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Factors Impacting Teachers' Adoption of Mobile Learning

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Abstract

As mobile technology has advanced, awareness is growing that these technologies may benefit teaching and learning. However, despite this interest, the factors that will determine the acceptance of mobile technology by lecturers have been limited. This study proposed and tested a new model that extends the technology acceptance model (TAM) with three new variables: digital literacy, ICT anxiety, and ICT teaching self-efficacy.

The TAM models the adoption of new technology based on measuring a users' beliefs and attitudes to the technology. In particular, the TAM states that two factors influence a user's use and perception of new technology. The first factor, perceived usefulness, is the degree to which a person believes that a particular technology will be beneficial to their lives. The second factor, perceived ease of use, is the measure of the degree an individual believes a particular technology is free from effort.

Research has shown that a large portion of lecturers still resists the integration of technology into the classroom. Two aspects, in particular, have been consistently found to impact lecturers' adoption of technology. The first aspect shown to influence the adoption of new technology is the beliefs held by the lecturers. Specifically, it is the perceived value of the new technology (perceived usefulness) and perceived effort needed to learn to use the new technology (perceived ease of use) that have been established as playing a major role in the adoption of technology. The second major aspect seen to influence adoption is the skill of lecturers to use digital technology (referred to as digital literacy) and the skill needed to integrate it into their teaching (teaching self-efficacy).

The new model that was proposed and tested measured the impact of digital literacy, ICT anxiety, and ICT teaching self-efficacy, along with the well established factors of perceived usefulness and perceived ease of use, on lecturer' acceptance of mobile learning. A survey was used to measure the major variables in this study. The research found that

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perceived usefulness, ease of use, digital literacy, anxiety, and teaching self-efficacy were critical factors in lecturers' behavioral intentions to use mobile learning. The results of this study indicated the importance of these factors in the acceptance of mobile learning. From this model, educationalists are able to identify and develop strategies to support the successful introduction of mobile technology with in educational setting.

This research has added to and clarified the existing literature into mobile learning. In particular, it recognizes the role that lecturers play in the future acceptance of mobile learning. It shows that the factors that influence lecturers' adoption of mobile learning may differ from those of their students. It therefore highlights that these factors need to be considered when implementing mobile technology into the teaching environment.

Keywords: Teacher technology adoption, mobile learning, technology use in education, technology acceptance.

Introduction

As technology has become more powerful and pervasive it has provided educators with a valuable tool to support learning. Mobile technology, which has advanced considerably over the last decade, has enabled learning to be more accessible. This accessibility has provided educators with a way to support learning inside and outside the classroom. Mobile technology integrates a wide set of tools and applications that enable learning to be dynamic so that students are no longer tied to their desks to experience and interact with learning objects.

The integration of mobile technology into teaching and learning is expected to have great influence on the experience and performance of learners (Mac Callum, & Jeffrey, 2013). However it will be the acceptance by lecturers that has the potential to have the greatest influence on the successful introduction of mobile learning (Mac Callum, 2010). Students are able to utilize mobile technology to support informal learning; however without the support and acceptance of educators, it is unlikely to be fully integrated into more formal learning. Substantial research has addressed the factors that influence educators' integration of a range of technologies into the classroom, including; environment, policies, support, and beliefs (Albion, 2001; Hammond, Reynolds, & Ingram, 2011; Sang, Valcke, Braak, & Tondeur, 2010). Factors that impact lecturers' adoption of mobile learning, however, has only been addressed in a few studies (Aubusson, Schuck & Burden, 2009; Lefoe, Olney, Wright, & Herrington, 2009; Seppala & Alamaki, 2003). Empirical quantitative research of lecturers' adoption of mobile learning has largely been overlooked, as researchers in the past have tended to focus on student adoption (Uzunboylu & Ozdamli, 2011).

Users' beliefs and attitudes have been shown to have a major influence on the acceptance of new technology (Venkatesh, Morris, Davis, & Davis, 2003). A number of models and frameworks have been developed to measure these influences on users' acceptance and model adoption. One of the most widely adopted adoption models is the technology acceptance model (TAM) (Venkatesh, et al., 2003). The TAM has been used and modified to explore the adoption a range of educational technologies. Since mobile technology offers different affordances to traditional and elearning environments, factors that influence other educational technologies may not necessarily apply. It is important, therefore to establish the pattern of influences on the adoption of mobile technology.

This research extents the TAM by adding three new variables – digital literacy, information and communications technology (ICT) anxiety, and ICT teaching self-efficacy – to determine a more complete picture of lecturers' behavioral intention to use mobile learning. According to the TAM, the intention to use new technology is determined by two factors, the perceived usefulness and perceived ease of use. These two factors have been shown to explain approximately 50% of the variance in acceptance levels (Davis, Bagozzi, & Warshaw, 1992). Other research has extended

and modified the TAM to increase this level within the educational setting (see for example Liu, Chen, Sun, Wible, & Kuo, 2010). This research proposes three additional variables to fully reflect the factors that will play a part in influences lecturers' acceptance of mobile learning.

In particular the following research questions will be addressed:

- What effect does the perceived ease of use and usefulness have on the behaviour intention of lecturers to adopt mobile learning
- How will the three new variables of digital literacy, ICT anxiety, and ICT teaching self-efficacy influence the perceptions and behaviour intention of lecturers to adopt mobile learning

The Teacher Mobile Learning Adoption Model

Research has shown that a large portion of lecturers still resists the integration of technology into the classroom (Balash, Yong, & bin Abu, 2011). Two aspects, in particular, have been consistently found to impact lecturers' adoption of technology. The first aspect shown to influence the adoption of new technology is the beliefs held by the lecturers (Kebritchi, 2010). Specifically, it is the perceived value of the new technology (perceived usefulness) and perceived effort needed to learn to use the new technology (perceived ease of use) that have been established as playing a major role in the adoption of technology (Wang, Wu, & Wang, 2009). The second major aspect seen to influence adoption is the skill of lecturers to use digital technology (referred to as digital literacy) and the skill needed to integrate it into their teaching (teaching self-efficacy) (Pianfettil, 2001).

