

A Mobile Human-Computer Interaction Perspective on Mobile Learning

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Applying a Mobile Human Computer Interaction (MHCI) view to the domain of education using Mobile Learning (Mlearning), the research outlines its understanding of the influences and effects of different interactions on the use of mobile technology in education. This research therefore evaluates specific mlearning projects, informed and directed from a MHCI perspective. The objective of this would be to highlight additional benefits, challenges, influences and effects of using mobile technology as an ICT in education. This investigation has led our research to suggest additional insights for MHCI and simultaneously provided a better understanding of the development and implementation of mobiles in teaching and learning.

Categories and Subject Descriptors: H.1.2 [User/Machine Systems]: Human Factors and J.1 [Administrative data processing]: Education

General Terms: Human Factors, Theory.

Additional Keywords and Phrases:

Mobile Learning, Mobile Human-Computer Interaction, Mobility, Context

1 INTRODUCTION

The implementations of mobile technologies, applications and data services have become integrated in the field of education. The fast growing technological developments have enabled and encouraged the investigation of “new geographies of learning [Thackara 2000].” These investigation fields such as mobile and technology-enhanced learning, have emerged as well-defined research areas in education and have their own design agenda and pedagogical concerns [Kelly, Lesh and Baek 2008; Kukulska-Hulme and Traxler 2005; Sharples, Taylor and Vavoula 2007; Voogt and Knezek 2008]. Nonetheless, designing learning activities, and their supporting technologies, pose significant challenges as a result of the intertwining of technological issues with pedagogical objectives and learning practices [Rossitto, Spikol, Divitini and Cerratto-Pargman 2010].

2 MOBILE LEARNING

Mobile technology’s application in education has been the focus of the emerging domain of Mobile learning and has, through numerous pilots and initiatives, been shown as having the potential to overcome several barriers experienced in education and to enhance the learning environment. Experience and expertise in the development and delivery of mlearning has resulted in a discrete community of practice evolving separate from the e-Learning community. Mlearning, an emerging discipline, has had a tendency to focus primarily on producing solutions and has tentatively developed distinctive theoretical conceptualisations [Hagen, Robertson, Kan and Sadler 2005; Traxler 2009]. The term Mlearning is currently applied to learning exploits with handheld computers and mobile phones as well as other mobile devices.

A definition of what Mlearning is, has been much debated, and appears to reflect the focus areas of the community that has put it forward. Solution based technology

research have a propensity to define Mlearning in terms of learning through mobile devices [Chen, Kao and Sheu 2003; Houser, Thornton and Kluge 2002; Liang, Liu, Wang, Chang, Deng, Yang, Chou, Ko, Yang, Chan and W. 2005; Quinn 2000; Trifonova and Ronchetti 2004]. Learners are described as accessing mobile devices to “acquire and learn through a wireless transmission tool anytime and anywhere [Chen, et al. 2003].” Reflecting the early solution based technology focus, Traxler [2005] initially suggested that Mlearning be regarded as “any educational provision where the sole or dominant technologies are handheld or palmtop devices.”

In contrast research which has been driven by concerns emanating from a pedagogical point of view, have defined Mlearning in terms of the extent it has enriched a particular learning environment and the learners’ experience of learning [Farooq, Schafer, Rosson and Carroll 2002; Grohmann, Hofer and Martin 2005; Rochelle, Vahey, Tatar and Penuel 2003; Rushby 2006; Young and Vetere 2005].

Another perspective has been in terms of the mobility affordance, framing Mlearning as “the study of how the mobility of learners augmented by personal and public technologies can contribute to the process of gaining new knowledge, skills and experience [Sharples, Arnedillo Sánchez, Milrad and Vavoula 2007].” Mobility is further deconstructed by Sharples et al. [2007] as the mobility:

- experienced by the user due to the change in physical space,
- as being able to interface between different technologies,
- in conceptual space as users move between topics,
- in social spaces, and
- over time, extending the formal learning situations as a cumulative experience.

Consensus, however, is that Mlearning, as a phenomenon needs to be considered in the context of the emergence of mobile phone [Laouris and Eteokleous 2005]. Traxler suggests mobile technology be recognised as fundamentally transforming societal notions of communication and understanding. Nyiri [2002; 2005] articulates this, stating that the

... mobile phone is evolving towards the dominant medium. It is becoming the natural interface through which people conduct their shopping, banking, booking of flights, etc. Moreover, it is turning into the single unique instrument of mediating communication not just between people, but also between people and institutions or more generally between people and the world of inanimate objects.

