	LE x Age	.035	.051	.137	.683	.494	
	Without moderator	.661	.096	.497	6.915	.000**	
	LE x eLearning experience	.081	.071	.224	1.134	.257	
Effort Expectancy (EE)	Without moderator	.680	.056	.443	12.144	.000**	H4 Not Supported
	EE x Gender	.048	.080	.134	.603	.546	
	Without moderator	.650	.098	.419	6.608	.000**	
	EE x Age	.041	.063	.160	.650	.516	
	Without moderator	.597	.124	.382	4.824	.000**	
	EE x eLearning experience	.071	.092	.199	.773	.440	
Social Influence (SI)	Without moderator	.270	.033	.310	8.313	.000**	H5 Not Supported
	SI x Gender	.135	.047	.316	2.897	.004*	
	Without moderator	.336	.058	.386	5.840	.000**	
	SI x Age	−.005	.037	−.019	−.139	.889	
	Without moderator	.410	.070	.470	5.829	.000**	
	SI x eLearning experience	−.065	.050	−.174	−1.290	.197	
Facilitating Conditions (FC)	Without moderator	.164	.080	.143	2.037	.042	H6 Not Supported
	FC x Age	−.120	.049	−.255	−2.448	.015	
	Without moderator	.168	.099	.146	1.693	.091	
	FC x eLearning experience	−.138	.071	−.221	−1.937	.053	

*Significant at $p < 0.005$

**Significant at $p < 0.001$

Behavioral Intention (BI) and Use Behavior (UB) of mobile learning technology. Exceptionally, gender significantly moderates interaction between Social Influence (SI) and Behavioral Intention (BI); however, the relationship between SI and BI was stronger for men ($r = .450$) than for women ($r = .321$).

In an ordinal fashion, Learning Expectancy (LE), Effort Expectancy (EE), Social Influence (SI), and Mobile Learning Technology Characteristics (MLTC) were found to contribute significantly in higher levels of Behavioral Intention (BI) regardless students' gender, age, and eLearning experience. In contrast, Facilitating Condition (FC) and Self-Management of Mobile Learning (SMML) were found to insignificantly influence students' Behavioral Intention (BI) or Use Behavior (UB) regardless their gender, age, and eLearning experience. Another element of the study model is the direct predictor of Use Behavior (UB) and Behavioral Intention (BI) being statistically significant and positive, $r(1.181) = .175$, $p < .001$. Moreover, distance education students also expressed higher level of Behavioral Intention (BI) ($M = 4.40, SD = 0.72$) than on-campus students ($M = 4.19, SD = 0.85$); but had no statistical significant differences between the two groups in Use Behavior (UB), ($U = 57,461.00$, $p = .249$ (two-tailed) where distance education students scored ($M = 3.19, SD = 1.61$) and on-campus students scored ($M = 3.01, SD = 1.42$).

Qualitatively, using a deductive approach, twenty themes were derived and placed in the model six constructs/categories. Students expressed high influence of Effort Expectancy (EE) and Mobile Learning Technology Characteristics (MLTC) on their Behavioral Intention to use mobile learning technology. In Effort Expectancy (EE), ease of use and learnability of mobile learning technology were reported due to its frequent use in daily lives. While in Mobile Learning Technology Characteristic (MLTC), timely access of information along with mobilized learning settings were the highest factors in driving students' behavioral intentions to use mobile learning technology. However, students had difficulties when using mobile learning technology in their learning with real-life issues and in integrating multiple resources to serve one learning objective.

In Learning Expectancy (LE), academic usefulness and expeditious accomplishment were the leading factors toward students' uses of mobile learning technology where students save time and accomplish more in their studies. In Social Influence (SI), most of students' encouragements to use mobile learning technology came from their schools, professors, and peers while most of the actual support they received came from themselves or their families. In terms of Facilitating Conditions (FC), participants reported low concerns regarding privacy and information security. Finally, and overall, it could be clearly deduced students found mobile learning technology helpful in achieving their learning goals; however, considerable responses indicated difficulties in time management and lack of organizing functions associated with mobile learning technology.