Digital literacy is the measure of an individual's ability to use digital technology, communication tools, and/or networks to access, manage and integrate digital resources (Markauskaite, 2007). Therefore, the measure of an individual's literacy in technology focuses on their relative skill to use a range of technologies (Madigan, Goodfellow, & Stone, 2007). For lecturers it is becoming increasingly more important to be digitally literate (Zhang, Tousignant, & Xu, 2012). Pianfetti (2001) stressed that lecturers need to be digitally literate. Through their own literacy they are able to inculcate in their students the skills and knowledge needed in a technology dominated world. Technology has become fully integrated into the workplaces, consequently education needs to reflect and support learners to survive in an increasingly connected world. To do this, lecturers must be confident and able to utilize the wide range of technologies in their classrooms.

Perceived digital literacy has been consistently reported in the literature as having a positive relationship with the adoption of new technology (Hasan, 2003; Hasan & Ahmed, 2010; Potosky, 2002). However, there has been little research into how digital literacy will influence the perceptions and acceptance of mobile learning (Wang, Wu, & Wang, 2009).

Along with digital literacy, the lectures' attitude to technology will also play a deciding role on their acceptance of technology. For example, anxiety about using technology has been identified as an important factor in the resistance to new technology (Buabeng-Andoh, 2012). For some people, the thought of having to use information communication technology (ICT) has been found to generate high levels of anxiety (Barbeite & Weiss, 2004). ICT anxiety is a negative emotional response typically ensuing from a fear that the use of the technology may have a negative outcome. The negative outcome may be anything from the fear that the user may damage the equipment to looking foolish in front of their peers. Anxiety about using ICT has been shown to have a strong negative impact on the future use of ICT (Agarwal, Sambamurthy, & Stair, 2000; Beckers, Wicherts, & Schmidt, 2007; Imhof, Vollmeyer, & Beierlein, 2007; Parayitam, Desai, Desai, & Eason, 2010; Saadé & Kira, 2007; Smith & Caputi, 2007).

A number of studies have shown that anxiety about using computers negatively influences a lecturers' adoption of ICT. Phelps and Ellis (2002) argued that there is a large disparity between lecturers' perception of their technological competence and the amount of learning they need to utilize ICT effectively. In particular, they often see technology as threatening and overwhelming. Feelings of anxiety may be further exacerbated if lecturers' perceive the skills of their students as being better than their own when using technology. This feeling of inadequacy can result in lecturers feeling insecure and disinclined to use ICT. This is especially true if there is a fear of looking foolish or incompetent in front of their students (Nunan & Wong, 2005). Such feelings can be a major barrier to lecturers using new technology. Furthermore, this negative attitude can also cause lecturers to doubt the usefulness of ICT in teaching. This will further reinforce their reluctance to use technology it in their teaching (Hennessy, Ruthven, & Brindley, 2005).

Overall, the anxiety of lecturers will influence the extent and the way technology is used in teaching. Teo, Lee, and Chai (2008) argue that anxiety is an important factor that needs to be addressed and managed by the teaching institution. This is important, since technology has the potential to transform the learning in and outside the classroom.

ICT anxiety and its specific effect on adoption of mobile learning has not been extensively researched (Wang, 2007). While, it is agreed that anxiety will play a role in the adoption of users of mobile technology, its role has yet to be tested empirically (Chu, Hwang, Huang, & Wu, 2008).

In addition to lecturer's digital literacy and anxiety impacting on adoption of new technology, the lecturers' perception of their ability to use it within the classroom will also play a role on the adoption of technology for teaching (Albion, 2001, Mac Callum, 2010). Teaching self-efficacy is the belief an educator has about his/her ability to perform a variety of teaching tasks (Dellinger, Bobbett, Olivier, & Ellett, 2008). Previous research has shown that teaching self-efficacy regarding the use of technology in the classroom has a strong influence on the integration of ICT into their teaching practice (Hasan, 2003; Potosky, 2002; Sang et al., 2010). Therefore, teachers' self-efficacy to effectively use ICT in their teaching will be an important factor in the adoption of new technology for teaching. A teacher with a strong teaching self-efficacy for using ICT is more likely to be experienced with technology and less anxious about using it in the classroom (Sang et al., 2010).

Teaching self-efficacy for using ICT in teaching has an impact on the level of anxiety teachers feel when using ICT in the classroom. Teachers' self-efficacy also influences their level of enjoyment and feeling of control when using technology in the classroom (Hammond et al., 2011; Sang et al., 2010). Other factors have also been shown to specifically influence teaching self-efficacy; these include the specific beliefs of an educator about whether they are able to use ICT as an instructional tool (Hammond et al., 2011; Mueller, Wood, Willoughby, Ross, & Specht, 2008) their teaching philosophy (Albion, 2001; Vannatta & Fordham, 2004), their past positive experiences with computers (Albion, 2001; Mueller et al., 2008; Sang et al., 2010), their past training or workshops attended relating to ICT use in teaching (Vannatta & Banister, 2009; Vannatta & Fordham, 2004) and the level of assistance needed from others (Mueller et al., 2008).

While there has been an extensive body of literature on teaching self-efficacy and use of ICT in the classroom, no reference could be found to its impact on adoption within the context of mobile learning. However, it is likely that ICT-teaching self-efficacy will play as significant a role in mobile learning adoption as it does in general technology adoption.

Due to the limited empirical research into lecturers' adoption of mobile learning, this paper proposes and tests a new model of adoption. This model measures the impact of digital literacy, ICT anxiety, and ICT teaching self-efficacy, in addition to the well established factors of perceived usefulness and perceived ease of use, on lecturer' acceptance of mobile learning.