Traxler proposes that “... mlearning is not about ‘mobile’ as previously understood, or about ‘learning’ as previously understood, but part of a new mobile conception of society [Traxler 2009]”.

The mlearning interaction is underpinned by the requirements of pedagogy and the attributes and affordances of the technology to realise and support the aims of the user. This acknowledged inter-relationships and dependency of mlearning on the technology that supports it, is well documented and accepted [Laouris and Eteokleous 2005; Quinn 2000; Sharples, et al. 2007]. Traxler [2009], however, while recognizing this interdependency, discounts technology as a defining characteristic stating that “different hardware and software platforms support rather different interpretations of Mlearning.”

Mlearning is primarily about the mobility of the learner and the quality learning that it enables anywhere or anytime [Ally 2009; Laouris and Eteokleous 2005].

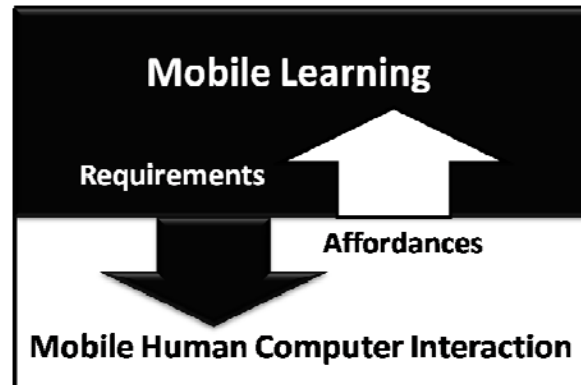


Figure 1: MHCI as support for Mobile Learning

The relationship between MHCI as outlining the affordances of the mobile technology, and Mobile Learning can be visualised as in Figure 1 above. The requirements for the interaction emanates from pedagogical concerns. The technology affordances does not define the Mobile Learning interaction, but rather supports it by offering needed qualities to fulfil the requirements for the interaction. This distinction, although slightly diffused, provides layers that present a direct or indirect impact on the mobile learning interaction of the user while providing a useful schema in that a clear statement of concern is represented.

These endeavours are within proven practices and models of teaching. Traxler concurs stating “...hardware devices and technical systems are all without exception designed, manufactured and marketed for corporate, retail or recreational users. Any educational uses of the devices and the systems are necessarily parasitic and secondary [Traxler 2009].”

3 MOBILE HUMAN-COMPUTER INTERACTION

HCI as an academic discipline is concerned with the study of situations involving people and technology, as well as the design practices and the tools and techniques used. MHCI is concerned with the reasons and ways in which people act and interact with mobile technology and the data that is accessed through these mobile devices [Bauer and Patrick 2004; Love 2005]. Mobile HCI underpins the Mobile Learning interaction by providing affordances to the teaching and learning interaction.

Context along with mobility emerge as common affordances framing mobile interactions [Bevan and Macleod 1994; Coursaris and Kim 2006; Han, Yun, Kwahk and Hong 2001; Lee and Benbasat 2003; Sarker and Wells 2003; Shackel 1991; Shami, Leshed and Klein 2005; Tarasewich 2003; Thomas and Macredie 2002; Yuan and Zheng 2005]. Each of these is elaborated on below:

3.1 Context

Context is a complex notion to define [Winters 2005]. According to Webster’s New Twentieth Century Dictionary [1980], context is “the whole situation, background or environment relevant to some happening or personality.” The concept has emerged and evolved alongside context-aware computing, but with little consensus on what is meant by it [Rodden, Chervest, Davies and Dix 1998; Winters 2005]. Oulasvirta *et al.* [2005] recognise two contrasting paradigms of thought. Realism,

grounded in natural science, positing that context is a construct, ontologically, can be measured and if properly instrumented and programmed, computing devices can adapt to different contexts. The constructivism paradigm, rooted in social sciences, holds that contexts are human creations, mental and social, and that computing devices ought to provide resources for managing them.