6 Discussion

The aim of this study is to explore the acceptance of mobile learning technology in higher education students of Saudi Arabia through an extended framework and a sequential mixed method research. Drawing upon the proposed extension of Unified

Theory of Acceptance and Use of Technology (UTAUT), Learning Expectancy, Effort Expectancy, Social Influence, and mobile learning technology Characteristics were significant predictors of students' acceptance of mobile learning technology. However, gender, age, and eLearning experience do not moderate the influence of any antecedent constructs on students' behavioral intentions or use behavior of mobile learning technology. This finding might be attributed to the limited variability in measuring age and eLearning experience in this study. As consistent with Al-Hujran et al. (2014); Donaldson (2011); Nassuora (2012); Wang et al. (2009), students perceived the academic usefulness, expeditious accomplishment, ease of use and learnability of mobile learning technology, disregarding students' gender, age, and eLearning experience. Most of students' social influence come from their school environments; however, most of the actual support that students receive were private either from themselves or their families and such a perception had no relationship with students' gender, age, or eLearning experience (Wang et al. 2009). That suggests Saudi universities' officials should create more supportive environments to use mobile learning technology and those officials could serve as early adopters who lead the late majority of mobile learning technology users (Rogers 2003). Saudi universities officials governance body are also urged about the importance of evaluating the use and interaction with educational tools, applications or systems is essential to provide better quality of education and to form and reform appropriate policies. Different evaluation tools are used to evaluate the interaction with mobile learning (Al Masarweh 2018).

Facilitating conditions (e.g. privacy and information security) did not predict students' acceptance of mobile learning technology and that has been reflected in the interviews where students expressed misconceptions regarding security and privacy issues. Thus, the awareness toward these two factors should be established immediately to protect both students and university available resources. Mobile-based social media applications have overwhelmingly changed the information-sharing perspective. However, with the advent of such applications at an unprecedented scale, the privacy of the information is compromised to a larger extent if breach mitigation is not adequate (Al-Muhtadi et al. 2017).

Specific characteristics of mobile learning technology succeeded in predicting Saudi students' acceptance of mobile learning technology. The highly reported characteristics are (a) timely access of information, (b) mobilized learning settings, (c) interactive communication, and (d) multiplicity of learning resources. Therefore, faculty should take the advantage of such a perception through offering multiple learning resources, more interactive communication, and on-the-go learning strategies. The introduction of this new construct in UTAUT informs the literature about very important predicting factor advance the acceptance of mobile learning technology within any organization; therefore, it is concluded that each technology has its peerless features that increase its acceptance potentials. As suggested by Donaldson (2011), Students' self-management of mobile learning does not predict their acceptance of mobile learning technology where considerable number of students found this technology encouraging their laziness through omitting other physical learning resources such as textbooks and library resources. Other students found much distractions when studying through mobile learning technology. This finding is interpretable considering wording issues such as self-disciplined where younger university students found it incomprehensible either in Arabic or English (Donaldson 2011).

Moreover, high behavioral intention toward using mobile learning technology that expressed by Saudi distance education is resulted from their high expectations in facilitating content access and communication. Alenezi (2017) in his research, found out students also revealed that Mobile learning apps always keep them notified about any direction of their lecturer. The ability to check E-mails via mobile devices keeps students informed of all circumstances regarding any changes in deadlines of submitting assignments, modification in course syllabus, attending class meetings and lectures, and information on the schedule for any incoming extra lectures whether they are moved elsewhere for some reason; similarly, they are in close contact with the faculty to receive their abrupt replies to streamline the things of priorities. Students reflections on the independence of accessing the study materials were emphasized.

However, insufficient infrastructure and support resulted equal use behaviors of mobile learning technology by both distance education students and on-campus students. Saudi universities should move forward in supporting mobile learning technology uses through establishing policies and systems that accommodate mobile learning technology requirements. Future efforts may focus on more alignment of already proposed constructs with the original UTAUT rather than keeping proposing new ones. Finally, with a rapid development of technology, also comes a rapid acceptance change, so it is important to consider longitudinal studies to ensure the appropriateness of used technology.