Methodology

The research model of this research is shown in Figure 1. The TAM has been extended to include digital literacy, ICT anxiety, and ICT teaching efficacy.

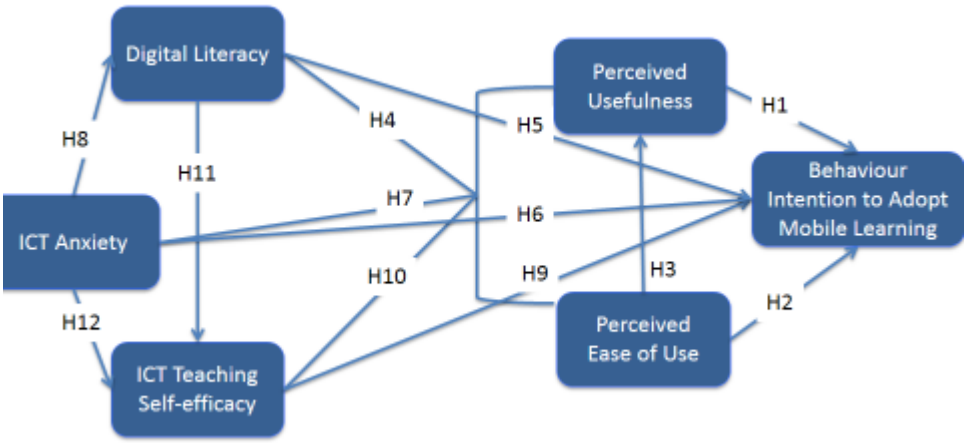

Figure 1: The proposed research model

Perceived Usefulness

Perceived usefulness is the degree to which a person believes that a particular technology will be beneficial to their lives (Chang & Tung, 2008). Research has shown that if a person believes a new technology will be of benefit to them, they will more likely adopt this new technology (Chin & Todd, 1995). Therefore it is hypothesized that:

H1: Perceived usefulness will have a positive effect on the behaviour intention to use mobile learning.

Perceived Ease of Use

Perceived ease of use is the measure of the degree an individual believes a particular technology is free from effort. Previous research has found a positive effect this perception has on the behaviour intention and perceived usefulness of the new technology (Chin & Todd, 1995, Chang & Tung, 2008). Therefore the following are hypothesized:

H2: Perceived ease of use will have a positive effect on the behaviour intention to use mobile learning.

H3: Perceived ease of use will have a positive effect on perceived usefulness.

Digital Literacy

Digital literacy is the measure of an individual's ability to use digital technology, communication tools, and/or networks to access, manage, and integrate digital resources (Markauskaite, 2007). A user's perceived digital literacy has been consistently reported in the literature as having a positive relationship with the adoption of new technology (Hasan, 2003; Hasan & Ahmed, 2010; Potosky, 2002). Therefore, it can be surmised that a lecturer with high digital literacy will be more confident about integrating technology into the classroom and therefore more likely to adopt new technology, such as mobile learning. Therefore the following are hypothesized:

H4: Digital literacy will have positive effect on the behaviour intention to use mobile learning.

H5: Digital literacy will have positive effect on perceived ease of use and usefulness.

ICT Anxiety

ICT anxiety has been defined as "the feeling of discomfort, apprehension and fear of coping with ICT tools or uneasiness in the expectation of negative outcomes from computer-related operations" (Rahimi, Yadollahi, 2011, p. 204). These negative feelings have been shown to have negative effect on lecturers' adoption of new technology and perception of how easy new technology will be to use (Agarwal et al., 2000; Beckers et al., 2007; Imhof et al., 2007; Parayitam et al., 2010; Saadé & Kira, 2007; Smith & Caputi, 2007). Anxiety has also been shown to have a negative influence on lecturers' digital literacy, making them more likely to resist learning new ICT skills (Barbeite & Weiss, 2004; Sun, Tsai, Finger, Chen, & Yeh, 2008; van Raaij & Schepers, 2008). Therefore the following are hypothesized:

H6: ICT anxiety will have a negative effect on the behaviour intention to use mobile learning.

H7: ICT anxiety will have a negative effect on the perceived ease of use of mobile learning.

H8: ICT anxiety will have a negative effect on a lecturers' digital literacy.

ICT Teaching Self-Efficacy

Teaching self-efficacy is the belief of a lecturer that they are able to effectively teach their students. According to Gibbs (2003, p. 3), educators who exhibit high levels of teaching self-efficacy tend to "persist in failure situations, take more risks with the curriculum, use new teaching approaches, make better gains in students' achievement and have more motivated students." When this form of self-efficacy is extended to the context of integrating ICT into teaching, it describes teachers who view technology as an effective way to enable student learning and perceive it as a useful medium to support their learning. Research has shown that a positive attitude to technology and having the skill to use the technology in the classroom are important and measurable factors in the level of integration of technology into their teaching (Zhao & Cziko, 2011). Therefore the following are hypothesized:

H9: ICT teaching self-efficacy will have a positive effect on the behaviour intention to use mobile learning.

H10: ICT teaching self-efficacy will have a positive effect on the perceived ease of use and usefulness.

H11: Digital literacy will have a positive effect on teaching self-efficacy.

H12: ICT anxiety will have a negative effect on a lecturers' teaching self-efficacy.

Research Method

A survey was used to measure the major variables in this study. A multi-stage stratified convenience sampling method was used to survey the lecturers. Two strategies were used to recruit lecturers: staff emails lists and presentations at conferences. These two methods where used to encourage eligible teaching staff to take part. Lecturers were also encouraged to distribute the invitation to participate to other lecturers. Although the sampling method in this research is a form of convenience sampling, the representativeness of the sample was checked against population characteristics and found to be within acceptable limits. However, the sampling approach used has made it difficult to determine the response rate. This therefore indicates an important limitation of this study, which may influence the generalizability of these findings.