Definitions and views of context that are rooted in a positivistic philosophy share the subsequent basic assumptions. Context is real, structured and the structure can be modelled. Contexts share properties that exist independent of human interpretation and computing devices can recognise these properties and adapt their behaviour [Dourish 2004; Oulasvirta, et al. 2005]. From this perspective, Scilit *et al.* [1994; 2003; 1995] identified the location of user, the identity of user and the user's proximity to resources as the focus of context. They view context as a constantly changing execution environment and offer the following broad definition for context, stating, “[c]ontext encompasses more than just the user's location, because other things of interest are also mobile and changing. Context includes lighting, noise level, network connectivity, communication costs, communication bandwidth, and even the social situation [Schilit, et al. 1994:1].”

Dey *et al.* [1998] initially defined context as the user's physical, social, emotional, or information state and later evolve their view of context as “any information that can be used to characterize the situation of entities [...] typically the location, identity and state of people, groups and computational and physical objects [1998; 2001]”. Brown, Bovey and Chen [1997] views context as location, the identity of the people around the user, the time of the day, the season, temperature and other physical attributes. Along the same lines Ryan, Pascoe and Morse [1998] define context as location of the user, the environment, the users identity and the time of the interaction. Referring to context as the environment or situation, Franklin and Flaschbart [1998] interprets context as the situation of the user and Ward, Jones and Hopper [1997] refer to context as the state of the applications surrounding [Dey, et al. 2001].

Dourish [2004] reflecting on these definitions of context, grounded in a realist paradigm, identifies four assumptions that underlie this notion of context. These assumptions, he states, are:

- Context is information. This implies that context can be known and encoded;
- Context is delimited. Implying that for some applications context can be predicted;
- Context is stable. Once context elements have been identified these stay the same;
- Context and activity are separable. Activities are viewed as happening within a context, separate from the activity that is taking place.

In essence, Dourish argues for a constructivism view of context, which recognises multiple interpretations and understandings of context as constructed by the individual. A constructivism paradigm recognises that context is socially constructed, through interactions with agents in the world. Interpretation of context is constituted within a frame of reference with computing devices providing resources for people to create and maintain contexts in their actions [Oulasvirta, et al. 2005: 196]. Dourish holds that “the idea that context consists of a set of features of the environment surrounding generic activities, and that these features can be

encoded and made available to a software system alongside an encoding of the activity itself, is a common assumption in many systems.”

Viewing context not as a representational problem, but as an interactional problem, Dourish interprets context as something that people do instead of something that describes a setting. Context is seen as an emergent feature of the interaction, “determined in the moment and in the doing” [Dourish 2004].

Oulasvirta [2005] highlights that “contexts are constructed in complex interaction and interpretation chains that include not only computers but also other resources and people [...] context information is a resource for human action and has to be accounted by their users in social situations.” This shifts the focus from improving the correctness of the computing inference to their reparability thereof in social interactions.

The notion of context for this paper lies in a balance between the two approaches. Not all interactions with and through mobile technology ascribes to the notion of ubiquitous computing. Aspects of context are viewed from a pragmatic viewpoint in that the research is cognisant of an amount of uncertainty in these interactions. The acceptance of constructed context, however, will have to be incorporated in some sense, as virtual reality through mobile technology becomes a reality. Elements of context can be naively described as situations where the user’s physical relation to space and time would be significant (high context) to the interactions at hand and situations where the physical relation to space and time are less significant (low context).

The concept of context as an affordance of MHCI is complimented by the mobility of the interaction.

3.2 Mobility

The term ‘mobility’ as applied to mobile technology is not underpinned by a clear-cut definition or understanding in the MHCI or MLearning literature. Ballard argues that “mobility refers to the user, and not the device or the application [2007:3].” Oulasvirta and Brewster [2008] concur proposing that the major phenomenon surrounding mobile HCI is the user’s mobility. They argue that the user’s physical movement changes the conditions of the interaction so drastically that they suggest mobility of the user as one of the key challenges for MHCI research.

The focus on the user’s mobility contrast with literature where the view of mobility include users engagement in mobile activities in which there is a differentiation between highly mobile, slightly mobile and stationary interactions; capturing the intensity of mobility within the interaction [Kristoffersen, Herstad, Ljungberg, Loberli, Sandbakken and Thoresen 1999]. This view incorporates the static use of mobile technology were the technologies are primarily seen as tools for accessing information, rather than as tools for making different types of communication and sociability possible [Hagen, et al. 2005].

