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Readiness for integrating mobile learning in the classroom: Challenges, preferences and possibilities

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ABSTRACT

Mobile learning readiness is a new aspect of technology integration for classroom teachers. Determining the best strategies for successfully implementing mobile devices in order to improve learning is an important topic needing systematic research, because targeted professional development can help ensure effective integration of mobile learning into classroom environments. Teachers must have supportive professional development fostering enthusiasm and willingness as well as skill in techniques for integrating mobile devices successfully in the classroom. In this study the Mobile Learning Readiness Survey (MLRS) scales are confirmed to be aligned with well-established measures of technology integration based on more traditional information technologies. Educators who are higher in technology integration report the greatest benefits from mobile learning, prefer online or blended learning and recognize the importance of external influences on implementation. The four scales of the MLRS generally exhibit the desirable properties of step-wise increases in readiness as teacher competence grows and include a basis for beginning the development of a classification framework to assist in targeting types of professional development.

1. Introduction

Mobile learning has been defined as the process of learning mediated by handheld devices such as smart phones and tablet computers (Schuler, Winters, and West, 2012). For K-12 classrooms, the use of mobile devices is increasingly more common, yet not as pervasive as predicted (Kearney, Burden, and Rai, 2015). The ways in which mobile learning devices are implemented vary greatly, from school-provided devices for each student to "bring your own device" programs. Determining the best strategies for successfully implementing mobile devices in order to improve learning is an important topic needing systematic research. How best to empower teachers to guide student learning with mobile devices is an urgent problem to be addressed.

In this paper the authors identify challenges, preferences and possibilities for integrating mobile learning into the classroom and assess how teacher attributes such as level of expertise in the integration of traditional technologies, and years of teaching, relate to mobile learning readiness. The Mobile Learning Readiness Survey (MLRS) is used to address many of the areas identified in the literature as concerns to be overcome en route to full acceptance and integration of mobile learning by classroom teachers.

In this paper, the authors first present a rationale for measuring teacher willingness to implement mobile learning in the classroom. Multiple factors are addressed that impact integration, such as challenges faced by teachers. In addition, teachers' preferred method of professional development to support mobile learning and how mobile learning integration relates to traditional technology integration are addressed in this paper. An additional relationship that is explored is the connection between willingness to implement mobile learning and number of years of teaching experience. Following the results of the analyses, implications for school leadership are included to assist in the design of effective professional development activities and support for educators as they implement mobile learning into the classroom.

2. Rationale for mobile learning readiness

A paradigm shift is required for teachers to effectively integrate mobile devices in classroom learning. Simply owning mobile technologies does not guarantee effective use in education by students and teachers (Cochrane, 2014). Teachers must have

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supportive training on the pedagogy of integrating these devices as well as useful strategies for classroom management that will enable the teachers to feel confident in their classroom instructional environment. "Current pedagogical approaches are not appropriate for mobile learning and for the new generation of learners. There must be an instructional paradigm shift that promises to fundamentally change the way students learn" (UNESCO, 2012). Given the autonomy and choices our youth currently exercise with their mobile devices, educators will need to incorporate opportunities for learners to have some agency in the way in which their learning is framed (Kearney et al., 2015). Successful teacher implementation of emerging technologies in education requires well-planned, ongoing professional development and support (Muir, Knezek, and Christensen, 2004). With the inevitable influx of mobile devices for learning, it is necessary to investigate the readiness of educators from a multi-dimensional perspective. The highly-evolved practice of focusing on specific needs-based aspects of traditional technology integration when implementing educator professional development has generally not been transferred into the mobile device domain. Researchers argue that the mobile learning implementation requires new pedagogies rather than substituting or reproducing traditional pedagogical activities (Cochrane, 2014; Laurillard, 2013). A growing number of researchers are investigating new approaches for pedagogical practices for mobile learning that create a more learner-centered environment (Bannan, Cook, and Pachler, 2015; Beetham and Sharpe, 2013; Herrington, Parker, and Boase-Jelinek, 2013; Narayan, 2017). The underlying constructs for mobile learning readiness, and the professional development strategies that would best promote professional development in these construct-focused realms, are not well defined. Further, Laurillard (2007) states "mobility of digital technologies creates intriguing opportunities for new forms of learning because they change the nature of the physical relations between teachers, learners and the objects of learning" (p. 154). Assessing and addressing the required and appropriate professional development strategies is essential in successful implementation of mobile learning implementation in the classroom.

2.1. Measuring mobile learning readiness

The Mobile Learning Readiness Survey (MLRS) was developed to fill a void in the literature and assessment measures currently available regarding the types of indicators and levels at which teachers report their acceptance and readiness for teaching in a mobile learning environment. The MLRS has been used to measure the extent to which teachers indicate a willingness to introduce and teach with mobile devices in their classrooms. The instrument was developed by adapting Likert-type items previously created to assess the impact of a one-to-one iPad implementation for high school teachers and students (Christensen and Williams, 2015), to produce a general purpose mobile learning instrument. Prospective items were reviewed for content validity by the public school district personnel where the survey was given, a chief technology officer from another large, suburban school district, a technology coordinator from an independent high school, and university researchers. Each item on the survey is rated on a scale of 1 = Strongly Disagree to 5 = Strongly Agree. The internal consistency reliability (Cronbach's alpha) was found to be .92 for all 28 items (Christensen and Knezek, 2017). The survey includes four factors related to various aspects of mobile learning readiness, with readiness interpreted as level of acceptance or willingness to incorporate mobile technologies into teaching and learning environments, in this context. Factor 1 is related to future possibilities (*Possibilities*); Factor 2 is related to practices for improving classroom instruction (*Benefits*); Factor 3 is related to mobile device preferences (*Preferences*); and Factor 4 is related to the environment/context (*External Influences*).