A total of 196 responses were received. Of these, 21 surveys were removed because they were incomplete or had significant outliers, giving a total of 175 eligible responses. The number of suitable responses received was not particularly large, but it is close to Hoelter's (1983) recommended 'critical sample size' of 200. While this sample size is considered adequate, caution is still needed when interpreting the results. Of the total responses 61% (n=107) were female. The average age fell within the 40-49 age group ($\bar{x}$=4.38, s =8.21). The vast majority of respondents were of European decent (90%, n=157). The remainder of the respondents were of Polynesian, Asian, or African descent.

Instrument

To ensure the content validity of the scales adopted in this study, the items were derived from existing instruments used to measure the concepts of interest in this study. This approach helped ensure content validity (Chang & Tung, 2008). All items were measured using a 7-point Likert scale where 1 represented "Strongly disagree" and 7" Strongly agree".

The questionnaire included 5 parts. The first part was used to measure the digital literacy of the respondents. Respondents were asked to rate their own skill in carrying out a range of tasks using either a computer or mobile device. These tasks used in this study were taken from Kennedy, Dalgarno, Bennett, Judd, Gray, and Chang (2008). Computer based activities required a range of skills from using word processing software to searching and downloading files from the Internet. Mobile device usage included items relating to activities such as sending and receiving texts and uploading programs onto their phone.

Part 2 of the questionnaire measured the construct of ICT anxiety. This measure was adapted from Wilfong (2006). Examples of statements include, "I feel apprehensive when using a computer" and "I have a lot of confidence when it comes to working with information and communication technology".

Part 3 of the questionnaire measured the respondents ICT self-efficacy for teaching. The items for this construct were derived from Mueller et al. (2008). In their study, they developed a comprehensive summary of teacher characteristics and variables that best discriminated between teachers who integrated computers into their teaching and those that did not. Mueller et al. (2008) did not formally define these characteristics nor coin a label. The scale used in this study assessed the attitudes of educators towards computers and their opinion of computers as an important instructional tool. The statements focused on ICT in general and included the following statements "I see ICT as tools that can complement my teaching," "ICT allows me to bring current information to the class", and "I feel frustrated more often when I use ICT in my classes than when I don't use them."

Part 4 of the questionnaire measured the constructs of the TAM, namely, perceived usefulness, perceived ease of use, and behavioral intention to use. This was adapted from Venkatesh et al. (2003). The items are slightly modified to fit the mobile learning context of this study. The last part collected demographic information and general comments about mobile learning. Questions included "Mobile technology will enable me to access learning content more often" for perceived usefulness and "I think it might take me awhile to get comfortable with using a mobile device for learning" for ease of use. One question was used to capture the future intention to adopt mobile learning, "Overall, I think mobile learning would be beneficial to my learning and I would be willing to adopt it, if I had the opportunity, in the future."

In part 2 and 3 the focus was placed on assessing anxiety and teaching self-efficacy of ICT in general rather than mobile technology specifically. The reason for this was it was considered that mobile anxiety and teaching self-efficacy and ICT anxiety and teaching self-efficacy were not disparate concepts. Furthermore, it could not be assumed that teachers would have used mobile

technology in their teaching, so asking teachers to self-report on this would be limited. Part 1 and 4 focused more specifically on mobile technology. In particular, part 4 did not assume teachers had used mobile technology in their teaching but rather focused on their perceived usefulness and ease of use based on non-teaching experience of mobile technology. This study did not assume that participants had any experience of mobile learning but relied on users' experience with mobile technology. Participants were expected to project their understanding of mobile technology to a situation of using that technology for learning. This approach of developing a mobile learning adoption model based on limited experience is not new and a number of studies have used this same approach (Akour, 2009; Lu & Viehland, 2008; Theng, 2009). In addition, future usage was calculated from a stated intention to adopt. Extensive empirical research has confirmed the causal link between intention to adopt and actual future adoption therefore giving some credence to using behavioral intention as an indicator of actual future adoption (Davis, 1989; Dillon, 2001).

Data Analysis

The research used structural equation modelling (SEM) to test the relationships between the identified factors. The data obtained were tested for reliability and validity using factor analysis. Exploratory factor analysis (EFA) was used to confirm the structure of the data and enable the selection of the strongest indicators of each construct (Pallant, 2007). Four indicators were selected to represent the latent constructs in the structural model (Little, Cunningham, Shahar, & Widaman, 2002). By using only four items to represent each construct the complexity of the structure model was reduced and a reasonable degree of freedom maintained (Schumacker & Lomax, 2010). This also improved parameter estimates and the reliability, validity, and stability of the latent variables (Floyd & Widaman, 1995; Mulaik & Millsap, 2000; Schumacker & Lomax, 2010). When determining which items to select to represent each latent construct, the factor loading was taken into account along with how well the items related to the overall construct of the latent factor (Schumacker & Lomax, 2010). The reliability of the items was also taken into account ($\alpha \geq .7$) (Mulaik & Millsap, 2000; Schumacker & Lomax, 2010). Table 1 shows the result of the factor analysis. Appendix A identifies the items adopted in this study.

Table 1: EFA results for educators

MEASUREMENT CLUSTER	# ITEMS	# FACTORS RETAINED	% VARIANCE EXPLAINED	KMO	BARTLETT'S TEST OF SPHERICITY P<
ICT literacy	16	3	94.8	.901	.000
Anxiety	11	1	57.0	.701	.000
ICT teaching self-efficacy	16	2	56.4	.691	.000
TAM	24	2	57.1	.733	.000

Based on the results of the exploratory factor analysis (EFA) of the 16 digital literacy items measured, three latent constructs for were identified. These 16 tasks were categorized into three key groups, namely tasks associated with basic ICT usage, tasks associated with expert/advanced ICT usage, and tasks associated with advanced mobile usage. In each category four items were retained to represent each construct. The items selected all had loadings greater than 0.7 as consistent with Mulaik and Millsap (2000). Basic ICT literacy assessed the competency of users in relation to basic computing tasks, such as using word processing software, searching and emailing on the Internet, and doing basic mobile activities, such as texting and calling. Advanced

ICT literacy assessed the competency of users in relation to more advanced computing, such as modifying images and sounds and using advanced software (such as Skype). Advanced mobile literacy related to using mobile technology for more complex mobile learning activities, such as accessing the Internet, emailing, and sending photos.