Such interactions include the ability to connect to remote information or to interact with information on the mobile device itself [Harper 2003]. Mobility here refers to the potential portability of the technology rather than the mobility in the use thereof. Ballard recognized this as ‘The Carry Principle’ and identified this portability as the distinction between mobile and other platforms in that the user is able to, typically carry the device all the time. The implications of this for the device and the users are listed below [Ballard 2007:2-3]

For the device:

- Form. The devices are small, have small screens and input devices battery powered with some type of wireless connectivity;
- Features. Any information or entertainment features;
- Capabilities. The wireless connection, size and power constrain the connection and processing speed;
- User interface. Due to the small screen, the device is a single window user interface making information sharing between applications awkward; and
- Proliferation. As always present and on personal devices individual taste and needs come into play negating a one fist all view to mobile technology.

The implications for the user are:

- User availability. The user is more available for communication and application interaction as the device is always present;
- Sustained focus. As the user is interacting in context, focus is not sustained, often interrupted or shared; and
- Social Behaviour. Always-available connections intrude in social and business activities.

The implications for the device and the user are not mutually exclusive when analysed from an interaction activity perspective as it incorporates both. The user acts with and through the technology to accomplish a goal [Kaptelinin and Nardi 2006; Nardi 1996].

Any analysis would include the actual interaction (mobile/stationary) as well as the setting (context) in which this interaction occurs as “the tool reveals itself to us only in use” [Bannon 1985]

4 MODEL

Amid the great diversity of initiatives and interactions, the challenge is to compare or group similar interactions in order to identify synergies and commonalities from the educational practise to feed into the design criteria for the mobile interaction. Such an endeavour would be facilitated with a classification matrix. The value of which would lie in its objective to establish and frame cross-disciplinary communication and understanding [Andriessen and Vartiainen 2006].

Thus, taking the interaction activity as the unit of analysis mobile technology enables mobility and interactions in context.

The following matrix for grouping and comparing mobile interactions, illustrated in the Figure 2, is discussed below to enable comparison.

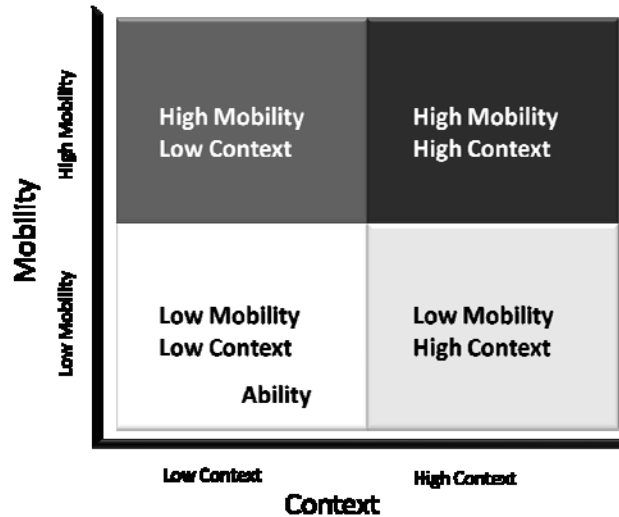


Figure 2: Mobility and Context in MHCI

4.1 Low Mobility

Low Mobility interactions can be viewed as the static use of mobile technology. The potential mobility of the device or the user is not essential for these interactions and the mobile technology is primarily in use because of other factors. These factors include low cost, availability, convenience and restricted connectivity. Such interactions include the connection to remote information or interactions with information on the mobile device itself.

4.2 High Mobility

High Mobility interactions are viewed as interactions in which the mobility of the technology or user is essential.

4.3 Low Context

In a low context scenario, users do not actively use the surrounding context and acts in context rather than with context. As such, context can be viewed as incidental. This does not imply that the context does not influence the interaction but rather that it does not actively feed in to make the interaction significant.

4.4 High Context

High context interactions are viewed as interactions in which the context feed directly into the interactions. This context is either the context of the user (marks, browsing history, preferences, points that have been visited) or the context of the interaction (significant environmental factors, locality, state of movement, surrounding). The latter being an example of ubiquitous computing.

4.5 Discussion

4.5.1 *Low Context Low Mobility Interactions*

These interactions are characterised by a general broadcasting of information to a selection of users or individuals. Users can give their full attention to the content, the device and more allows some complex interactions to be navigated (for example charging airtime through USSD).

Additional examples are use of SMS to inform parents of school activities, the announcement of lecturer consulting hours, sport results and the changing of lecture times or support of distance students are [Riordan and Traxler 2005; Silander, Sutinen and Tarhio 2004; Viljoen, Du Preez and Cook 2005]. This interaction moreover incorporates the access of information or applications on the mobile device [McAlister and Peng Hui 2005].

