Focus and Setting in Mobile Learning Research: A Review of the Literature

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Abstract

Mobile learning (mLearning) is an ubiquitous learning activity supported by the appropriate mobile technology and pedagogical approach. Mobile learning research has experienced a significant growth in the last half a decade, following the increase in innovative applications and the expansion of the contexts in which mLearning is deployed. Based on a review of publications found in international conference proceedings and journals, this study classifies mLearning research according to its focus, and proposes a classification framework. Patterns in shifting research focus are identified and some defining characteristics of the approaches undertaken are elicited. The results of the analysis show that while mobile learning research continues to be motivated by the innovative mobile technology it is also increasingly concerned with the development of a theoretical foundation in order to underpin the new paradigm and inform contemporary mobile learning design and practice.

Keywords: mobile learning, mLearning, classification, research focus, research setting, research domains, research patterns.

1. Introduction

The application of mobile technologies in education has given birth to a new application area known as 'mobile learning'. Mobile learning (mLearning) can be defined as a ubiquitous learning activity occurring through person-to-person communication using a mobile device which is supported by an appropriate mobile technology, user interface and a pedagogical approach (Nyiri 2002; Petrova 2007a; Sharma and Kitchens 2004). Mobile learning (mLearning) has attracted significant research interest in recent years. Published work spans a range of topics including theories underpinning learning design (Hartnell-Young 2007; Ng and Nicholas 2007; Petrova 2007b) and factors affecting learner experiences and influencing mobile learning adoption including social interaction (Göth et al. 2006; Naismith and Smith 2006; Nickerson and Isaac 2006; Petrova 2007c; Tan and Henten 2006). Based on a review of the existing literature (work published in international conference proceedings and journals), this paper proposes a classification framework for mobile learning research and applies it to identify the themes and trends in mobile research focus with the objective to understand better the relationship between the choice of a research setting and educational theory and pedagogy. The guiding research questions of the study can be formulated as: 1) What are the

emerging research domains in mobile learning research?, and 2) What is the relationship between research domain focus, and research setting? More specifically it is hoped that by investigating the choice of a research setting and its implications the study will be able to provide recommendations for further research and development in mobile learning.
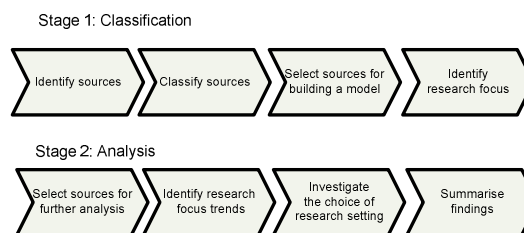

Fig 1. Classification and Analysis Process

In order to achieve its objective, the study followed the two-stage exploratory process depicted in Fig 1. The rest of the paper presents the study findings and is organized along the process chain. The next section introduces an initial classification and a mobile learning analysis framework. The sections following present and discuss mobile learning research with respect to research focus and setting. The last section summarizes the results, discusses their implications, indentifies the limitations of the work and suggests directions for further research.

2. Classifying Mobile Learning Research

An initial review of the literature in the field suggested that both conference proceedings and journals published research related to mobile applications including mobile learning. The initial review drew on the experience of the authors in their prior work in the area which also suggested that mobile learning research was widely published and publicized online. Therefore it was considered that a useful first step would be to compile a start-up list of international conference and journal titles using Google® search with two simple search arguments: 'mobile learning conference' and 'mobile learning journal'.

The search results were cross-checked against the reference sections of papers already known to the authors. Two selection criteria were applied next: 1) By the end of 2007, all selected journals should have published at least two complete annual volumes, and all selected conferences should have run at least twice, ; and 2) The selected conferences and journals should have carried out a quality assurance process (e.g. a peer review or similar) for accepting papers / articles for publication.