3. Review of the literature: challenges, preferences, and possibilities for mobile learning acceptance

3.1. Challenges

A number of barriers and challenges exist for the integration of mobile learning in the classroom. Lack of self-efficacy to integrate technology, classroom management issues, attitudes toward technology and lack of pedagogical strategies contribute to the barriers and challenges to the successful integration of mobile learning in schools. Many of the barriers are the same that exist for technology integration in general – lack of access, funding, time, training and attitudes (Ertmer and Orrenbreit-Leftwich, 2010; Ertmer, 1999; Penuel, 2006). In addition, the number of years of teaching or age may be related to the willingness to integrate new technologies into the classroom. In a study of mobile device use in the classroom, older teachers perceived the barriers for classroom use to be significantly more problematic for successful implementation than did younger teachers (O'Bannon and Thomas, 2014).

While many teachers report that mobile devices are disruptors in the classroom (Lenhart, Ling, Campbell, and Purcell, 2010), some research has shown a shift may be occurring in teachers' support of mobile devices in the classroom due to the instructional benefits of the devices (Thomas, O'Bannon, and Britt, 2014). Low teacher self-efficacy as well as lack of pedagogical knowledge for effectively integrating technology can impede use in the classroom (Christensen and Knezek, 2001; Ertmer and Orrenbreit-Leftwich, 2010).

Attitudes, including anxiety, have been determined to impede the recognition of mobile learning as an effective teaching and learning tool (Celik and Yesilyurt, 2013). Positive teacher attitudes toward computers have long been recognized as a necessary condition for effective use of information technology in the classroom (Woodrow, 1992). Needs-based technology integration education has been shown to have a rapid, positive effect on teacher attitudes, such as computer anxiety, perceived importance of computers, and computer enjoyment (Christensen, 2002). Looking across many 1:1 implementation classrooms, Bebell and O'Dwyer (2010) concluded the main predictor of successful implementation was quality professional development.

Several models of technology integration have been proposed over the past two decades to define and describe the relationship between technology and the integrative use of technology for teaching and learning. While models differ, their common goal is to have technology integrated into the classroom to support meaningful learning. Models help provide a framework to understand and organize the necessary components for successful implementation of a program.

Many models of technology integration begin at the stage of overcoming barriers, then build proficiencies in a step-wise manner (Knezek and Christensen, 2008). Several well-respected models emphasize removing internal and external barriers, increasing usage and skills, or building toward desirable goals, as the path to meaningful classroom technology integration (Ertmer, 1999; Rogers, 1999; Vannatta and Fordham, 2004; Zhao and Cziko, 2001). McCombs and Marzano (1990) proposed that achievement outcomes can be viewed as a function of two teacher characteristics, "skill" and "will." Other researchers have demonstrated that the addition of self-reported "tool access" and "constructivist pedagogy" to "will" and "skill" can result in the ability to predict 60%–90% of a teacher's level of classroom technology integration (Knezek and Christensen, 2016; Morales, 2006;

Morales, Knezek, and Christensen, 2008; Petko, 2012).

New frameworks emerging for mobile learning can possibly be merged with established models to create more robust frameworks accommodating traditional as well as new information technologies such as mobile devices and applications. For example, Cochrane (2014) proposes mobile learning as a catalyst for pedagogical change and introduced a framework for new teaching strategies in the implementation of mobile learning to move from traditional teacher-directed pedagogies to strategies that included more student agency in their learning. The three key elements of the framework include professional development that models a community of practice that is successful due to sustained relationships, redefining pedagogy, and designing an appropriate technology support infrastructure. Cochrane's framework has many features in common with the well-established models previously described.

3.2. Preferences of teachers for style of professional development

Researchers have demonstrated that teacher quality is dependent on effective and ongoing professional development (PD) opportunities (Desimone, 2009; Penuel, 2006). The learning environment, especially regarding technology, has changed in the last decade and teachers who have been in the classroom for many years may not have the PD support needed to transform their practices to meet the needs of the newer learning environments (Johnson, 2013). Shapley, Sheehan, Maloney, and Caranikas-Walker (2010) found that teachers' level of implementation of a mobile learning environment was related to the quality of professional development. Creating a learning environment that is enhanced by the use of mobile learning devices requires new approaches that include the design of instruction, the pedagogical strategy and the management of instruction (Kearney et al., 2015). Teachers must have supportive training regarding the pedagogy of integrating these devices as well as useful strategies for classroom management that will enable the teachers to feel confident in their classroom instructional environment.

While online PD programs have an important role in the professional development of teachers (Dede, Ketelhut, Whitehouse, Breit, and McCloskey, 2009; Surrette and Johnson, 2015), determining which teachers may or may not be successful in a particular type of learning environment is important for offering effective PD leading to successful implementation of a classroom-based mobile learning environment.

3.3. Possibilities for mobile learning

Mobile devices afford teachers and students the ability to learn anytime and anywhere (Traxler, 2009). The majority (92%) of teens report going online daily via a mobile device (Lenhart, 2015). Pervasive access provides immediate potential for use in the classroom. These devices also offer the ability to personalize instruction (Steel, 2012), collaborate (Corbeil and Valdes-Corbeil, 2007) and allow self-regulated learning (Sha, Looi, Chen, and Zhang, 2012). Other features useful for learning include audio and video recording, instant access to the Internet, texting, uploading and sharing files in addition to a growing number of learning apps. The portability of these mobile devices allows students to connect to content within and beyond the classroom walls and the time periods when students are in school.

