

ADOPTION THEORY AND THE INTEGRATION OF MOBILE TECHNOLOGY IN EDUCATION

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ABSTRACT

Mobile technology is increasingly becoming the focus, in academic circles, as a way to enable learning not confined to a time and place. A large number of research activities have looked at how this technology can be harnessed, and the benefits that it affords students and educators, especially in the distance learning sector. Mobile technology is still in the early stages of adoption and its continued acceptance will be influenced by minimising the barriers and by highlighting the benefits that this technology offers.

This paper reviews the current literature on mobile learning, through the lenses of two adoption theories: Roger's Innovation Diffusion Theory and Davis's Technology Acceptance Model (TAM). The paper discusses the factors that will affect the adoption of this technology into education.

Introduction

The term mobile learning (m-learning) refers to the use of mobile and handheld devices, such as Personal Digital Assistants (PDAs), mobile telephones and MP3 players, in supporting teaching and enabling learning. As computers and the Internet become essential educational tools and the technology becomes more portable, affordable, effective, and easy to use, so too have they become the focus on how they can be incorporated to support learning. These technologies provide many opportunities for widening participation and enable easier access to learning. Mobile devices such as phones and PDAs are more reasonably priced than desktop computers, and therefore, present a less expensive method of accessing a myriad of tools all in one small device. Feature such as the facility to make phone calls, take pictures, record audio and video, store data, music, and movies, and interact with the Internet all provide opportunities

that could be harnessed in the educational context. As new devices continue to enter the market, new features and capabilities are appearing at an accelerated pace. Mobile learning offers a fundamental change in the way learning can be regarded and opens the door to countless uses for educational purposes.

The decision of both students and educators to adopt mobile learning is a complex process with a wide number of influencing factors. A key question in trying to determine future adoption with the technology environment is determining why an individual would adopt one technology while resisting another. The aim of this paper is to look at two adoption theories and assess how well they could be used to help bring meaning and understanding to why an individual may choose to adopt or reject mobile learning. According to Straub (2009, p.626) “technology adoption is (a) a complex, inherently social, developmental process; (b) individuals construct unique (but malleable) perceptions of technology that influence the adoption process; and (c) successfully facilitating a technology adoption needs to address cognitive, emotional, and contextual concerns”.

Technology adoption in education

User acceptance can be defined as “the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support” (Dillon and Morris, 1996, p.5). Therefore, in terms of this paper, user acceptance is the willingness of instructors and students to use their mobile devices to support their teaching and learning. Interest is focused on identifying the factors that influence the adoption of technologies by users who have some degree of choice. A high number of models and theories have arisen which aim to uncover the factors that will influence the adoption of technology. These factors range from focus on the technology itself through to the psychological characteristics of the individual (see Dillon and Morris, 1996 for a detailed review of various theories and models of user acceptance). Due to the wide ranging issue of why an individual would accept or reject a technology it is unlikely that a single-variable explanation could account for this decision. However, a number of theories have been developed to help understand adoption and have been used to explain adoption in the educational context.

Diffusion of Innovation

An influential author in the area of adoption is Everett M. Rogers who has developed a general framework which outlines the concept of diffusion of innovation. According to

Rogers (2003, p.10) "Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system." Rogers goes on to state that there are four main elements of diffusion: innovation, time, communication channels, and social systems. These elements are defined as follows:

- Innovation, the idea, practise or object that is developed that is the focus of the adoption.
- Time, the acceptance rate of the innovation over time.
- Communication channel, how the innovation is introduced or how it is marketed to an individual.
- Social system, the elements (such as individuals, groups, organisations and/or subsystem) that are involved in the adoption of the innovation and their impact on each other.

These four elements each play a role in the adoption of technology and is the foundation with which mobile technology adoption in education will be discussed in this paper. When assessing the adoption of mobile learning, focus needs to be placed on the innovation itself, in particular, does mobile learning offer greater benefit over existing tools and methods? In addition do potential users, educator and learners see a need to change and learn a new form of interaction? Also it is necessary to consider where mobile learning is in its adoption cycle? Related to this is which 'adopter categories' are using mobile technology and how mobile learning can be encouraged to be used by other categories? The way in which mobile learning is communicated and encouraged by the social system will also play a role. The instructors will be the main players in introducing this tool to their students and it being incorporated into the classroom. However, the instructor will be impacted by other instructors seeing mobile technology in use, which will impact and encourage others to adopt.