The EFA also indicated two distinct sub-scales for the ICT teaching self-efficacy construct. The first sub-scale related to whether lecturers saw ICT as giving them an advantage in their teaching over traditional methods (r = .85). The second sub-scale related to the ability of lecturers to use ICT in their teaching (referred to as ICT ability) (r = .70).

Correlations between the relationships were assessed to determine the level of multicollinearity. Multicollinearity exists when factors are highly correlated (Gefen, Straub, & Boudreau, 2000). High correlation can pose a risk of Type II errors in statistical modelling (Grewal, Cote, & Baumgartner, 2004). The correlations were determined using a bivariate Pearson product-moment coefficient (r). Based on the results of the correlation it was possible to determine that there were a number of significant relationships between the two important relationships in the study. However, these correlations were not sufficiently high for multicollinearity to be a concern. Table 2 presents the correlation matrix.

The composite reliability (internal consistency reliability) approach was estimated using Cronbach's alpha. Composite reliabilities of constructs ranged between 0.71 and 0.93, exceeding the threshold of 0.7 (Nunnally & Bernstein, 1994).

Table 2: Means, standard deviations, and inter-correlations between latent constructs

ITEM	MEAN	SD	BICTL	AML	AICTL	ANX	SE-ATT	SE-ABL	PU	PEOU
Digital Literacy										
Basic ICT literacy (BICTL)	3.92	1.702								
Advanced mobile literacy (AML)	5.63	1.120	.793**							
Advanced ICT literacy (AICTL)	3.45	2.112	.651**	.627**						
Perceived anxiety (Anx)	3.61	1.505	-.589**	-.545**	-.377**					
ICT Teaching Self-Efficacy										
Attitude (SEAtt)	5.55	.639	.300**	.281**	.179*	-.180*				
Ability (SEabl)	4.47	1.352	.565**	.579**	.444**	-.393**	.334**			
Mobile learning perceptions:										
Perceived usefulness (PU)	5.32	.969	.199**	.206**	.101	-.068	.207**	.086		
Perceived Ease of use (PEOU)	3.51	1.190	.459**	.527**	.283**	-.498**	.426**	.196**	.067	
Behaviour Intention (BI)	5.46	1.159	.157*	.093	.156*	-.001	.006	.012	.168*	.076

Notes: ** $p < 0.001$, *$p < 0.05$ level, highlighted cells refer to non-significant results, $p > .05$. Means for all scales: 1=minimum (low), 7=maximum (high). Educator n = 175

Results

Structural equation modelling was used to analyze the influence that digital literacy, anxiety, and teaching self-efficacy has on perceived ease of use, perceived usefulness, and behaviour intention.

Figure 2 shows all the significant standardized path coefficients for the student model (all paths that were significant were at p<.000 unless indicated with a * where p>.01).

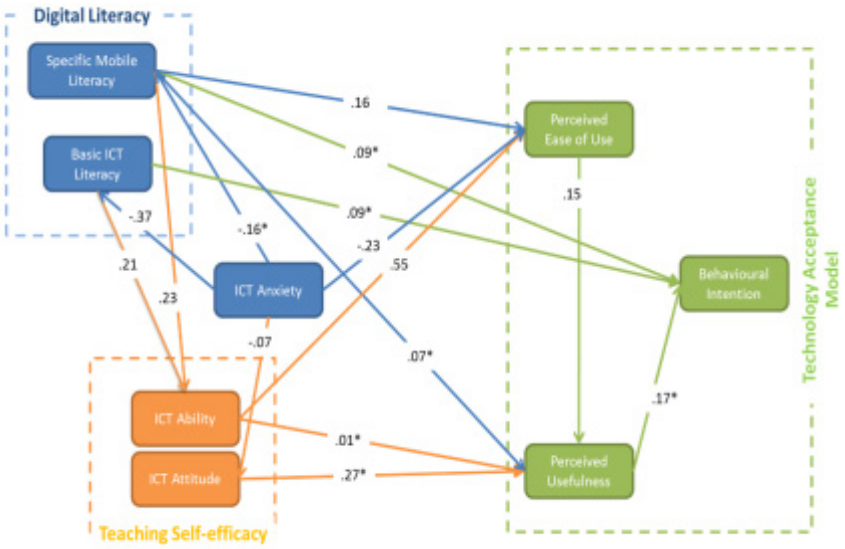

Figure 2: SEM results

As recommended by Hooper, Coughlan, and Mullen (2008), the goodness of fit statistics for the model shows in general good fit (Table 3).

Table 3: Model fit indices

	χ^2	χ^2 /df	SRMR	NFI	CFI	PCFI	RMSEA
Recommended value		<3	<.08	>.90	>.90	>.50	<.10
Model	670.7	2.85	.08	.97	.90	.69	.00

This paper set out to examine the influence of digital literacy, ICT anxiety, and teaching self-efficacy on the adoption of mobile learning. These factors were found to impact both perceived ease of use and usefulness and intention to adopt. Of the 12 hypothesis tested 9 were supported or partially supported in the model. Appendix B outlines and compares the significant hypotheses.

A number of factors were found to be influential in the adoption model. Lecturers' intentions to adopt mobile learning were impacted by all three new variables. However a direct relationship was shown between the behavioral intention of lecturers' to use mobile learning and their perceived usefulness of mobile learning and their digital literacy.

The perceived usefulness of mobile learning was further shown to be influenced by two factors: the level of experience with using advanced features of mobile technology and the self-efficacy of teachers to use ICT in the classroom. Specifically, advanced mobile literacy and ability and atti-

tude to integrating technology into the classroom were shown to have a significant influence on perceived usefulness.