In order for implementation to occur in a successful way, teachers must judge the technology enrichment activities to be beneficial for their teaching and for student learning (Drayton, Falk, Stroud, Hobbs, and Hammerman, 2010). Teachers' beliefs about the perceived ease of use and usefulness of mobile learning are important predictors of adoption into teaching and learning (Chiu and Churchill, 2016).

4. Purpose of the study

This study examines the challenges, preferences and possibilities for integrating mobile learning into the classroom. The challenges with mobile learning faced by educators might be anticipated to vary based on overall levels of technology integration. While professional development is an essential element for success, the way in which PD is designed and delivered may be a critical factor in effective implementation by educators, depending on educator's preferences and self-efficacy for implementation. In addition, more educators are beginning to realize the possibilities afforded by each student having access to a powerful device held in their hands. A primary purpose of this study is to determine how teachers perceive the implementation of mobile learning into the classroom and how those factors relate to levels of technology integration. Other relationships that may impact mobile learning readiness and implementation, such as preferred method of professional development as well as teacher tenure, are also included in the study to determine how to best prepare teachers for a mobile learning environment.

4.1. Research questions

The following research questions are addressed, with each further delineated in terms of specific expected outcomes.

Research Question 1. To what extent does the Mobile Learning Readiness Survey identify perceived level of challenges, preferences, and possibilities among teachers facing the prospect of using mobile learning in a teaching/learning context? Expectations in this area were that identified constructs could be used to explain strengths and weaknesses on each construct, thereby leading to identification of specific areas of need for professional development.

Research Question 2. What are the relationships of the MLRS constructs to self-reported levels of technology integration? The anticipated outcomes in this area were that one or more constructs on the Mobile Learning Readiness Scale would positively align with self-reported Stage of Adoption of Technology.

Research Question 3. What are the relationships of the MLRS constructs to preference for online, blended, or face-to-face professional development? Conjectures in this area were that teachers who were lower in the MLRS factors would indicate that they preferred professional development in a face-to-face environment.

Research Question 4. What are the relationships of the MLRS constructs to years of teaching? In this area, researchers hypothesized that teachers with fewer years of teaching would perceive greater benefits for mobile learning, because teachers with fewer years of experience tend to be younger and more comfortable with mobile technologies.

4.2. Methods

4.2.1. Participants

Educators from grades K-12 in a large school district in the southwestern US were invited to submit data related to mobile learning readiness in the fall of 2015 as a part of a needs assessment for the school district considering how to best implement mobile learning. Of the 1430 respondents, slightly fewer than half ($n = 640$, 44.8%) reported teaching at the elementary school level while the remainder were middle school teachers ($n = 370$, 25.9%), high school teachers ($n = 404$, 28.3%), or were undesignated ($n = 16$, 1.1%). Almost two-thirds of the respondents (61.5%) had been

teaching seven or more years.

4.2.2. Instrumentation

Participants were administered a battery of instruments including the Mobile Learning Readiness Survey (Christensen and Knezek, 2017) designed to measure whether teachers feel prepared to introduce and teach with mobile devices in their classrooms. Twenty-eight (28) Likert-type items representing four factors were responded to by participants on a scale of 1 = Strongly Disagree to 5 = Strongly Agree. Exploratory factor analysis (Principal components, varimax rotation) was used to determine the most meaningful structure of the MLRS in terms of constructs. Based on the inflection points of a scree plot and content analysis of clusters of items, a four-factor solution was selected, creating factors that were reliable and judged to possess content as well as construct validity. The total variance explained by the four-factor solution was 58%. Based on reading the items in each of the factors, in the order of strongest to weakest correlations of the items in each factor with the underlying construct (factor loadings) – names were assigned to help identify the themes for each factor. It was determined that Factor 1 is related to future possibilities (*Possibilities*); Factor 2 is related to current practices for improving classroom instruction (*Benefits*); Factor 3 is related to mobile device preferences (*Preferences*); and Factor 4 is related to the environment/context (*External Influences*). The survey instrument used in this study, annotated with the factor designation for each item, is included in Appendix A.

The internal consistency reliabilities for four scales produced from this instrument, for this set of data, are listed in Table 1. These reliabilities range from minimally acceptable (.6 or greater) to excellent (.9 or greater) according to guidelines provided by DeVellis (2017).

The Stages of Adoption of Technology survey (Christensen, 2002) was also administered to the teachers. Stages of Adoption is a self-assessment of a teacher's level of adoption of technology based on Rogers's (1983) Diffusion of Innovations theory (see Appendix B). There are six possible stages in which educators rate themselves: Stage 1 (*Awareness*), Stage 2 (*Learning the process*), Stage 3 (*Understanding and application of the process*), Stage 4 (*Familiarity and confidence*), Stage 5 (*Adaptation to other contexts*), and Stage 6 (*Creative application to new contexts*). Because the Stages of Adoption of Technology instrument is a single item survey, internal consistency reliability measures cannot be calculated. However, a high test-retest reliability estimate (.91) was found on a pre-post test large group of teachers (Christensen and Knezek, 1999).

In addition, teachers were asked to report their number of years of teaching as well as their preference for professional development related to technology integration. Their selection options were face-to-face, blended and online learning. Data were gathered via an online system by district personnel and supplied to the researchers in a spreadsheet format.