Each of these elements helps explain the possible adoption of mobile technology. This paper will focus on adoption in term of the innovation and its relationship to the user's attitudes.

The characteristics of innovation

A key focus of Rogers' framework is the focus on the innovation. Rogers (2003) states in general that successful adoption of a particular innovation should score higher in terms of its relative advantage over existing practices, compatibility to users' needs, trialability and observability, and lower in its complexity to use.

The relative advantage of one technology over another is a key determinant of the adoption of new technology. The issue of relative advantage has been shown to have a positive relationship with adoption of innovation (Tornatzky & Klein, 1982; Anderson & Harris, 1997; Teng, Grover, & Güttler, 2003). Users need to be shown that mobile technology offers considerable benefit compared to traditional offering. A large number of researchers have highlighted some of the key benefits that mobile learning offers, these include:

- No time constraints (Peters, 2009; Johnson, McHugo & Hall, 2005)
- Available wherever and whenever (Chen & Kinshuk, 2005; Csete, Wong, & Vogel, 2004).
- Content is adaptable to meet individual needs (Trifonova & Ronchetti, 2004; Taylor & Evans, 2005)
- Easier access (Noelting & Tavangarian, 2003; Schreurs, 2006)
- Increases motivation (Duncan-Howell & Lee, 2007)
- Enhances knowledge (Attewell & Gustafsson, 2002)
- More independent (Holzinger, Nischelwitzer & Meisenberger, 2005)
- Improved communication and organisation (Mac Callum & Kinshuk, 2008; Stead et al., 2006)

Compatibility of the innovation needs to align with individual's current values and experiences. The more compatible mobile learning will be to students and educators the less a change of behaviour is required, therefore, allowing for faster adoption of mobile learning into the educational setting. If mobile learning requires users to adjust their existing behaviour or is in contrast to their attitudes the more unlikely they are to adopt (Zaltman & Lin, 1971). In addition the user's previous experience of adoption of new tools in education, whether this was a positive or negative experience will also influence the adoption of mobile technology. A negative previous experience can result in innovation negativism which is where a negative previous experience with one innovation can negatively impact the adoption of another. This could be very likely to be an issue in mobile learning with which existing users experience of elearning may impact on the perception and future adoption of mobile learning.

Trialability, is the extent that the innovation can be tested and experimented before its inclusion. Mobile phones have enjoyed extensive diffusion, however, their use as an educational tool has not been as widely adopted. The widespread availability of the mobile devices is important for mobile learning to become widely adopted however, by itself it will not guarantee the wide adoption of mobile learning (Cobcroft, Towers, Smith & Bruns, 2006). For mobile learning most users would have a mobile device,

however, using the mobile device for learning is significantly different and its introduction should be deliberate and allow users to slowly get familiar within the new tool. This is especially true of educators as they need to feel confident when using the device before they use it within their teaching.

The complexity (its ease of use or learning) of mobile technology will also impact on adoption. If the use of mobile technology requires considerable learning it is less likely that educators and students will persevere with mobile learning. In addition the perceived complexity of the technology can lead to increased uncertainty and perceived risk, and these in turn could lead to a resistance to adopt (Fidler & Johnson, 1984). According to Sharples, Taylor, and Vavoula (2005) that to explore the complexity of mobile learning it is necessary to understand the contexts in which it occurs. For example, visitors to an art gallery continually create contexts for learning from their paths through the paintings, their goals and interests, and the available resources including curators and other visitors.

Observability, is whereby the innovation use and effects must be visible by other. The introduction of mobile learning must be visible and the effects that it has on learning must also be visible or enthusiasm for the tool would wane. Wide research and long term studies are need to truly represent the true value of mobile learning. Currently most studies focussing on mobile learning are short term and limited in focus, therefore, failing to provide concrete and ongoing benefit.

Overall for mobile technology to be adopted into the educational context it needs to show relative advantage, compatibility and lack of complexity. In addition users, especially educators need to see mobile learning in action and be given a chance to try out this technology themselves. The innovation itself is important to consider however, as shown in the last two characteristics that the perception of the user is also important.

Modelling the process of acceptance

In relation to the concept of assessing the suitability of an innovation in terms of its characteristics and the overall context of the adoption over time it is important to consider the user acceptance itself (Dillon & Morris, 1996). Dillon (2001) raised the concern that the characteristics Rogers lists are too loosely defined to provide a sound basis for a complete theory. The Technology Acceptance Model (TAM) has a slight different focus compared to Rogers's Diffusion Model in the fact that it focuses not just the specific type of adoption environment but it focuses on a specific type of innovation.