The perceived ease of use of mobile learning was influenced by three factors which were, in order of strength, their perceived self-efficacy of teachers to use ICT in the classroom, their level of anxiety educators felt when using technology, and their experience with the advanced features of mobile technology.

The ability to utilized more advanced computing features, such as modifying images and sounds and using advanced software (such as Skype), was found to have no relationship to the acceptance of mobile learning.

Discussion

Based on the results of the analysis a number of relationships were confirmed. In particular, the study was able to confirm that digital literacy, ICT anxiety, and ICT teaching self-efficacy have an impact on the lecturers' behavioral intention to use mobile learning. Teaching self-efficacy is particularly important. The findings of this research help to identify the role these factors have in influencing the acceptance of mobile learning, thus enabling educators and their institutions to assess and plan a successful introduction of mobile learning.

The results of this paper confirm the role of perceived ease of use and usefulness on the acceptance of mobile learning. These two factors were shown to have a positive effect on the behavioral intention to use mobile learning. This meant that lecturers who see mobile learning as a way to offer a substantial advantage to students' learning or their own teaching will adopt mobile learning. Though perceived ease of use was not shown to have a direct influence on behavioral intention, the study did indicate that it had a mediating effect on perceived usefulness. This result was not necessarily surprising. A number of studies have shown that perceived ease of use does not necessarily have a direct effect on behavioral intention (Akour, 2009; Donaldson, 2011; Huang, Lin, & Chuang, 2007; Wang et al., 2009). It is however, more likely to have a direct impact on the perceived usefulness. The perceived benefits of new technology will often be influenced by how much effort users feel is needed to use and learn to use new technology. This therefore highlights the importance of how lecturers perceive mobile learning. Lectures need to feel that the technology is easy to use and beneficial to their teaching and students' learning. These two findings highlight the need for developers and instructional designers, researchers, and teaching institutions to focus on ease of use and to highlight the benefits of mobile learning. Designers need to remove technical obstacles to ensure that all mobile learning initiatives are as easy to use as possible with little initial learning needed. While institutes and researchers need to provide effective IT support and access to training and pilot initiatives before a major rollout, institutions also need to promote the benefits of the mobile learning initiative so that they are clear and evident to all parties. This can be done by ensuring lecturers are aware of the advantages of mobile learning has to support their students' learning and their teaching. Opportunities should also be provided to lecturers to enable them to explore mobile learning on their own.

In addition to confirming the basic structure of the TAM, the new variables were also confirmed as playing a significant role in the acceptance of mobile learning. Digital literacy, in particular, was shown to have a major influence on a wide range of factors that mediate the behavioral intention to use mobile learning. It also had a direct influence on the behavioral intention to use mobile learning. The study indicated that digital literacy should be considered in two distinct ways as each will influence acceptance to a different degree.

The first category of digital literacy was the basic ICT literacy of lecturers. This included the competency of users using general computing tasks, such as using word processing software, searching and emailing using the Internet, and doing basic mobile activities, such as texting and

calling. Basic ICT literacy was shown to have a direct positive impact on behavioral intention to use mobile learning. It also had a positive impact on teaching self-efficacy to use ICT in the classroom. This confirms the importance of ensuring lecturers have a good foundation in basic digital literacy. Other studies have shown that digital literacy will generally play a role in the adoption of new technology and its use in the classroom. For example, in an early study by Cox, Preston, and Cox (1999) teachers who were already regular users of ICT were more likely to have higher levels of confidence in using ICT in their teaching and were more likely to extend their use of ICT further in the future. This finding was further supported Mueller et al. (2008) who found that educators with direct experience of ICT were more confident using a wider range of technologies. Therefore parties that are interested in implementing mobile technology need to carefully consider lecturers' confidence and ability with ICT. Strategies need to be set in place to up-skill lecturers' general ICT literacy and not just to focus on teaching lecturers how to use the mobile technology.

However, teaching lectures to use the mobile technology is also important. The study indicated that advanced mobile literacy played a significant role on adoption. The second category of digital literacy was the advanced mobile skill; this related to using mobile technology for more complex mobile learning activities, such as accessing the Internet, emailing and sending photos. This factor was shown to have a direct impact on the perceived ease of use and usefulness of mobile learning, as well as having a positive impact on the perceived teaching self-efficacy of lecturers to use ICT in the classroom. Previous research has shown that past experience with a specific technology is a key determinant of the future adoption of technology (Ajzen & Fishbein, 1980; Kidwell & Jewell, 2008; Saadé & Kira, 2009). The study highlighted that lecturers' experience with mobile technology will impact their perceptions of its ease of use and usefulness. The mobile literacy of lecturers' enables them to better evaluate how valuable mobile learning will be in supporting their learning and teaching. It will also give them confidence it its use. The familiarity with mobile technology will help support the extension and experimentation of its use in other areas – such as for teaching. Conversely lecturers that seldom use mobile technology or have a low level of skill with technology will be less likely to experiment or deviate from existing use. It will therefore be less likely that they see mobile learning as easy to use or useful for learning. Lefoe et al. (2009) found that educators who became more familiar with their mobile devices developed a better understanding of how mobile learning activities could be developed and incorporated.

Along with the skills to use technology generally, the study also clearly indicates that lecturers will also need specific skills to use the technology in the classroom. General use of technology does not necessarily translate its effective use inside the classroom. Specific skills and pedagogies are needed to translate this general literacy in using ICT in teaching. In addition to these skills, the lectures' attitudes toward the inclusion of ICT into the classroom will play a mediating role on their behavioral intention to implement mobile learning. This study confirms that teachers who fail to see the value of technology in the classroom will resist its introduction. They are therefore less likely to seek out new technology and integrate it into their teaching (Duncan-Howell & Lee, 2007).