A total of 25 sources (18 journals and seven conferences) were identified as containing a relatively high number of papers or articles related to mobile learning. A comprehensive literature review report on mobile learning (Cobcroft 2006) was used as an additional means of verifying and confirming the selection, shown in Table 1 (in alphabetical order according to the source name, with conferences explicitly marked as 'c').

Table 1: Conference and Journals with Mobile Learning Content

#	Journal / Conference	Acronym
1	Global Mobility Roundtable	GMR 'c'
2	IBIMA (International Business Information Management Association) Conference	IBIMA 'c'
3	International Conference on Interactive Mobile and Computer Aided Learning	ICML 'c'
4	International Conference on Mobile Business	ICMB 'c'
5	International Conference on Mobile Learning	mLearn 'c
6	IADIS (International Association for Development of the Information Society) International Conference Mobile Learning	IADIS ICML 'c'
7	International Journal of Computer Applications in Technology	IJCAT
8	Journal of Computer Assisted Learning	JCAL
9	International Journal of Continuing Engineering Education and Life-Long Learning	IJCEEL
10	International Journal of Information and Operations Management Education	IJIOME
11	International Journal of Innovation and Learning	IJIL
12	International Journal of Knowledge and Learning	IJKL
13	International Journal of Learning Technology	IJLT
14	International Journal of Learning and Change	IJLC
15	International Journal of Learning and Intellectual Capital	IJLIC
16	International Journal of Management in Education	IJMIE
17	International Journal of Mobile Communications	IJMC
18	International Journal of Mobile Learning and Organization	IJMLO
19	International Journal of Mobile Network Design and Innovation	IJMNDI
20	International Journal of Teaching and Case Studies	IJTCS
21	International Journal of Technology Enhanced Learning	IJTEL
22	International Journal of Technological Learning, Innovation and Development	IJTLID
23	International Journal of Virtual Technology and Multimedia	IJVTM
24	International Journal of Wireless and Mobile Computing	IJWMC
25	IEEE International Workshop on Wireless and Mobile Technologies in Education & IEEE International Workshop on Wireless, Mobile and Ubiquitous Technology in Education (continues from WMTE)	WMTE/ WMUTE 'c'

An inspection of the scope of each source was carried out in order to determine its relevance to mobile learning research. The analysis of the subject themes covered showed that the sources in Table 1 could be broadly categorized as 'general' (i.e. journals and conferences publishing across the whole range of mobile technology and applications including mobile learning), or as 'specific' (i.e. journals and conferences dedicated almost exclusively to mobile learning). It was noted that many journals and also conferences included mobile learning as part of eLearning, or technology supported learning.

To understand the focus of the mobile learning content published in the selected sources, a further review of the titles and the abstracts of the relevant papers and articles found in each source was conducted. The results showed that while many publications placed a strong emphasis on the development of mobile technologies and techniques and their integration into student learning activities, other studies were primarily concerned with issues related to the adoption of mobile learning, the development of mobile learning pedagogical and business models, and the implications of mobile learning for student-centered learning and distance education. A number of works shared both main foci ('technology' and 'pedagogy').

These findings suggested that the selected conference proceedings and journals could be classified in a 2*3 framework using the source category (either 'general' or 'specific') and the source focus ('technology', or 'pedagogy', or both) as classification criteria. Next each source was examined in order to determine its category and the prevailing focus of the works published in it, thus determining its placement in one of the three vertical sections shown in Fig 2 ('mobile technology', 'mobile technology and mobile pedagogy', and 'mobile pedagogy').

A source is represented by a number in an oval positioned at the appropriate side of the horizontal axis to reflect its category ('specific' vs 'general'). The numbers in the ovals correspond to the numbers in Table 1.