4.3. Results

Descriptive statistics including means and standard deviations for the measurement scales produced for each of the four factors are provided in Table 2. As shown in Table 2, this group of teachers reported high agreement with Factor 1 *Possibilities* for integrating mobile learning (M = 4.26 on a 1 to 5 scale). This is a positive indication that the educators see an opportunity for having their students learn with mobile devices. By contrast, the same group of teachers were not uniform in their ratings for Factor 3 *Preferences*, as indicated by the relatively high standard deviation of the Factor 3 responses (SD = 0.81) and the group mean average rating of 3.09, very close to the middle rating among the 1–5 possible ratings. This distribution indicates that some respondents tended to disagree with items such as "I prefer reading a book on an electronic device […]" while others tended to agree, leaving the central tendency of the group as a whole best represented as undecided.

In response to Research Question #1, the MLRS does assess perceived levels of mobile learning readiness in four identifiable areas, with reliabilities ranging from acceptable to excellent, as shown in Table 1. Degrees of advancement (levels of agreement) on each of these constructs for the group of teachers in this study vary widely, indicating that these four dimensions of mobile learning readiness may require different strategies for improving the implementation of mobile learning by educators. The following section will address Research Question #2 regarding the relationship between the MLRS constructs and levels of technology integration.

4.3.1. Association of mobile learning readiness and levels of technology integration

Stages of Adoption of Technology (Christensen, 2002) was the instrument used to record each educator's self-reported level of technology integration. As shown in Table 3, the range in reported level of technology integration ability varied widely for this group of teachers, spanning the entire six-stage range of the instrument. The greatest number of educators (n = 454, 31.7%) reported being in Stage 4 (*Familiarity and confidence*), followed by a large number in Stage 5 (*Adaptation to other contexts)* (n = 397, 22.4%). The mean Stage for this group of respondents was 4.51 (SD = 1.10) out of maximum of 6. There were very few educators in Stage 1 (*Awareness).*

Analysis of variance and correlational analyses were used to assess the relationship between mobile learning readiness and the technology integration measure included in this study. An analysis of variance contrasting Mobile Learning Readiness Factors 1–4 by Stages of Adoption of Technology determined that all four factors exhibited significant ($p < .0005$) differences in levels of readiness across Stages of Adoption of Technology as reported by the teachers (see Tables 4 and 5). The Pearson Product Moment Correlations of Stages with each of the Mobile Learning Readiness factors were F1 *Possibilities* = 0.28 ($p < .01$), F2 *Benefits* = 0.16 ($p < .01$), F3 *Preferences* = 0.21 ($p < .01$), and F4 *External Influences* = 0.13 ($p < .01$). According to guidelines developed by Cohen (1988), these significant ($p < .01$) relationships were in the range of small to moderate associations between mobile learning readiness constructs and level of technology integration as measured by Stages of Adoption of Technology. As illustrated graphically in Fig. 1, the general trend that emerged is a positive linear relationship between MLRS scale scores and Stages of Adoption of Technology for

Table 1
Internal consistency reliabilities for four scales of the MLRS.

	Cronbach's Alpha	No. of Items
Factor 1 (Possibilities)	.92	8
Factor 2 (Benefits)	.91	10
Factor 3 (Preferences)	.79	5
Factor 4 (External Influences)	.61	4

Table 2
Descriptive statistics for the mobile learning readiness factors.

	N	*Mean*	*SD*
Factor 1 Possibilities	1430	4.26	.60
Factor 2 Benefits	1430	3.58	.64
Factor 3 Preferences	1430	3.09	.81
Factor 4 External Influences	1430	3.36	.69

Table 3
Frequencies of stage of adoption for 1430 participants.

Stage	Frequency	Percent
Stage 1 - Awareness	6	.4
Stage 2 - Learning the process	40	2.8
Stage 3 - Understanding and application of the process	213	14.9
Stage 4 - Familiarity and confidence	454	31.7
Stage 5 - Adaptation to other contexts	397	27.8
Stage 6 - Creative application to new contexts	320	22.4
Total	1430	100.0

Table 4
Four mobile readiness factors by stage of adoption of technology (means and SD).

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
F1 Possibilities	2.92 (1.04)	3.94 (.51)	4.09 (.61)	4.16 (.57)	4.34 (.56)	4.49 (.53)
F2 Benefits	2.53 (.77)	3.24 (.59)	3.52 (.60)	3.53 (.61)	3.59 (.61)	3.74 (.70)
F3 Preferences	2.60 (1.05)	2.56 (.66)	2.92 (.74)	2.98 (.79)	3.17 (.77)	3.32 (.86)
F4 External Influences	3.08 (.90)	3.24 (.58)	3.24 (.71)	3.34 (.64)	3.33 (.66)	3.53 (.75)

Table 5
Analysis of variance for scale scores on four factors by stages of adoption of technology.

		df	*SS*	*MS*	*F*	*Sig.*
Factor 1	Between Groups	5	45.44	9.09	28.08	.0005
	Within Groups	1424	460.93	.32		
	Total	1429	506.37			
Factor 2	Between Groups	5	21.91	4.38	11.01	.0005
	Within Groups	1424	566.87	.40		
	Total	1429	588.78			
Factor 3	Between Groups	5	43.97	8.80	14.08	.0005
	Within Groups	1424	889.68	.63		
	Total	1429	933.65			
Factor 4	Between Groups	5	13.35	2.67	5.72	.0005
	Within Groups	1424	664.49	.47		
	Total	1429	677.84			

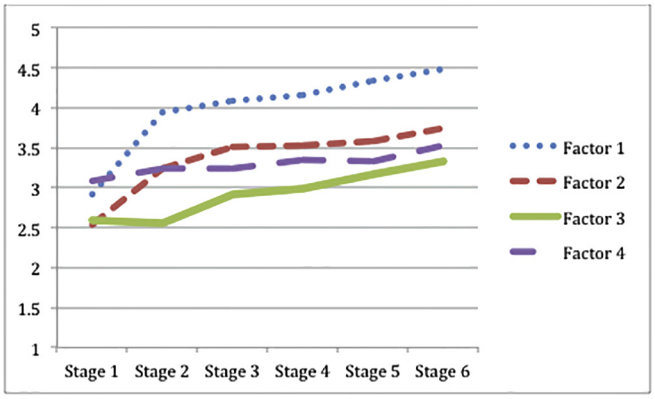

Fig. 1. Teachers' mobile learning readiness by stages of adoption of technology.

all four factors.