This study created an extension of the Unified Theory of Acceptance and Use of Technology (UTAUT) to study educational settings especially with mobile learning technology. The six proposed constructs (learning expectancy, effort expectancy, social influence, facilitating conditions, mobile learning characteristics, and self-management of mobile learning) explained 58.61% of variance in students' behavioral intention and use behavior of mobile learning technology. This study has partially succeeded in extending UTAUT to include one new significant construct which is Mobile Learning Technology Characteristics (MLTC). Also, it succeeded to signify the rephrased and rewritten learning expectancy construct. On the contrary, another proposed construct, Self-Management of Mobile Learning (SMML), needs further investigation in future research to justify its evolvement in Unified Theory of Acceptance and Use of Technology and confirm its significance to predict behavioral intentions toward mobile learning technology. However, the results of this study are limited to participants who were recruited through various school's official social media websites and accounts. More challenging populations (i.e. students with no social media accounts as well as have no links to any of the school's official social media websites and accounts) were not represented in this study. Investigating thoughts of such an unreached population may result into different findings, and it is to be noted that most of the population study for this study was derived from social media based on a factor of being able to reach out to the lot when it comes to the youth in Saudi Arabia. There was also the hindrance of culture and Islamic traditions of communicating with the opposite sex as well as lengthy protocol procedures to conduct a one-on-one interview of students in most of the schools, hence the heavy use of Social Media as a form to reach out and collect sample data.

Results of this study provide great insights and guidelines for policymakers and decision-makers in Saudi higher educational systems especially concerning mobile learning technology initiatives. University administrators and faculty members may

use these findings as well to facilitate mobile learning and meet their students' expectations. Finally, instructional designers should move forward and consider mobile-based interventions since most students showed high intentions of using mobile learning technology. Further research is proposed for government officials and school administrators to also find a common ground on providing more technological facilities for students to embrace the use of mobile learning as well introducing subjects that will help students practice and engage more in it.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

Abdulrahman, R. A., & Benkhelifa, E. (2017, October). A systematic literature review on mobile learning in Saudi Arabia. In *Computer Systems and Applications (AICCSA), 2017 IEEE/ACS 14th International Conference on* (pp. 1354–1361). IEEE.

Aifan, H. A. (2015). *Saudi students' attitudes toward using social media to support learning*. Kansas, USA: (Unpublished doctoral dissertation), University of Kansas, Lawrence Retrieved from http://hdl.handle.net/1808/19498.

Aissani, R., & Dheyab, A. (2018). Motives for the use of twitter by Arab youth. *Communication Today, 9*(1), 114–139.

Al Masarweh, Mohammed. (2018). Evaluating M-learning in Saudi Arabia universities using concerns-based adoption model level of use framework. *(IJACSA) International Journal of Advanced Computer Science and Applications*. Vol. 9*, No. 6, 2018*.

Alenezi, A. R. (2017). An exploratory studyon students mobile technology usage as learing tool at Aljouf University in Saudi. *International Interdisciplinary Journal of Education, 6*(5), 301–108.

Alfarani, L. A. (2014). Influences on the adoption of mobile learning in Saudi women teachers in higher education. In *2014 International Conference on Interactive Mobile Communication Technologies and Learning (IMCL) (pp. 30–34)*. Thessaloniki, Greece: IEEE.

Al-Hujran, O., Al-Lozi, E., & Al-Debei, M. (2014). "Get ready to mobile learning": Examining factors affecting college students' behavioral intentions to use m-learning in Saudi Arabia. *International Journal of Business Administration, 10*(1), 16.

Al-Muhtadi, J., Shahzad, B., Saleem, K., Jameel, W., & Orgun, M. A. (2017). Cybersecurity and privacy issues for socially integrated mobile healthcare applications operating in a multi-cloud environment. *Health Informatics Journal.* https://doi.org/10.1177/1460458217706184.