As described by Lim and Khine (2006), support is needed when introducing new technology into education. Duncan-Howell and Lee (2007) argued that "teachers need access to more training, more information and more opportunities to see and use new technologies for themselves" (p. 229). The role of time and support will be vital to mobile learning adoption as it has been for general ICT adoption.

One factor shown to have a negative mediating effect on behavioral intention to implement mobile learning was ICT anxiety. ICT anxiety was shown to influence the digital literacy of lecturers, their attitudes toward the use of ICT in the classroom, and the perceived ease of use of mobile

learning. ICT anxiety is an emotional response resulting from the fear that use of ICT may result in a negative outcome, such as damaging the equipment or looking foolish (Barbeite & Weiss, 2004). Little previous research has specifically investigated the effect that ICT anxiety has on mobile learning; however, the effect ICT anxiety has on an individual's adoption and use of technology in education has been identified in a number of studies (Barbeite & Weiss, 2004; Beckers & Schmidt, 2003; Rahimi & Yadollahi, 2011; Wang, 2007). Other studies have shown that anxiety about computer use will negatively influence an individual's use and adoption of ICT in their teaching and learning (Phelps & Ellis, 2002; Teo, 2011; Wilfong, 2006). For lecturers, ICT anxiety also influenced the perceived ease of use of mobile learning. Phelps and Ellis (2002) found that lectures who perceived their technological competence to be low often felt threatened and overwhelmed when using ICT in the classroom, a finding confirmed later by Jeffrey, Hegarty, Kelly, Penman, Coburn, & McDonald (2011). Therefore, anxiety will make the adoption of new technology seem harder and will ultimately result in lecturers avoiding the introduction of new technology into their teaching. This study therefore establishes the role of ICT anxiety on mobile learning adoption, a finding not been previously discussed in the literature.

ICT anxiety also influences the digital literacy of lecturers. As found in other research, as a user becomes more experienced with computers they are more likely to form a positive attitude to them (Shih, Munoz, & Sanchez, 2006). Anxiety typically arises from the fear of the unknown and the confidence to cope with changes (Beckers, Rikers, & Schmidt, 2006). When individuals become more secure and positive about their technology usage, they are more likely to relax and not feel as anxious about its use (Beckers & Schmidt, 2003; Cowan & Jack, 2011). This is because they have developed an assurance that they can cope with learning new technology and can solve issues that may arise.

Support is therefore needed for lectures that have negative attitudes toward technology. Additional support and training may therefore be needed over and above the standard support given.

Conclusion

This study extends the TAM with digital literacy, ICT anxiety, and teaching self-efficacy to model the acceptance of mobile learning by lecturers. The study helps predict the influence of each factor on the adoption and discusses the impact these factors will have on the successful implementation of mobile technology into the education setting. In particular this study had the following major contributions:

1. This research found that digital literacy, ICT anxiety, teaching self-efficacy, and perceived ease of use and usefulness were critical factors for lecturers' behavior intentions to implement mobile learning.
2. This research confirmed the role of perceived ease of use and usefulness on the acceptance on mobile learning and confirmed that the TAM provides a valuable tool for modelling lecturers' adoption of mobile learning.
3. The research indicates the negative role of ICT anxiety in digital literacy, teaching self-efficacy, and perceptions of mobile learning.
4. The study highlighted that digital literacy has a distinct role on acceptance. Specifically, basic ICT literacy and advanced mobile literacy each play a separate but vital role on acceptance.
5. The findings also differentiated between digital literacy and the ability to use technology within the classroom. The study highlights the notion that lecturers not only need to be digitally literate but also be able to implement the technology into the classroom. This research indicated that ability and attitudes played a strong role in acceptance of mobile learning.

6. This research fills the current gap in mobile learning adoption and addresses an often-overlooked area of research addressing lecturers' adoption.
7. This research identifies the role of three new research constructs – digital literacy, ICT anxiety, and teaching self-efficacy – within the limited research investigating mobile learning adoption.

The research strongly indicates the role of support needed for lecturers to successfully implement mobile learning into the classroom. Support is needed in terms of supporting general literacy. In particular, support is needed to help teachers with the technology and supporting them to effectively integrate it into the teaching environment.

This research has added to and clarified the existing literature into mobile learning. In particular, it recognizes the role that lecturers play in the future acceptance of mobile learning. It shows that the factors that influence lecturers' adoption of mobile learning may differ from those of their students and therefore need to be considered when implementing mobile technology into the teaching environment.

In general, though these factors have been explored in other studies, gauging ICT adoption, there have been a limited number of studies specifically looking at mobile learning adoption by lecturers. The measures adopted in this study focus on existing variables, such as digital literacy, ICT anxiety and ICT teaching self-efficiency, to a context of mobile learning. This however may limit the study's findings, in general, since the variables adopted are ICT focused, rather mobile specific. Despite this however, the study has been able to confirm the role of perceived ease of use and usefulness on the acceptance of mobile learning. However, results have indicated that mobile learning adoption is influenced by some of the same factors that influence adoption of other technologies in the classroom. The findings indicate that mobile technology may not be too dissimilar to other technology adoption in education. However, a different approach may be needed when introducing mobile technology to lectures. Specifically, if mobile learning is to be introduced into the classroom, teachers need to first have a good foundation in general computing. The need to scaffold technologies is seen as very important to successful introduction of mobile learning.