It was found that both general and specific sources included papers and articles ranging from technology focused to pedagogy focused. It was also established that the majority of the sources tended to publish work across the range of foci, maintaining a balance between technology oriented and pedagogy oriented mobile learning content (see the clustering of sources in the inner section of the figure).
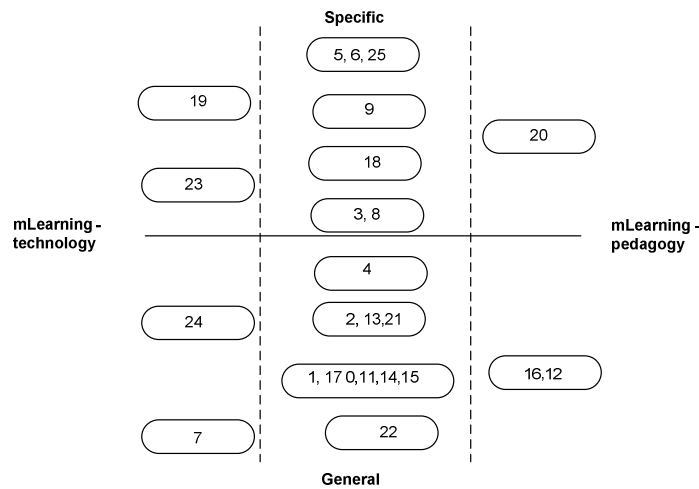
Specific

5, 6, 25

19

9

20

23

18

mLearning - technology

3, 8

mLearning - pedagogy

4

24

2, 13,21

1, 17 0,11,14,15

16,12

7

22

General

Fig 2. Mobile Learning Research - Sources

A further in depth review of all relevant published work in all sources included in the research so far would provide additional justification of the classification derived and help build a model suitable for subsequent investigation. As it would be technically very difficult to accomplish such a review, a representative sample was chosen instead consisting of two 'specific' conference sources, whose proceedings spanned the period 2002-2007.

The sources selected were the mLearn conference, and the WMTE/WMUTE workshop. It was assumed that conferences would present the field sufficiently well as journal publications would normally extend and expand an already presented conference contribution. In addition mLearn had been an annual international conference since 2003 (Naismith and Corlett 2006) with proceedings available online since 2002; WMTE/WMUTE had been an international workshop since 2002, with proceedings accessible through IEEE Xplore (published in 2002, and in 2004-2006). It was considered that a review of the papers presented at these two long standing and internationally acknowledged events would allow to identify reliably the main research themes in mobile learning research and their relationship to the domains of 'technology' and 'pedagogy'.
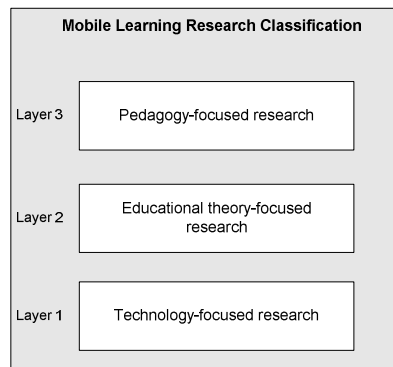
A total of 424 publications were included in the review. Their titles and the abstracts were used to inform the subsequent classification process (where necessary a reference was made to the text itself).
It was found that the majority of reviewed publications explored the two already identified research domains ('technology' and 'pedagogy'), often with the two areas covered in a single work. A number of studies also discussed the emergence

and development of educational theories for mobile learning (such as constructivism or behaviorism) thus adding a third research domain ('educational theory') to the initial two. These findings allowed to expand the classification of the mobile learning research domains look at the relationship between them. A model adapting an earlier reference framework for mobile commerce (Petrova 2006) comprising the three domains is shown in Fig 3.

Mobile Learning Research Classification

Layer 3   Pedagogy-focused research

Layer 2   Educational theory-focused research

Layer 1   Technology-focused research

Fig 3. Mobile Learning Research - Domains

The assumptions underlying the model can be summarised as follows:

1. Technology-focused research is conducted to investigate issues such as mobile device usability, or network related information transmission delay, and their implications with respect to the integration of mobile technology into learning. For example the Short Message Service (SMS) data technology may be used as a platform to support learning activities that can occur

'anywhere, anytime' (Komninos et al. 2006).