Arabian Business. (2018). Saudi Kids Given First Mobile Phone Aged Just 7. Retrieved from https://www.arabianbusiness.com/technology/407635-saudi-kids-given-first-mobile-phone-aged-just-7.

Arpaci, I. (2015). A comparative study of the effects of cultural differences on the adoption of mobile learning. *British Journal of Educational Technology, 46*(4), 699–712.

Askool, S. S. (2013). The use of social media in Arab countries: A case of Saudi Arabia. In J. Cordeiro & K.-H. Krempels (Eds.), *Web information systems and technologies* (pp. 201–219). Berlin, Heidelberg: Springer.

Attuquayefio, S. N., & Addo, H. (2014). Using the UTAUT model to analyze students' ICT adoption. *International Journal of Education & Development using Information & Communication Technology, 10*(3), 75–86.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, California: SAGE Publications.

Davis, F. D., & Venkatesh, V. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*, 186–204. Retrieved from. https://doi.org/10.1287/mnsc.46.2.186.11926.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982–1003.

de Sena Abrahão, R., Moriguchi, S. N., & Andrade, D. F. (2016). Intention of adoption of mobile payment: An analysis in the light of the unified theory of acceptance and use of technology (UTAUT). *RAI Revista de Administração e Inovação, 13*(3), 221–230.

Dimitrios, X., & Alali, A. S. (2014). Investigating the attitude of the average Saudi towards the social media. In A. Zaharim, K. Sopian, K. Psarris, & M. Margenstern (Eds.), *The 13th international conference on applied computer and applied computational science*. Kuala Lumpur, Malaysia: WSEAS Press.

Donaldson, R. L. (2011). Student acceptance of mobile learning (Doctoral dissertation) Retrieved from http://purl.flvc.org/fsu/fd/FSU_migr_etd-0716. Accessed 1 December 2018.

Dwivedi, Yogesh K., Rana, Nripendra P., Jeyaraj, Anand, Clement, Marc ,Williams, Michael D. (2017). Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model SN -1572-9419 Retrieved from - https://doi.org/10.1007/s10796-017-9774-y

El-Gayar, O., Moran, M., Hawkes, M. (2011). Students' Acceptance of Tablet PCs and Implications for Educational Institutions. *Journal of Educational Technology & Society, 14*(2), 58–70.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191.

Fenton, William. (2018) The best (LMS) Learing Management Systems for 2018. Retrieved from https://www.pcmag.com/article2/0,2817,2488347,00.asp. Accessed 1 January 2019.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly, 19*(2), 213–236.

Hamzat, S., & Mabawonku, I. (2018). Influence of performance expectancy and facilitating conditions on use of digital library by engineering lecturers in universities in south-west, Nigeria. *Library Philosophy and Practice, (e-journal)*. Retrieved from https://digitalcommons.unl.edu/libphilprac/1620. Accessed 1 August 2018.

Hsu, H.-H. (2012). The acceptance of Moodle: An empirical study based on UTAUT. *Creative Education, 3*, 44–46. https://doi.org/10.4236/ce.2012.38B010.

Imtiaz, M. A., & Maarop, N. (2014). A review of technology acceptance studies in the field of education. Jurnal teknologi. A, Pembuatan, bahan termaju, tenaga dan pengangkutan, 69(2), 6.

Iqbal, S., & Qureshi, I. A. (2012). M-learning adoption: A perspective from a developing country. *The International Review of Research in Open and Distributed Learning, 13*(3), 147–164.

King Abdulaziz University. (2014). *Measuring the Readiness of Faculty Members and Female Students at King Abdulaziz University for Blended Learning and Mobile Learning. In Vol. 2016*. Jeddah, Saudi Arabia: King Abdulaziz Univesity.

Kline, P. (2000). *The handbook of psychological testing*. London: Routledge.