The TAM focuses on the perceived ease of use (PEOU) and usefulness (PU) of the innovation as perceived by the intended user to determine based on these two variables the likely adoption of the innovation. In addition the innovation should be easy to use (similar to Roger's complexity characteristic), whereby the innovation should be easy to learn and not too complex that it negates its usefulness.

Research has shown that the TAM model can be used to explain approximately 50% of the variance in acceptance levels (Davis, Bagozzi, & Warshaw, 1992). The TAM model has been used considerably in the education setting to determine adoption of instructional technology by educators and students. In Huang, Lin & Chuang (2007) they show that the TAM model worked very well in terms of determining adoption of mobile learning by students. Their study shows that perceived usefulness (PU) and perceived ease of use (PEOU) are key determinants of user perception of m-learning, however, the usefulness of mobile technology was a vital characteristic of adoption. Liu (2008) proposed a change to the TAM model and included four additional variables to help determine mobile learning adoption, namely: performance expectancy, effort expectancy, social influence and facilitating conditions. These additional variables stemmed from Carlsson et al. (2006) who stated that "mobile technology adoption is more individual, more personalized and focused on the services made available by the technology". Other authors have used a number of other variables in addition to PEOU and PU to help explain mobile learning adoption these include: the measurement of enjoyment (Phuangthong & Malisawan, 2005), self-efficacy (Lee, Kim, & Chung, 2002; Pedersen, 2003; MacCallum & Jeffrey, 2009) access to resources (Pedersen, 2003), image (Teo & Pok, 2003), and motivation (Kwon & Chidambaram, 2000; MacCallum & Jeffrey, 2009).

The characteristics of user

In Rogers's Diffusion Model it categorises and groups users according to the speed in which they adopt new technology. These categories include: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. These have been described by Kiljander (2004) as follows:

- The innovators are the 'techies', the experimenters who have technology as a central interest in their lives and pursue new technology as soon as it appears, no matter what its function is.
- The early adopters are the 'visionaries' who blend an interest in technology with a concern for significant professional problems and tasks.

- The early majority are the ‘pragmatists’. Although fairly comfortable with technology in general, their focus is on concrete professional problems rather than on the tools (technological or otherwise) that might be used to address them.
- The late majority are the conservatives or ‘sceptics’. They share the attitude of the early majority, though being less comfortable with technology.
- The laggards are the most likely never to adopt at all.

Each category represents a certain proportion of the population total. Figure 1 shows these five categories along with the three typical ‘diffusion curves’. Given the rapid spread of mobile phone adoption, the innovation of mobile phones is already being adopted by the late majority and the laggards (van Biljon & Kotzé, 2008). However, the same cannot be said about its use in the educational context. According to Masters (2008) only the innovators and early adopter are currently using and researching m-learning. Most research has been in the form of pilots and individual projects. There are many reasons that mobile technology has not found its footing with the educational context. However, one key reason highlighted by Masters (2008) is that there are few concrete examples of mobile technology use in education, other than small scale pilot and once off experiments. Therefore, there is a significant amount of scepticism on the benefit that mobile technology could offer learners and educators.

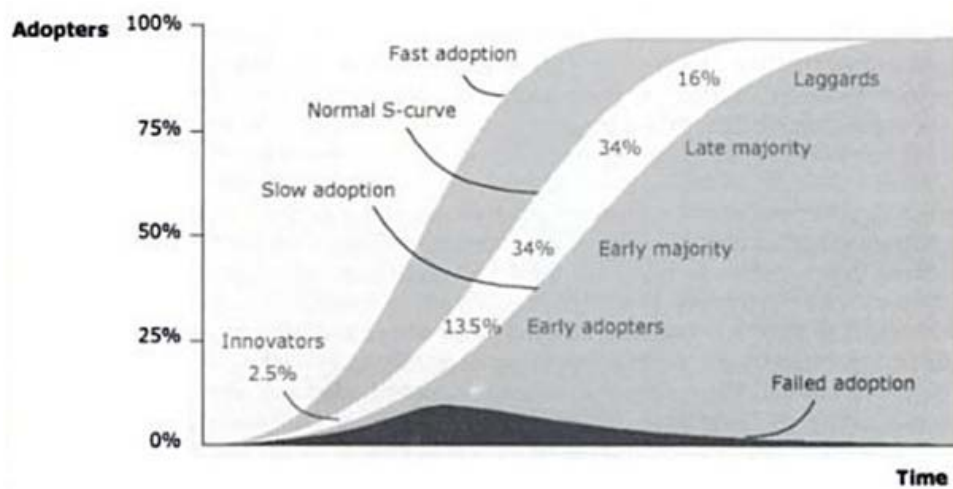


Figure 1. Diffusion curve and innovativeness.