A closer examination of Fig. 1 reveals that even within the general tendency for higher Stages of Adoption of Technology to be associated with higher Mobile Learning Readiness, there are distinctively different transition points for the four MLRS scales. An analysis of variance for MLRS F1–F4 constructs by Stages of Adoption, with Tukey Post-hoc analysis options included, was used to formally identify transition points across Stages of Adoption for each of the four types of Mobile Learning Readiness. As shown in Table 6, for F1 *Possibilities*, Stage 1 (*Awareness*) teachers are significantly ($p < .05$) lower in their perceptions of mobile learning F1 *Possibilities* than teachers in any of the other Stages 2–6 (see Appendix B for complete descriptions of Stages). In a similar manner, Stage 6 teachers (*Creative applications to new contexts*) were significantly ($p < .05$) higher than any of the other teachers in Stages 1–5 in their perceptions of the *Possibilities* for mobile learning (F1). Stage 5 teachers (*Adaptation*) were also significantly ($p < .05$) higher than any of the other teachers in Stages 1–4.

For F2 *Benefits*, teachers in Stage 1 (*Awareness*) were significantly ($p < .05$) lower than any of the other groups except Stage 2 teachers in perceptions of *Benefits* of mobile learning (F2). Stage 6 teachers (*Creative applications*) were significantly ($p < .05$) higher than any of the other teachers in Stages 1–5.

Table 6
Group mean significant differences for mobile learning readiness factors by stages of adoption of technology.

Factors	Post-hoc Comparisons
Factor 1 Possibilities	Stage 1 < 2,3,4,5,6
	Stage 2 > 1; Stage 2 < 5,6
	Stage 3 > 1; Stage 3 < 5,6
	Stage 4 > 1; Stage 4 < 5,6
	Stage 5 > 1,2,3,4; Stage 5<6
	Stage 6>1,2,3,4,5
Factor 2 Benefits	Stage 1 < 3,4,5,6
	Stage 2 < 5,6
	Stage 3 > 1; Stage 3<6
	Stage 4>1; Stage 4<6
	Stage 5>1,2; Stage 5<6
	Stage 6>1,2,3,4,5
Factor 3 Preferences	Stage 2 < 4,5,6
	Stage3<5,6
	Stage 4 > 2; Stage 4 < 5,6
	Stage 5 > 2,3,4
	Stage 6 > 2,3,4
Factor 4 External Influences	Stage 3 < 6
	Stage 4 < 6
	Stage 5<6
	Stage 6>3,4,5

Note: Includes only pairs of group means that are $p < .05$ based on Tukey's Post-hoc test.

For F3 - *Preferences*, teachers in Stage 2 (*Learning the Process*) were significantly ($p < .05$) lower than the teachers in Stages 4–6. Stage 6 teachers (*Creative applications*) were significantly ($p < .05$) higher than the teachers in Stages 2–4.

For F4 *External Influences*, teachers in Stage 6 were significantly ($p < .05$) higher than teachers in Stages 3–5. Unlike the differences in F1–F3, there were not distinctive transition points on F4 between different stages of teachers. Perhaps Factors 1–3 are viewed as being within the realm of internal locus of control, versus Factor 4 that may be viewed as outside the control of an individual teacher.

In response to Research Q2 regarding the relationship between the MLRS factors and levels of technology integration, there is a positive linear relationship between each of the four MLRS factor mean scale scores and teacher stages of technology integration. Teachers at the lowest stages of adoption also have the lowest reported means for each of the four mobile learning readiness scales. It appears that teachers at higher stages of technology adoption are more ready for the integration of mobile learning into the classroom. Transition points from lower to higher plateaus of mobile learning readiness differ for each for the four MLRS constructs. These MLRS transition points can be identified based on teachers' self-reported Stages of Adoption of Technology.

4.3.2. Association of mobile learning readiness and preference for style of professional development

Participating teachers were asked to select their preference for style of professional development related to technology integration. Their selection options were face-to-face, blended and online learning. The majority of respondents (53%, n = 755) preferred a blended style of professional development with the next largest percentage being face-to-face (28%, n = 395) and only 20% (n = 279) preferring online.

Analysis of variance was computed for the four factors of the MLRS by preferred professional development format. There were significant ($p < .01$) differences based on style of preferred learning for each of the four factors, as shown in Table 7.

A series of three regression analyses using dummy-coded variables for face-to-face, blended, and online professional development preference confirmed not all constructs contributed equally to preference for a specific form of professional development (PD). The results of the regression analyses are presented in Table 8.

As shown in Table 8, for educators with an affinity for face-to-face professional development, F1 *Possibilities,* ($p = 0.021$, $\beta = -0.082$) and F3 *Preferences,* ($p < .0005$, $\beta = -0.186$) contributed significantly while for those wishing to have Blended PD, only F3 *Preferences,* contributed significantly ($p < .05$, $\beta = 0.080$). For those who indicated they would like Online PD, F3 *Preferences*, ($p = 0.002$, $\beta = 0.111$) contributed significantly. Note that for the group who indicated they would like face-to-face PD, their areas of significant association with mobile learning readiness were negative. That is, teachers who were lower on the MLRS scales tended to desire face-to-face professional development. The trend across these findings is that F3 *Preferences* is an important discriminator (positive or negative) for each of the types.

