

A Synthesis of Current Mobile Learning Guidelines and Frameworks

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Abstract: As mobile devices with wireless access become more readily available, learning delivered via mobile devices of all types must be designed to ensure successful learning. This paper addresses three questions related to the design of mobile learning: 1) what m-learning guidelines can be identified in the current literature, 2) what m-learning frameworks exist and what do they claim about the design of m-learning, and 3) what insights can be gained from attempts to bring m-learning to developing countries. Based on an examination of these questions, we aim to synthesize existing guidelines, understand these guidelines in light of the theory of transactional distance, and present a preliminary discussion of reasons why m-learning is not merely an evolution of e-learning. We also identify areas where additional research is needed to further develop guidelines and frameworks and address these topics.

Introduction

While standards for developing and delivering e-learning content have been the subject of significant study, the same is not true of m-learning. Currently, only 0.3% of the world's population has a smart phone or tablet (Frommer, 2011). But as mobile devices with wireless access become more readily available, creating learning content delivered via mobile devices of all types, that ensures successful learning, will be a serious challenge. This is particularly true in developing countries where many people have limited or no access to wired broadband internet.

Given the early stage of m-learning development, there has been limited research attempting to create a comprehensive set of design guidelines. A lack of a consensus on what constitutes the essential focus of m-learning is one factor hindering this effort. For example, researchers and practitioners disagree on what is mobile learning. Early attempts to define m-learning focused on the devices that allowed learning to occur anywhere and at any time. Caudill (2007) considers six definitions of m-learning, and the focus in each was on the idea of mobility made possible by the use of wireless devices. This emphasis in early definitions was on the idea that m-learning would be learning anywhere, at any time because learners could access instructional resources via wireless devices from any location at any time. Therefore, design guidelines focused on the device that makes m-learning possible.

Over past several years, the focus in defining m-learning is on the idea of learner mobility that results from the devices used. Traxler (2010) noted this shift from the device to learner when he stressed how new mobile devices such as netbooks and the iPad "*problematise the boundary between the mobile learning and the portable and the merely 'luggable' aspects of e-learning*" (p. 130). El-Hussein and Cronje (2010) noted the same emphasis when they stated that m-learning makes sense "*only when the technology in use is fully mobile and when the users of the technology are also mobile while they learn*" (p. 14). This shift in defining m-learning indicates designers should not understand m-learning merely as an evolutionary step of e-learning using untethered electronic devices, where the focus is on designing instruction for a new class of mobile technology. Rather, designers need to broaden their perspective of what the mobility of the learner entails in relation to learning. By recognizing this shift in the definition of m-learning, it is possible to identify a dichotomy of guidelines with one set focusing on the technology and one set focusing on the learner.

m-Learning Design Guidelines

A review of available literature relating to definitions of m-learning clarifies two broad categories of guidelines: 1) technical and device guidelines; and 2) guidelines related to considerations of the environment of

the learner. Since early attempts to define m-learning focused on the mobile devices, there are more guidelines related to technical and device considerations. Table 1 summarizes these guidelines.

1. Choosing technology	primarily consider the type of technology to use and its suitability for the type of learning.
2. Usability	ensure that one considers issues of usability as they relate to using small mobile devices and requirements of learners who will be using the devices.
3. Platform and format	m-learning should be designed for as many platforms as possible using cross-platform compatible formats (PDFs, HTML, mp3, etc.) while reducing file size and subsequent processor requirements.
4. Tools and user interface	user interface must not be too complex as to add to cognitive load and take away from desired learning.
5. Design of content	make sure content is chunked and ensure only required content is presented to ensure information is displayed on screen to reduce the need for scrolling if possible.
6. Range of User Technology	design content to be accessible by users with limited mobile technology (e.g. texting or SMS) while being ready to leverage options available through new technologies such as 3G and 4G mobile devices.

Table 1: Technical and device design guidelines

Technical and device design guidelines: Vavoula, Lefrere, O'Malley, Sharples, and Taylor (2004) note that any m-learning guidelines should rest on best practices and insights informed by research. They identify nine guidelines, but only two of these are for designers: choosing technology and usability. First, the technology should support the type of learning one is designing. Second, designers must take into account the usable limits of the technology, e.g., screen size, and any limitations users may encounter with the technology, e.g., visual impairments.

Low and O'Connell (2006) propose three areas of technical guidelines. They stress that m-learning design should be an outgrowth of e-learning design. One principle is usability, reiterating a point made by Vavoula et al. (2004). Two others they note are that the platform/format ought to be as universal as possible and design the m-learning content according to standards of instructional design as well as meeting design guidelines for mobile devices published by the World Wide Web Consortium (W3C).

Peng and Chou (2007), in their study on using mobile computing as cognitive tools by middle school students, note that different tools may be useful for different cognitive tasks. They stress that not only should one select the appropriate tool for the desired learning, but also the learning interface must allow learners to focus on higher order thinking.

Finally, Xiao, Wang, Callaghan, Chen, and Zhao (forthcoming) identify four principles of design. Two of these – “*Design for eLearning, Adapt for m-learning*” and “*Design Short and ‘Condensed’ materials for Smart Phones*”, reflect points made by Low and O'Connell (2006). The other principles are “*Design for the Least Common Denominator*” and “*Be Creative when Designing for Mobile Devices for 3G Technology.*” These stress that, on the one hand it is important to recognize that many mobile devices are limited technology, and designers must make materials accessible to users of such technology. On the other hand, newer technologies open the possibility to leverage a greater variety of delivery options and materials. Designers need to keep the extremes of technology in sight when designing m-learning content. This point is identified as *Range of User Technology* in Table 1.