Source: Bouwman, H., Hooff, B. v., Wijngaert, L. v., & Dijk, J. A. 2005 *Information and Communication Technology in Organizations: Adoption, Implementation, Use and Effects*. SAGE Publications.

Conclusion

The aim of this paper was to provide an overview of how adoption theory could help interpret adoption of mobile technology in the learning context. The theory shows that there are a wide variety of factors that will influence the adoption of mobile learning. Factors include: the characteristics of the innovation, such as its relative advantage; compatibility; trialability and observability; and complexity. In addition variables such as its perceived usefulness and ease of use will feature in the adoption. Individual attitudes and variables could also be included to help determine the relationship. The research also shows us that due to the relative newness of mobile learning, only the innovators and early adopters are currently adopting mobile learning, and that a critical mass is needed to enable mobile learning to truly become widely adopted. Overall mobile learning does offer considerable advantages to educators and students alike however, the continued adoption needs to be encouraged for future uptake.

References

Anderson, S. & Harris, J. (1997). Factors associated with amount of use and benefits obtained by users of a statewide educational telecomputing network. *Educational Technology Research and Development*, 41(1), 19-50.

Attewell, J. (2005). From research and development to mobile learning: Tools for education and training providers and their learners. In H. van der Merwe & T. Brown, *mLearn 2005 4th World Conference on mLearning*. Retrieved November 4, 2009, from www.mlearn.org.za/CD/BOA_p.13.pdf.

Carlsson, C. et al., (2006). Adoption of mobile devices/services: Searching for answers with the UTAUT. *Proceedings of the 39th Annual Hawaii International Conference on System Sciences* (pp. 132-132). Hawaii, USA,

Chen, J. & Kinshuk. (2005). Mobile technology in educational services. *Journal of Educational Multimedia and Hypermedia*, 14(1), 91-110.

Cobcroft, R., Towers, S., Smith, J. & Bruns, A. (2006). Mobile learning in review: Opportunities and challenges for learners, teachers, and institutions. *Proceedings Online Learning and Teaching (OLT) Conference* (pp. 21-30), Queensland University of Technology, Brisbane.

Csete, J., Wong, Y. & Vogel, D. (2004). Mobile devices in and out of the classroom. In L. Cantoni & C. McLoughlin (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2004* (pp. 4729-4736). Chesapeake, VA: AACE.

Davis, F.D., Bagozzi, R.P., & Warshaw, P.R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, 22(14), 1111 - 1132.

Dillon, A. (2001) User acceptance of information technology. In W. Karwowski (ed). *Encyclopedia of human factors and ergonomics*. London: Taylor and Francis.

Dillon, A., & Morris, M. G. (1996). User acceptance of information technology: Theories and models. *Annual Review of Information Science and Technology*, 31, 3-32.

Duncan-Howell, J., & Lee, K.T. (2007). M-learning: Finding a place for mobile technologies within tertiary educational settings. In *ICT: Providing choices for learners and learning. Proceedings ASCILITE Singapore*. Retrieved November 4, 2009, from <http://www.ascilite.org.au/conferences/singapore07/procs/duncan-howell.pdf>

Holzinger, A., Nischelwitzer, A., & Meisenberger, M. (2005). Lifelong-learning support by m-learning: Example scenarios. *eLearn Magazine*, 2.

Huang, J.H, Lin, Y.R., & Chuang S.T. (2007). Elucidating user behaviour of mobile learning: A perspective of the extended technology acceptance model. *The Electronic Library*, 25(5), 586 – 599.

Fidler, L.A., & Johnson, J.D. (1984). Communication and innovation implementation, *Academy of Management Review*, 9(4), 704–11.