Table 7
Type of preferred professional development by four factors of the MLRS (means and *SD*).

	Face to Face	Blended	Online	Sig.
F1 Possibilities	4.12 (.62)	4.31 (.58)	4.35 (.58)	.0005
F2 Benefits	3.44 (.62)	3.62 (.61)	3.67 (.71)	.0005
F3 Preferences	2.82 (.74)	3.16 (.78)	3.27 (.88)	.0005
F4 External Influences	3.28 (.71)	3.40 (.65)	3.89 (.74)	.016

Table 8
Contributions of F1-F4 for teachers preferring Face-to-Face, Blended and Online Professional Development.

	Face-to-Face		Blended		Online	
	Beta	Sig.	Beta	Sig.	Beta	Sig.
F1 Possibilities	-.082	.021	.053	.148	.027	.455
F2 Benefits	.053	.206	-.032	.447	-.019	.653
F3 Preferences	-.186	.0005	.080	.028	.111	.002
F4 External Influences	-.025	.363	.034	.229	-.014	.611
R^2	.042	.0005	.011	.003	.012	.002

In response to Research Q3 regarding the relationship of the MLRS and teacher preference for style of PD, teachers who preferred online professional development also reported the highest means on each of the four mobile learning readiness factors. The teachers who preferred face-to-face professional development reported the lowest means on each of the four mobile learning readiness factors. It appears that teachers who are more comfortable with online professional development are also more ready to integrate mobile learning into the classroom.

From a cross-level perspective, Fig. 1 depicts that teachers transitioning from Stages 1 and 2 (lowest levels) come to report much higher degrees of readiness for F1 *Possibilities* compared to the small change on F3 *Preferences* for the same transition. This strong allegiance with F1 *Possibilities* versus F4 *External Influences* and F2 *Benefits* or F3 *Preferences* persists for teachers in Stages 5 or 6. It appears that teachers must have direct exposure (Stage 2) rather than "considering use" (Stage 1) in order to fully realize the possibilities of mobile learning. Once exposed, this appreciation of possibilities for teaching and learning with mobile devices persists across many additional stages of technology integration development.

4.3.3. Association of mobile learning readiness and years of teaching

Pearson correlations and regression analyses were used to determine the strength of associations of the MLRS factors with years of teaching. As shown in Table 9, all four factors were negatively correlated with years of teaching, indicating a trend toward teachers with fewer years of teaching reporting a greater readiness for mobile learning. For F2 *Benefits* the association was sufficiently strong ($r = -0.08$, $p < .003$) that the researchers could be quite certain the effect was real. Nevertheless, the magnitude of this effect (approximately $r = 0.1$) would be considered small according to guidelines established by Cohen (1988).

Regression analysis was used to explore possible joint associations of Factors 1–4 with years of teaching. As shown in Table 10, the overall association between four scales on the MLRS and years of teaching was significant ($p = 0.030$) and F2 *Benefits,* was an individually significant contributor ($p = 0.007$) with an inverse relationship ($\beta = -0.115$). Apparently the greater the number of years in teaching, the lower the perceived benefits of mobile learning in the classroom. This outcome provided greater confidence in the trend toward fewer years of teaching being associated with more positive views toward mobile learning readiness shown in Table 9, and could possibly be due to the relationship between age and years of teaching (Christensen, Knezek, and Tyler-Wood, 2016).

In response to Research Q4, there is a relationship between number of years of teaching and readiness for mobile learning in the classroom. Specifically a greater number of years of teaching appears to be aligned with teachers seeing fewer benefits in using mobile learning in the classroom.

Table 9
Correlation between the MLRS four factors and number of years of teaching.

		Yrs Tching	Factor1	Factor2	Factor3	Factor4
Yrs Tching	Pearson Correlation	1	-.050	-.079**	-.029	-.014
	Sig. (2-tailed)		.062	.003	.284	.588
	N	1414	1414	1414	1414	1414

Note. **. Correlation is significant at the $p = 0.01$ level (2-tailed).

Table 10
Regression Analysis for Four Factors by Years of Teaching

	B	*SE B*	β	t	Sig.
(Constant)	4.214	.280		15.04	.000
Factor 1	.002	.081	.001	.03	.977
Factor 2	−.236	.088	−.115	−2.70	.007
Factor 3	.071	.059	.044	1.21	.227
Factor 4	.030	.055	.016	.55	.582

Notes. $R^2 = 0.087$ ($p = 0.03$).

5. Discussion and limitations

In this study the relationship of four dimensions of mobile learning readiness to level of technology integration, preference for face-to-face, blended, or online professional development, and association with years of teaching were explored. Findings are suggested as useful toward the development of a framework that will aid in the identification and measurement of attributes important for guiding educators in extending traditional technology integration skills into the realm of mobile learning. The authors envision that this foundation may lead to a taxonomy of different dimensions of mobile learning readiness, similar to the different constructs that we now know are associated with technology integration for classroom computers, but were just beginning to be identified in the early days of microcomputers, in the 1980s (Christensen and Knezek, 1997; Loyd and Gressard, 1985).

Mobile learning readiness as a new aspect of technology integration is confirmed through the findings of this study to be significantly aligned with well-established measures based on more traditional information technologies and generally exhibits the desirable properties of step-wise increases in readiness as teacher competence grows. Different demographics and professional development affinities align more closely with subsets of the four constructs measured by the MLRS; in particular, F3 *Preferences* is an important discriminator (positive or negative) for teachers who prefer face-to-face, blended, or online professional development, and F1 *Possibilities* has the highest Pearson Product Moment Correlation ($r = 0.28$, $p < .01$), with Stages of Adoption of Technology, the general measure of level of technology integration used in this study. These and other relationships would occur so rarely by chance that we conclude they are real even though the magnitude of the associations are typically in the range that would be considered small to moderate effects according to the guidelines provided by Cohen (1988).