2. Educational theory- focused research deals mostly with the feasibility and validity of employing the novel mobile technologies in teaching and learning and investigates their suitability for particular learning designs. For example, behaviorism, which is a traditional educational theory, may underpin the use of SMS-based 'vocabulary learning' (Ally et al. 2007) New theories for mobile learning are also sought: According to Hartnell-Young (2007) educational theories rather technologies will have influence on learning activities design.

3. Researchers involved in pedagogy-focused research normally would assume that the mobile technology of their choice is available and acceptable to be used, and that the use of the particular technology is justifiable in an educational context; therefore their work often results in tangible outcomes such as graphs or audio files delivered to students in a teaching and learning setting (Lavoie 2006).

It needs to be noted that while the model reflects the nature and direction of the vast majority of publications in the sample, some works (a limited number) were concerned with multiple aspects of mobile learning as used by both individuals and organizations; such 'generalist' works tended to span themes from more than one research domain (e.g. Goerke and Oliver 2007; also Yen and Chen 2007).

Despite this limitation, the model was successfully implemented to study the emerging directions in mobile learning research and its relevance to practice, as shown in the next two sections.

3. Emerging Research Directions
In order to identify the emerging directions in contemporary mobile learning research, the initial selection of sources was first filtered to remove sources with relatively small amount of mobile learning related content, and/or being published in less than three yearly volumes. To ensure that the data capture process had enough breadth, both specific and general sources from the inner section in Fig 2 were considered. To ensure currency of information, only sources published in 2005-2007 were included.

Thus three 'specific' and three 'general' sources were selected for the second stage of the project, including three international conference proceedings and three international journals. For each source, only articles or papers with mobile learning research content reporting the results of a

research project were counted (i.e. articles or papers presenting literature review findings only were excluded).

The selection process resulted in identifying a total of 333 publications (2005-2007) suitable for subsequent analysis as shown in Table 2 (the numbers in brackets refer to the codes used in Table 1).

Table 2: Mobile Learning Publications 2005-2007 (six sources)

	(5)	(6)	(4)	(8)	(11)	(17)	Total
2005	66	50	2	4	0	1	123
2006	35	69	0	2	1	1	108
2007	38	52	0	6	3	3	102
Total	139	171	2	12	4	5	333

All 333 articles and papers were further analyzed in order to identify their research focus, or multiple research foci with respect to the three main research domains (technology, educational theory, pedagogy). For comparison purposes, 'generalist' papers as defined in Section 2 were also included. The results indicate at a shift from focus on technology to focus on theory (Fig 4).
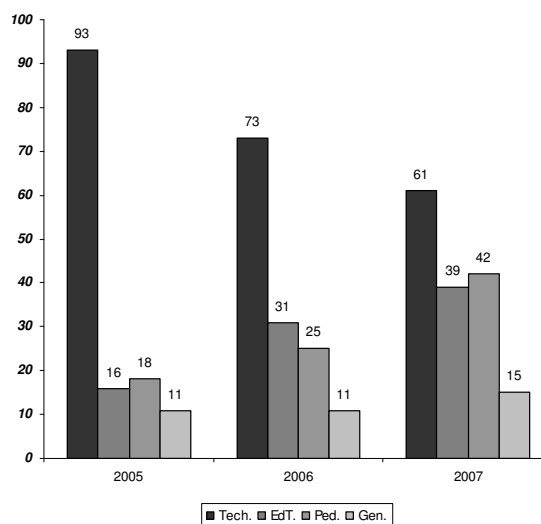

Fig 4. Mobile Learning Research - Directions

It can be seen that initially researchers had placed a very strong emphasis on the use of mobile technology and the issues related to its integration into learning (in 2005, the technology theme appears 91 times in 123 publications). In 2006 and 2007 the focus of research shows a shift towards theory building in the educational theories domain and the contextualization of theories as a pedagogical approach signaling the emergence of the mobile learning paradigm (Laouris and Eteokleous 2005; Petrova 2007a; Sharples et al. 2007). Even though in i2007 technology-oriented research dominates the sample (in 61 publications out of 108 one of the main

foci is technology), in a total of 81 publications, research focuses on building or applying a theory.