Kiljander, H. (2004). *Evolution and usability of mobile phone interaction Styles*. (Master's thesis, Helsinki University of Technology, 2004). Retrieved November 4, 2009, from <http://lib.tkk.fi/Diss/2004/isbn9512273209/>

Johnson, K., McHugo, C., & Hall, T. (2005). Analysing the efficacy of blended learning using Technology Enhanced Learning (TEL) and m-learning delivery technologies. In, *Who's learning? Whose technology? Proceedings ASCILITE Singapore*. Retrieved

November 4, 2009, from

http://www.ascilite.org.au/conferences/sydney06/proceeding/pdf_papers/p73.pdf

Kwon, H.S., & Chidambaram, L. (2000). A test of the technology acceptance model: The case of cellular telephone adoption. In *Proceedings of the 33rd Hawaii International Conference on System Sciences* (pp. 1-10). IEEE Computer Society.

Lee, W.J., Kim, T.U., & Chung, J. (2002). User acceptance of the mobile internet. In *M-Business 2002*. Athens, Greece.

MacCallum, K., & Jeffrey, L. (2009). Identifying discriminating variables that determine mobile learning adoption by educators: An initial study. In *Same places, different spaces. Proceedings ASCILITE Auckland 2009*.

<http://www.ascilite.org.au/conferences/auckland09/procs/maccallum.pdf>

Mac Callum, K., & Kinshuk. (2008). Mobile technology in collaboration: Evaluation of a web-based discussion board. *International Journal of Mobile Learning and Organisation*, 2(4), 318–328.

Masters, K. (2008). M-learning: How much of what has been diffused? A systematic literature review. In *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2008* (pp. 5790-5795). Chesapeake, VA: AACE. Retrieved from <http://www.editlib.org/p/29185>.

Noelting, K., & Tavangarian, D. (2003). New learning scenarios? Mobile learning and teaching at universities. In *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2003* (pp. 658-661). Chesapeake, VA: AACE. Retrieved November 4, 2009, from <http://www.editlib.org/p/15026>.

Pedersen, E. (2003). Adoption of Mobile Internet Services: An Exploratory Study of Mobile Commerce Early Adopters. *Journal of Organizational Computing and Electronic Commerce*, 15(3), 203-222.

Phuangthong, D., & Malisawan, S. (2005). A study of behavioral intention for 3G mobile internet technology: Preliminary research on mobile learning. In *Proceedings of the Second International Conference on eLearning for Knowledge-Based Society*.

Peters, K. (2009). M-learning: Positioning educators for a mobile, connected future. In M. Ally (Eds.), *Mobile learning transforming the delivery of education and training*. Athabasca University, Canada.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.

Schreurs, J. (2006). M-learning using PDA's and our supporting LOMS. *International Journal of Computing and Information Sciences*, 4(2), 9-15.

Sharples, M., Taylor, J., & Vavoula, G. (2005). Towards a theory of mobile learning. In H. van der Merwe & T. Brown, *mLearn 2005 4th World Conference on mLearning*. Retrieved November 4, 2009, from <http://www.mlearn.org.za/CD/papers/Sharples-%20Theory%20of%20Mobile.pdf>

Stead, G., Sharpe, B., Anderson, P., Cych, L., & Philpott, M. (2006). *Emerging technologies for learning*. Coventry, UK: Becta.

Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research*, 79(2), 625–649.

Taylor, J., & Evans, D. (2005). Pulling together: Keeping track of pedagogy, design and evaluation through the development of scenarios - a case study. *Learning, Media and Technology*, 30(2), 131-145.

Teng, J.T.C., Grover, V., & Guttler W. (2002). Information technology innovations: General diffusion patterns and its relationships to innovation characteristics. *IEEE Transactions on Engineering Management*, 49(1), 13-27.

Teo, T.S.H., & Pok, S.H. (2003). Adoption of the internet and WAP enabled phones in Singapore. *Behaviour & Information Technology*. 22(4), 281-289.

Trifonova, A., & Ronchetti, M. (2004). A general architecture to support mobility in learning. *Proceedings of the IEEE International Conference on Advanced Learning Technologies* (pp. 26-30), IEEE Computer Society.

Tornatzky, L.G., & Klein, K.J. (1982). Innovation characteristics and innovation adoption implementation: A meta-analysis of findings, *IEEE Transactions on Engineering Management*, 29(1), 28–45.

Van Biljon, J., & Kotzé, P. (2008). Cultural factors in a mobile phone adoption and usage model. *Journal of Universal Computer Science*, 14(16), 2650-2679.

Zaltman, G., & Lin, N. (1971). On the nature of innovations, *American Behavioral Scientist*, 14(5), 651-73.