These findings are noteworthy because teachers will be charged with creating a learning environment to accommodate multiple types of mobile devices that will be constantly changing. These changes in the way instruction occurs require a great deal of professional learning by the educators. Understanding the different ways teachers would like to acquire professional development for the integration of mobile learning in the classroom is an important factor in the success of the effectiveness of classroom learning with mobile devices. Because many school administrators are beginning to offer more online professional development for their educators, it is useful to know which teachers may not be open to learning in that type of online environment. When planning PD, a needs assessment should include indicators such as the ones presented in this paper as a guide to delivering the most effective PD. Future research in this area might include contrasts by gender regarding preferences for online PD as well as contrasts by grade level in which educators are teaching.

Based on the collective findings of this study, a typology of different categories of mobile learning readiness can begin to be identified. At the lowest level of readiness are teachers at the beginning Stage of Adoption of Technology (*Awareness*), who prefer and probably need face-to-face professional development. These tend to be teachers who have been in teaching for many years. Yet teachers of this type have not yet developed strong opinions about possibilities or benefits of mobile learning, although they share concerns with other mobile learning readiness types about external influences.

The next category of mobile learning readiness includes teachers at Stage 2 in the Stages of Adoption of Technology progression (*Learning the process*). These teachers have greatly advanced in their perceptions of F2 *Benefits* and F1 *Possibilities* of mobile learning, compared to teachers in Stage 1 of the Stages of Adoption of Technology progression (see Fig. 1). Yet they still prefer face-to-face rather than online professional development.

Teachers at Stage 3 (*Understanding and application of the process*) and beyond in the Stages of Adoption of Technology progression exhibit smoother progression for all four MLRS factors as stages increase. Among teachers at Stage 3, Stage 4 (*Familiarity and confidence*), and Stage 5 (*Adaptation*), higher Stages of Adoption are associated with ever more positive ratings on all Mobile Learning Readiness constructs. At Stage 6 (*Creative applications*) there is a slight upward slope in the *External Influences* line, compared to the other constructs and Stage 5 teachers are often significantly higher than all other groups except Stage 6 teachers, across the four MLRS factors (See Table 6).

The implication that there may be categories of mobile learning readiness among teachers is an encouraging prospect for school leaders. It appears that it is very important to nurture Stage 1 teachers as a unique type on their own, with special needs regarding mobile learning readiness. It also appears that middle stage teachers are sufficiently distinct from Stage 1 teachers and Stages 5–6 teachers that they could benefit from professional development as a group on their own. Likewise, teachers in Stages 5–6 have many mobile learning preferences in common so their approach to professional development might be different from other groups. This group of teachers might be considered in leadership roles for professional development activities. Therefore the teacher support environment that is implied is one of special help for a small percentage of the teachers in any typical school in the US today, with large group or remote delivery of teacher training for mobile learning probably succeeding for most. Additional research is needed to determine whether these findings are replicable in other locations, based on additional data.

Prospects for targeting training aimed at different types of mobile learning readiness have also emerged from this study. In particular, the emergence of developmental plateaus tied to Stages of Adoption of Technology for three of the four Mobile Learning

Readiness Survey scales, implies that mobile learning readiness could be woven into an integrated, multi-year, technology integration professional development plan for teachers at the individual teacher, school, or district level. Based on the transition points for trend lines shown in Fig. 1, it appears (for example) that activities intended to target F1 *Possibilities* could be included for teachers just beginning general technology integration training (Stage 1), while F2 *Benefits* might be more effective if school leaders waited until teachers are at Stage 2 or beyond. For F3 *Preferences*, development would appear to benefit from waiting even longer, until teachers are at Stage 3 or beyond. Many more complex thought experiments about inter-weavings, are possible.

Limitations of the study include having a small number of demographic variables, because other demographic variables may have revealed additional relationships to mobile learning readiness, had the data been available. The data are self reported and were collected by the district as a needs assessment and provided to the researchers so no additional demographic variables were available. In addition, while the Stages of Adoption of Technology survey that was used to associate the MLRS with a technology integration measure has been shown to have a high test-retest reliability estimate (.91) on a pre-post test large group of teachers (Christensen and Knezek, 1999), nevertheless it has limited robustness as a one-item measure.

6. Summary and conclusions

This study examined emerging mobile learning constructs as indicators of teachers' readiness to integrate mobile technologies into the classroom. The research addressed the challenges of integrating mobile learning in the classroom, the preferences for how teachers best learn to integrate mobile learning and the possibilities for enhanced learning. The data displayed a positive linear relationship between MLRS scale scores and Stages of Adoption of Technology for all four factors.

This study also examined the modes of professional development preferred among educators at different levels of Mobile Learning Readiness. Educator tendencies can be summarized as:

1) Teachers who perceive themselves as the most challenged in Mobile Learning Readiness tend to be those who have been teaching the longest. They are low in technology integration and they prefer face-to-face professional development.
2) Teachers who anticipate the greatest benefits from mobile learning are high in technology integration, and tend to have the least number of years of teaching experience.
3) Teachers who most prefer mobile learning are high in technology integration and prefer online professional development.
4) Teachers who recognize the importance of external influences tend to be higher in Stages of Adoption and are significantly higher on preference for online learning.