The technology is used for other reasons that its mobility and these interactions can be viewed as about the ability to connect, either to communicate or to access remote undirected information. The mobile device is used because it is conveniently accessible, affordable and/or connected. Many ICT4D interventions fall in this category.

4.5.2 *Low Context High Mobility Interactions*

The portability of the device and the mobility of the users are facilitated in the interaction but the physical context does not feed into the interaction. Examples of these interactions are characterised by activities on the move [Trifonova and Ronchetti 2005], learning in a train, watching mobileTV on the bus or sending English text to second language learners [Thornton and Houser 2001; Thornton and Houser 2005]. These interactions are characterised by users that cannot give their full attention to the interaction and they happen against a dynamic, often noisy and mostly incidental backdrop. Content delivered is to the point and consists of short snippets of information, more often than not irrelevant to the surrounding context. Most of these interactions do not demand immediate user interaction and information transfer is asynchronous.

4.5.3 *High Context Low Mobility Interactions*

In these interactions, the user has a virtual context or history. Some examples would include the stationary access to context in a lecture room or class that is linked to the specific learners context within the learning experience [Meawad and Stubbs 2005] Medical records accessed in hospitals [Smordal and Gregory 2003; Smordal, Gregory and Langseth 2002] or school attendance records being filled in by teaching staff, Classroom m-learning that allows for personalised learning and scaffolding [Gwo-Jong, Yuh-Shyan and Kuei-Ping 2004; Kuei-Ping, Chih-Yung, Hung-Chang and Sheng-Shih 2005; Shih, Lin, Hsuan-Pu and Kuan-Hao 2004; Shih 2005] and the creation of ad-hock classrooms [Chang, Sheu and Chan 2003]. These interactions are characterised by focussed user attention and often structured physical environments. The feedback needs to be instant as the user is waiting for a system reply. This type of interaction is often part of a formal environment and access is through a dedicated network specifically aimed at supporting the interaction. Many of these interventions are top down organisation initiated and users are supplied with identical devices.

4.5.4 *High Context High Mobility Interactions*

In these interactions the context, physically and virtual, feed into the interaction that is on the move. Pervasive learning environments [Schwabe and Goth 2005; Schwabe and Goth 2005; Syvanen, Beale, Sharples, Ahonen and Lonsdale 2005]; embedded learning in natural environments, GPS based games and collecting data in field studies with GPS based coordinates [Nova, Girardin and Dillenbourg 2005]

are some of the examples. Relevant campus announcements that are delivered to students in relevant proximities and campus navigation systems are additional examples. These interactions are typically restricted to higher end devices and demand some technical skill from the user due to design limitations.

5 CONCLUSIONS

Mobile Learning has great potential to enhance educational environments by providing access to information and communication capacities in a personal and ubiquitous manner. A neat definition of mobile learning that incorporates the whole of the phenomenon is unlikely, as it seems to morph as it is examined from different perspectives and the focal point shifts to accommodate the context and individuality of the user. In approaching mobile learning, the focal point of the interaction has stayed with the enabling of teaching and learning and the structuring of environments to optimally enable learning.

Mobile learning, however, is not a silver bullet. Mobile learning is perceived as successful when it appeases a pedagogical need within the complex interactions that frame the learning process, by either removing a barrier to the interaction or by augmenting an interaction. The versatility and ubiquitous nature of the technology allows Mobile learning to potentially service both measures in a host of innovative ways while increasing learner motivation as an additional extra. Mobile learning's potential might be attributed to the attributes of the technology that allow it to seamlessly integrate into pedagogical practices and assist interactions between the role-players in the teaching and learning interaction.

The criteria for learning interactions should be that they are meaningful and useful to the educational communities in which they are contextualised [Beetham and Sharp 2007]. The learner experience grounded in the teaching and learning context needs to be the focal point of any Mobile Learning design.

In contrast, the interdisciplinary nature of MHCI has the potential to silo results and research to domain specific investigations and theory development. The dynamic and volatile nature of the practice driven by rapid development in the commercial product market has far-reaching effects for research, demanding a rapid and relevant research base to reflect on. In order for this to become a reality researchers will have to move on from writing about mobile usage as if they discover a new continent with uncharted landscapes. The categorisation framework that is presented aims to prompt discourse across domain distinctions in order to facilitate reflection beyond producing solutions.

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