Kutbi, A. (2015). *How Undergraduate Female Students in the Kingdom of Saudi Arabia Perceive Social Media as a Learning Tool: An Exploratory Study. (Unpublished M.Ed. thesis)*. Windsor, Ontario, Canada: University of Windsor Retrieved from https://scholar.uwindsor.ca/etd/5290. Accessed 3 February 2019.

Liew, B. T., Kang, M., Yoo, E., & You, J. (2013). Investigating the determinants of mobile learning acceptance in Korea. In J. Herrington, A. Couros, & V. Irvine (Eds.), *EdMedia: World Conference on Educational Media and Technology 2013 (pp. 1424–1430)*. Victoria, Canada: Association for the Advancement of Computing in Education (AACE).

Lorenz, Graf-Vlachy and Buhtz, Katharina, (2017). "Social influence in technology adoption research: A literature review and research AGENDA". In *Proceedings of the 25th European Conference on Information Systems (ECIS)*, Guimarães, Portugal, June 5-10, 2017 (pp. 2331–2351).

Ma, Will. (2019). Implementation Strategies and the Technology Acceptance Model: Is "Ease of Use" Really Useful or Easy to Use in Implementation?. Retrieved from https://www.researchgate.net/publication/228454664_Implementation_Strategies_and_the_Technology_Acceptance_Model_Is_Ease_of_Use_Really_Useful_or_Easy_to_Use_in_Implementation.

Ministry Deputyship for Planning and Information. (2016). *A statistical summary for students by regions for the academic year 2014–2015*. Riyadh: Ministry of Education.

Mirabeau, L., Mignerat, M., & Grange, C. (2013). The Utility of using social media networks for data collection in survey research. In R. Baskerville & M. Chau (Eds.), *Thirty Fourth International Conference on Information Systems* (pp. 1–9) Retrieved from http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1313&context=icis2013.

Narayanasamy, F. S., & Mohamed, J. B. K. (2013). Adaptation of mobile learning in higher educational institutions of Saudi Arabia. *Age, 18*(10), 34–38 Retrieved from https://pdfs.semanticscholar.org/b80a/4ab96745439aa15e246913415f0cfba3fe62.pdf.

Nassuora, A. B. (2012). Students acceptance of mobile learning for higher education in Saudi Arabia. *American Academic & Scholarly Research Journal, 4*(2), 24–30.

Neufeld, D. J., Dong, L., & Higgins, C. (2007). Charismatic leadership and user acceptance of information technology. *European Journal of Information Systems, 16*(4), 494–510.

Nistor, N., Göğüş, A., & Lerche, T. (2013). Educational technology acceptance across national and professional cultures: A European study. *Educational Technology Research & Development, 61*(4), 733–749.

Oliveira, T., Faria, M., Thomas, M. A., & Popovič, A. (2014). Extending the understanding of mobile banking adoption: When UTAUT meets TTF and ITM. *International Journal of Information Management, 34*(5), 689–703.

Oye, N. D., A.Iahad, N., & Ab.Rahim, N. (2014). The history of UTAUT model and its impact on ICT acceptance and usage by academicians. *Education and Information Technologies, 19*(1), 251–270.

Pedro, L. F. M. G., de Oliveira Barbosa, C. M. M., & das Neves Santos, C. M. (2018). A critical review of mobile learning integration in formal educational contexts. *International Journal of Educational Technology in Higher Education, 15*(1), 10.

Platzer, E., & Petrovic, O. (2010). Development of technology acceptance research for mobile services. In *In 2010 Proceedings of the 33rd International Convention MIPRO (pp. 1154–1159)*. MIPRO Croatian Society: Opatija, Croatia.

Raman, A., Don, Y., Khalid, R., Hussin, F., Omar, M. S., & Ghani, M. (2014a). Technology acceptance on smart board among teachers in Terengganu using UTAUT model. *Asian Social Science, 10*(11), 84–91.

Raman, A., Don, Y., Khalid, R., & Rizuan, M. (2014b). Usage of learning management system (Moodle) among postgraduate students: UTAUT model. *Asian Social Science, 10*(14), 186–192.