Summarizing the observations that emerged from this study, the authors conclude the following: a) High scores on F1 *Possibilities* and F2 *Benefits* of mobile learning are associated with high levels of technology integration; b) Similarly, high ratings on F2 *Benefits* and F3 *Preferences* are associated with desiring online and blended professional development, rather than face-to-face instruction; and c) Greater numbers of years of teaching are negatively correlated with perceived benefits of mobile learning.

This study is considered to be a first step toward the construction of an explanatory framework that could eventually incorporate the rapidly expanding field of mobile learning into traditional technology integration schema. The authors plan additional research in this area, including how these newly-identified constructs align with established constructs for teachers' attitudes toward computers, such as acceptance and anxiety (Christensen and Knezek, 2009). Details related to school organization demographics that need more research include how mobile learning readiness differs for male versus female teachers, and how mobile learning readiness differs among elementary, middle and high school teachers. One concrete next step forward for researchers in the field could be to combine the newly-identified MLRS constructs from this paper with measures of additional aspects of the domain, to show that a battery of framework-based mobile learning indices relate in expected ways to established measures. Findings reported in this paper provide positive initial indications toward the broader goal of formalizing a mobile learning framework that will aid in the incorporation of mobile learning into established technology integration schema.

Appendix A

Mobile Learning Readiness Survey

Mobile Learning Readiness Survey						
Instructions: Select one level of agreement for each statement to indicate how you feel. **SD** = **Strongly Disagree, D** = **Disagree, U** = **Undecided, A** = **Agree, SA** = **Strongly Agree**						
	Factor	SD	D	U	A	SA
Part 1.						
1. Mobile devices can play an important role in K-12 education.	F1	①	②	③	④	⑤
2. Mobile learning will bring new opportunities for learning.	F1	①	②	③	④	⑤
3. Mobile technology should be used to connect learners to people, content, and resources.	F1	①	②	③	④	⑤
4. Mobile learning will increase flexibility of learning.	F1	①	②	③	④	⑤
5. Mobile learning can be used to improve traditional literacy programs.	F1	①	②	③	④	⑤
6. Mobile technology can be used to improve 21st century skills.	F1	①	②	③	④	⑤
7. Technology can be used to level the playing field for special needs students.	F1	①	②	③	④	⑤
8. Mobile devices can enhance learning if there is adequate support for teachers.	F1	①	②	③	④	⑤
9. Mobile devices would introduce a significant distraction in my classroom.	F2	①	②	③	④	⑤
10. Using a mobile device will help me be better organized in my daily activities.	F3	①	②	③	④	⑤
11. Using a mobile device will allow me to be better organized in my teaching.	F3	①	②	③	④	⑤
12. I prefer to read a book on a mobile device rather than a traditional book.	F3	①	②	③	④	⑤
13. I prefer to use an electronic textbook rather than a traditional textbook.	F3	①	②	③	④	⑤
14. I prefer to use a mobile device rather than a computer for learning.	F3	①	②	③	④	⑤

(*continued on next page*)

(*continued*)

		Factor	SD	D	U	A	SA
15.	The use of mobile technology in the classroom makes students more motivated to learn.	F2	①	②	③	④	⑤
16.	The use of mobile technology in the classroom increases student participation in classroom discussions.	F2	①	②	③	④	⑤
17.	The use of mobile technology in the classroom increases student engagement.	F2	①	②	③	④	⑤
18.	The use of mobile technology in the classroom allows students to own their learning.	F2	①	②	③	④	⑤
19.	The use of mobile devices in the classroom allows students to work together more often.	F2	①	②	③	④	⑤
20.	The use of mobile technology in the classroom allows students to develop creativity.	F2	①	②	③	④	⑤
21.	Mobile learning will improve communication between students and teachers.	F2	①	②	③	④	⑤
22.	Mobile learning devices improve communication between students.	F2	①	②	③	④	⑤
23.	Having a mobile device would improve student organization.	F2	①	②	③	④	⑤
24.	Students are more knowledgeable than I am when it comes to using mobile technologies.	F4	①	②	③	④	⑤
25.	My school is doing a good job of using technology to enhance learning.	F4	①	②	③	④	⑤
26.	My campus technical infrastructure and wireless network can accommodate students bringing their own technology.	F4	①	②	③③	④	⑤
27.	My curriculum is conducive to students having their own technology.	F4	①	②	③	④	⑤
28.	My administration is supportive of students having their own device.	F4	①	②	③	④	⑤

Christensen, R., & Knezek, G. 2015, v2.2FB

Appendix B. Stages of Adoption of Technology Survey Instrument

Stages of Adoption

Instructions: Please read the descriptions of each of the six stages related to adoption of technology. Choose the stage that best describes where you are in the adoption of technology.

①	**Stage 1: Awareness** I am aware that technology exists but have not used it - perhaps I'm even avoiding it. I am anxious about the prospect of using computers
②	**Stage 2: Learning the process** I am currently trying to learn the basics. I am sometimes frustrated using computers. I lack confidence when using computers.
③	**Stage 3: Understanding and application of the process** I am beginning to understand the process of using technology and can think of specific tasks in which it might be useful.
④	**Stage 4: Familiarity and confidence** I am gaining a sense of confidence in using the computer for specific tasks. I am starting to feel comfortable using the computer.
⑤	**Stage 5: Adaptation to other contexts** I think about the computer as a tool to help me and am no longer concerned about it as technology. I can use it in many applications and as an instructional aid.
⑥	**Stage 6: Creative application to new contexts** I can apply what I know about technology in the classroom. I am able to use it as an instructional tool and integrate it into the curriculum.

Stages of Adoption. Christensen (1997) based on Russell (1995)

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