The number of articles or papers of a 'generalist' nature shows a slight increase as well. It must be noted that the overall number of publications in the sample has decreased from 2005 to 2007, possibly related to factors outside the scope of this study (e.g. travel constraints).

In order to gain an insight into how relevant the outcomes of mobile learning research may be to real life implementations of mLearning, at the next and final step of the analysis an attempt was made to identify the relationship between the research domain and the research setting of the individual studies.

4. Mobile Learning Research Setting

Assuming that a project investigates a research problem related to technology, pedagogy or educational theory, it may be postulated that the more realistic the research setting is the more valuable and informing the research results would be. In order to define a 'realistic' research setting, a framework found in (Carter 2007) was adapted.

The framework describes the setting within which a research project occurs in terms of time, place, technological artifact, and participants, among others. In educational research the research setting can be close to real life (e.g. when the research activity occurs directly in the classroom), or relatively removed from it (e.g. when the research design involves a simulated learning activity).

In the specific context of mobile learning a 'realistic'; research setting is characterized by one or more of the following: i) the research activity occurs where participants normally engage in learning; ii) the research activity occurs when participants normally use mobile technology, iii) the research activi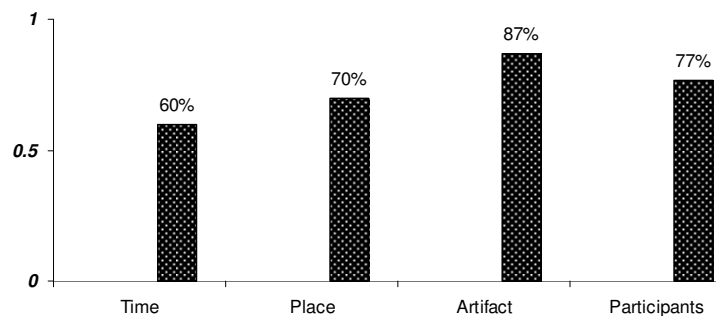ty is based on the use of a mobile device connected to a the network of a mobile provider; and iv) the research activity involves the actual learners (e.g. students) as participants.

Further in-depth analysis was conducted in order to identify the choice and use of the research setting used in publications reporting on research projects. However only one most recent, specific conference source was chosen – the mLearn 2007 conference proceedings volume.

The number of papers in the volume (38) represents 37% of all papers and articles in the 2007 sample used at the previous step. The mix of papers in the volume is similar to the distribution of themes of the 2007 sample, with eight papers of a 'generalist' nature. Out of the remaining 30 papers, technology was the main focus in 25 papers, educational theory – in 19, and pedagogy –in 20 papers. Therefore it was assumed that despite the small sample of papers the findings would allow to identify meaningful patterns and provide an insight into the issues faced by researchers.

With respect to the use of a research setting it was found that in 17 papers all setting dimensions were realistic, while in 12 papers only some of them were; one paper was a research in progress but planning to use a fully realistic setting for the actual data. The percentage distribution across the dimensions is shown in Fig 5. It can be seen that the most often chosen realistic dimension is the use of the technological artifact, followed by participants and place.

Fig 5. Mobile learning research – Setting

Only in 60% of the settings the time when the research occurred was also the time when participants would use the technology in everyday life. In other words, research into using mobile technology for learning activities may have made somewhat limited use of the 'study anytime any place' opportunity offered by the technology: a number of research activities were not carried out in

an environment where the participant was normally mobile, but in a physical classroom setting and during scheduled class hours.