Rao, S., & Troshani, I. (2007). A conceptual framework and propositions for the acceptance of mobile services. *Journal of Theoretical and Applied Electronic Commerce Research, 2*(2), 61–73.

Rogers, E. M. (2003). *Diffusion of innovations*. New York: Free Press.

Salman, M. B. (2016). Saudi Vision 2030. Retrieved from http://vision2030.gov.sa/en.

Seliaman, M. E., & Al-Turki, M. S. (2012). Mobile learning adoption in Saudi Arabia. *World Academy of Science. Engineering and Technology, 69*, 391–293.

Shorfuzzaman, M., & Alhussein, M. (2016). Modeling learners' readiness to adopt mobile learning: A perspective from a GCC higher education institution. *Mobile Information Systems, 2016*. Retrieved from, 1–10. https://doi.org/10.1155/2016/6982824.

Smith, P. J., Murphy, K. L., & Mahoney, S. E. (2003). Towards identifying factors underlying readiness for online learning: An exploratory study. *Distance Education, 24*(1), 57–67.

Stakkestad, S. V., & Fladvad Størdal, G. (2017). The Effects of technology on students' academic performance rollout of individual laptops in norwegian upper secondary schools(Master's thesis). Retrieved from https://brage.bibsys.no/xmlui/bitstream/handle/11250/2487301/master2017.PDF?sequence=1

Statista.com. (n.d.). In *Penetration of leading Social Networks in Saudi Arabia as of 3rd quarter 2017*. Retrieved January 6, 2019, from https://www.statista.com/statistics/284451/saudi-arabia-social-network-penetration/.

Taif University. (2016). *Mobile learning Systems in Taif University*. Taif, Saudi Arabia: Taif University.

The Social Clinic. (2015). *The State of Social Media in Saudi Arabia Vol.3*. Jeddah, Saudi Arabia: The Social Clinic.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research Agenda on interventions. *Decision Sciences, 39*(2), 273–315.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478.

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157–178.

Vrana, R. (2018). Acceptance of mobile technologies and m-learning in higher education learning: an explorative study at the Faculty of Humanities and Social Science at the University of Zagreb. In 41. Međunarodni skup za informacijsku i komunikacijsku tehnologiju, elektroniku i mikroelektroniku. Retrieved from https://bib.irb.hr/datoteka/939831.Acceptance_of_mobile_technologies_and_m-learning_in_higher_education_learning.pdf. Accessed 2 January 2019.

Wang, Y.-S., Wu, M.-C., & Wang, H.-Y. (2009). Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British Journal of Educational Technology, 40*(1), 92–118.

Wen-Hong, C., Huan-Neng, C., Chen, J. K. C., Hui-Ru, C., & Chu, F. L. S. (2010). Exploring acceptance of technology-based service innovations: A perspective of social learning theory. In *7th International Conference on Service Systems and Service Management 2010* (pp. 1–6). https://doi.org/10.1109/icsssm.2010.5530136.

Wong, K.-t., Teo, T., & Russo, S. (2013). Interactive whiteboard acceptance: Applicability of the UTAUT model to student teachers. *The Asia-Pacific Education Researcher, 22*(1), 1–10.

Zhao, Y., & Zhu, Q. (2010). Influence factors of technology acceptance model in mobile learning. In R. K. Belew & L. B. Booker (Eds.), *Proceedings of the fourth international conference on genetic and evolutionary computing* (pp. 542–545). San Francisco, CA: Morgan Kaufmann Publishers.

Affiliations

Talal Alasmari [1] · Ke Zhang [2]

Ke Zhang
bb2145@wayne.edu

[1] Instructional Technology Department, College of Education, University of Jeddah, P.O. box 15758, Jeddah 21454, Saudi Arabia

[2] Learning Design and Technology Department, College of Education, Wayne State University, 385 Education, 5425 Gullen Mall, Detroit, MI 48202, USA