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Appendix A

Table A. 1: Statements from digital literacy scale adopted

ADVANCED MOBILE LITERACY (AML) ITEMS
Use a mobile phone to send or receive email
Use a mobile phone to access information/services on the web
Use a mobile phone to access information/services on the web
Use a mobile phone to send pictures or movies to others
BASIC ICT LITERACY (BICTL) ITEMS
Use the web to send or receive email
Use the web to look up reference information for study purposes
Use a mobile phone to call people
Use a mobile phone to text/ SMS people
ADVANCED ICT LITERACY (AICTL) ITEMS
Use a computer to create/edit audio and video
Using a computer to play digital music files (e.g. iTunes) without accessing the Internet
Use a computer to manage/manipulate digital photos
Use a mobile phone to download and play games or applications from the Internet

Table A. 2: Statements from ICT Anxiety scale adopted

ICT ANXIETY (ANX) ITEMS
ICT is difficult to use
ICT frustrates me
I feel insecure about my ability to use ICT
I need someone to tell me the best way to use a computer

Table A. 3: Statements from ICT teaching self-efficacy scale adopted
ICT ABILITY (SEABL)
I see ICT as tools that can complement my teaching.
ICT provide variety in instruction and in content for my students.
ICT allows me to bring current information to the class
ICT provides opportunities for individualized instruction.
ICT ATTITUDE (SEATT)
I feel frustrated more often when I use ICT in my classes than when I don't use them (R)
I have positive ICT experiences at my teaching institute.
I had positive experiences with computers when I was younger
I feel I am trained well enough to use a variety of ICT tools when teaching

Table A. 4: Statements from the Technology Acceptance Model (TAM) scale adopted
PERCEIVED USEFULNESS (PU)
Mobile technology will make learning and teaching more interesting
I see ML as a way of encouraging more interaction by students and educators
I see ML as a way to improve student learning as it allows students to access learning content anywhere and anytime
I see ML as a way to enhance/encourage my students' self-directed learning
PERCEIVED EASE OF USE (PEOU)
I would be anxious about having to use my mobile device to help support my teaching (R)
I think it might take me awhile to get comfortable with using a mobile device for teaching (R)
I believe I would find it easy to use a mobile device to support my teaching
I feel that I would have the knowledge necessary to implement and use mobile technology in my teaching
I would be anxious about having to use my mobile device to help support my teaching (R)

Appendix B

SUMMARY OF HYPOTHESES	PATH	SUPPORTED?
H1: Perceived usefulness will have a positive effect on the behaviour intention to use mobile learning.	PU → BI	Yes
H2: Perceived ease of use will have a positive effect on the behaviour intention to use mobile learning.	PEOU → BI	No
H3: Perceived ease of use will have a positive effect on perceived usefulness.	PEOU → PU	Yes
H4: Digital literacy will have positive effect on the behaviour intention to use mobile learning.	H4a: BICTL → BI H4b: AML → BI H4c: AICTL → BI	Yes Yes No
H5: Digital literacy will have positive effect on perceived ease of use and usefulness.	H5a: BICTL → PEOU H5b: BICTL → PU H5c: AML → PEOU H5d: AML → PU H5e: AICTL → PEOU H5f: AICTL → PU	Yes No Yes Yes No No
H6: ICT anxiety will have a negative effect on the behaviour intention to use mobile learning.	H6: Anx → BI	No
H7: ICT anxiety will have a negative effect on the perceived ease of use of mobile learning.	H7: Anx → PEOU	Yes
H8: ICT anxiety will have a negative effect on a lecturers' digital literacy.	H8a: Anx → BICTL H8b: Anx → AML H8c: Anx → AICTL	Yes Yes No
H9: ICT teaching self-efficacy will have a positive effect on the behaviour intention to use mobile learning.	H9a: SEAtt → BI H9b: SEabl → BI	No No
H10: ICT teaching self-efficacy will have a positive effect on the perceived ease of use and usefulness.	H10a: SEAtt → PEOU H10b: SEAtt → PU H10c: SEabl → PEOU H10d: SEabl → P	No Yes Yes Yes
H11: Digital literacy will have a positive effect on teaching self-efficacy.	H11a: BICTL → SEAtt H11b: BICTL → SEabl H11c: AML → SEAtt H11d: AML → SEabl H11e: AICTL → SEAtt H11f: AICTL → SEabl	No Yes No Yes No No
H12: ICT anxiety will have a negative effect on a lecturers' teaching self-efficacy.	H12a: Anx → SEAtt H12b: Anx → SEabl	Yes No

Biographies

Kathryn Mac Callum is a senior lecturer at the School of Computing at Eastern Institute of Technology, New Zealand. Her PhD addressed the adoption of mobile learning by students and teachers in the tertiary sector. Her PhD research proposed and tested a structural model of the adoption of mobile learning in tertiary education. Her current research focuses on the use of smart devices in the primary sector. She has a strong interest in the effective use and adoption of technology in education. Her current research interest is looking at how smart technology can be effectively used to support students in Primary education.

Lynn Jeffrey is an Associate Professor at the School of Management in Massey University (New Zealand). Her PhD is in learning psychology. She has a particular interest in improving adult and tertiary learning, and the role that technology might play in achieving that end. Technology that she's developed includes a computer-based, examination-on-demand system (CALES) which was used by the New Zealand Civil Aviation Authority for pilot theory examinations; a learning style website that can be used by tertiary students to get advice on improving their learning, and by their teachers for developing more relevant teaching methods; and a learning style evaluation website for workplace training. Her current research focuses on student engagement in blended learning environments, occupational competency identification, teaching international students and mobile learning.

Dr. Kinshuk is Full Professor and Associate Dean of Faculty of Science and Technology at Athabasca University, Canada. He also holds the NSERC/iCORE/Xerox/Markin Industrial Research Chair for Adaptivity and Personalization in Informatics. Areas of his research interests include Adaptive and personalized learning; learning analytics; learning technologies; mobile, ubiquitous and location aware learning systems; cognitive profiling; and, interactive technologies. With more than 400 research publications in refereed journals, international refereed conferences and book chapters, he is frequently invited as keynote or principal speaker in international conferences. He has been twice awarded the prestigious fellowship of Japan Society for the Promotion of Science (2008 and 2013). He is Founding Chair of IEEE Technical Committee on Learning Technologies, and Founding Editor of the Educational Technology & Society Journal (SSCI indexed with Impact Factor of 1.171 according to Thomson Scientific 2012 Journal Citations Report).