However this might also point out at the emerging of two types of mobile learning approaches– one a classroom centred mobile learning as a type of blended learning- (see also Song 2008), and the other - extramural learning as illustrated in (Motiwalla 2007; Ryu, 2008).

The choice of participants in most cases involved students or other types of learners as appropriate to the context. However participants from other groups (academics, the researchers themselves) acted as domain experts or usability testers performing a cognitive walk through (Carter 2007), especially in the case of novel technology. Researchers focusing on educational theory or pedagogy mostly used settings involving the intended participants and easily accessible, 'every day' mobile technology.

Even though the choice of artifact was realistic in most settings, all papers in the sample of 30 were examined in order to identify the factors influencing the choice of artifact. Two groups of factors affecting the design of a research setting with respect to the artifact were identified: socio economic, and technology related.

Socio-economic factors included high service cost (for participants), or participants not owing a personal mobile device. To ensure research result value, in some cases the negative effect of the socio-economic factors would be mitigated by he organization supporting the research project, or by the researchers themselves bearing the cost for participants.

Technology factors included the application of novel technology, technology still under development, and/or service not yet available on the market. As expected, in projects dealing with new technology or service the use of the artifact was not realistic however this should not have affected negatively the expected research outcomes as these would serve to inform future development. The type of technology used varied from 'popular' such as SMS (text messaging) to 'still under development' such as RFID (Radio Frequency Identification). The comparison between research focus (technology, educational theory, pedagogy) and technology type (popular vs. new) showed a pattern of exploring new technologies in technology–oriented research and using trialed and tested technologies in theory-oriented research.

While technology focused research tended also to suggest new educational models, theory-focused research was mostly concerned with the investigation of the educational and pedagogical value of the emerging technology innovations. As

emphasized in the discussion of the layered framework (Fig 3) innovative mobile learning experiments with technology need to be further contextualized within the appropriate educational theory and then pedagogy in order to inform teaching practice and learning and offer implementable mobile learning models meeting the needs of academic but also non-academic participants (Cobcroft et al. 2006; Raleru 2003; Chong 2007).

5. Concluding remarks

The paper reviewed the literature on mobile learning research, identified relevant sources (journals and conference proceedings), and categorized the initial sample applying a two dimensional framework. Based on a study of a smaller sample of six sources it was found that contemporary mobile learning research no longer focuses exclusively on technology but is also concerned with building the theoretical foundation of mobile learning both in terms of educational and pedagogical theories. However technology focused research tends to use new or untested technology (innovation) and thus drives both technology development, and further mobile learning research.

Theory focused research tends to use 'old' technology as it consolidates the results of technology focused research into learning practice experiences, and educational and business models underpinned by educational and pedagogical theories. As implied by the layered classification model introduced in the second section of the paper mobile learning as a widespread practice results from the theory building efforts which in turn are based on innovative technology oriented mobile learning research .

Through the investigation of a smaller sample (the papers found in one source only) it was found that a significant number of the examined research designs deployed a realistic research setting, engaging real students and using real technology in the research activity. However in some cases researchers had to counteract socio-economic factors such as service cost and device ownership in order to carry out the research; cost therefore might still be a barrier to the wider spread of mobile learning. According to the time and place of the activity, in a significant number of projects the time and place were chosen to align with actual classroom and class time, meaning that the mobile learning approach was not really targeting a mobile learner. This may also signify the emergence of two different mobile learning models: classroom centred, extramural.

Despite the study limitations such as not including some recently launched academic journals dedicated to mobile learning , the small sample size used in the second stage of the study, and the relatively narrow analysis scope, it is hoped that the work highlights the patterns in terms of focus shift, and the importance of the research setting. Directions for

further work include expanding the scope of the literature review, testing and possibly refining the frameworks introduced with new data, investigating the choice or research method, and studying the relationships between research focus, research method and research setting and their implications for mobile learning practice and adoption.

6. Acknowledgement

7. References

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