Learner-based design guidelines: Recent definitions of m-learning have emphasized the learner as mobile, and this had led to initial attempts to identify design guidelines that focus on the learner. Researchers have done far less to formalize these than the technological guidelines, but it is possible to identify two categories of learner-based design guidelines: m-learning should be learner centric and it should account for the variety of environments learner may find herself. These are clarified below and summarized in Table 2, Learner-based design guidelines.

1. Learner centric	learning activities should be learner centered, collaborative, and constructive
2. Learner environment	consider the learners location on both micro (place) and macro levels (locale, culture)

Table 2: Learner-based design guidelines

One area of focus is on designing instruction that is learner centric. In discussing criteria for evaluating mobile learning, Traxler and Kukulska-Hulme (2005) argue that any evaluation of m-learning should include an attempt to determine whether any cognitive or meta-cognitive change occurred in the learner. Prior emphasis on content design related to the technological resources for delivery of m-learning, but it is also important that the design of m-learning should focus on the learner and not just the delivery of the content. How to ensure that m-learning remains learning centric is still an open issue, but some research has illustrated what is necessary to follow this guideline.

Zurita and Nussbaum (2007) present a conceptual framework for integrating collaborative learning into mobile computer systems. Relying on action theory, they attempt to show how the use of mobile technology can fit into collaborative learning activities. They identify the role technology would play in the tools needed for collaborative learning, but more importantly they stress the need to clarify the roles and rules of learners when using mobile computer systems in a collaborative learning environment. Clarifying the roles and rules for learners is one way to ensure m-learning remains focused on the learner.

Wang (under review) also expresses a similar claim that m-learning ought to be learner centric. In addition to noting that designers should design material for different devices, Wang notes that designers should design m-learning for 1) interactivity and 2) knowledge construction and sharing. These guidelines emphasize the need for ensuring opportunities for interactivity of learners and that learners are able to construct and share learning activities with others. These both situate the learner at the center of learning activities and reinforce the need for a learner centric guideline.

A second area of focus in the literature is on the environment where the learner is learning. As researchers have recognized that it is the learner who is mobile, there is the need to consider the learner's environment when designing m-learning. One of the only studies on this point is from Wang (under review). Noting that learners will engage in a variety of environment locations (mass transit systems, work place, home, etc.), Wang notes that this will have an impact on what type of content would be most effective. Recognition of this will help to identify the content of successful m-learning, but it also helps to raise a caution that learners will have different needs for different types of content as they move from environment to environment.

One additional point emphasized in Wang's research is that the learner's environment is a function of location. Location though refers to not only a micro-level, a specific setting where the learner is present, but also a macro-level, which refers to the place or locale where the learner finds herself. Recognizing this distinction leads to the further realization that the learner's social and culture environment will have an influence on m-learning and should be included in any design guidelines. This point is discussed further in the following sections.

Frameworks for m-Learning Design

Guidelines are helpful for designers, but they only point to issues that designers ought to consider when creating m-learning content and courses. What they lack is an overarching framework or model to direct the process for designing and developing courses and content. Since m-learning is still in its relatively infancy, few frameworks or models have been advanced and evaluated. These would provide not only insights into additional design guidelines but also help designers by highlighting a procedure to follow when creating m-learning.

Two fully worked frameworks have been developed and presented in the literature. The first framework is the 'Framework for the Rational Analysis of Mobile Education' (FRAME) model proposed by Koole and her colleagues (Koole, McQuilkin, & Ally, 2010). The FRAME model "*defines mobile learning as a convergence of device, learner and social aspects*" (p. 62), and it views m-learning as the intersection between:

- a. the mobile device and its characteristics (D)
- b. the characteristics of the learner including prior learning, cognitive abilities, and memories (L), and
- c. the social aspects, which are the social rules for interactions between individuals (S)

These three aspects overlap in different ways. When considering how the learner uses the device (LD), one can identify issues related to usability. The connection between the device and social aspects (DS) relate to the tools, particularly networking and collaboration tools that the learners are able to access. Finally, the learner and social aspects intersect (LS) and identify issues of social learning, issues dominated by

constructivist learning theory. The FRAME model then is able to provide a framework for identifying, organizing, and understanding the guidelines that designers should consider in the design and development of m-learning.

Wang (under review) has proposed a second framework. Wang's model evolved from Keller's ARCS model, and it identifies four learner variables related to m-learning. These are location, technology, culture, and satisfaction (LTCS). Because Wang's particular concern is with learner attrition and retention, the variable of satisfaction is crucial to the success of an m-learning design model. It is for this reason that Wang situates learner satisfaction at the center of the model. Designers must account for the three remaining variables to achieve learner satisfaction. In terms of location, designers must account for the learner's location on both a micro-level (where the learning takes place) and macro-level (understood as global location or place of the learning) since m-learning can take place in a variety of settings and in different places around the world. The technology variable refers to the physical, technological devices the learner uses and the teaching and learning methods employed in the m-learning environment. This variable points to the importance of considering issues of usability in the design of m-learning and reinforces the guideline of accounting for the learner environment point identified above (see Table 2). Finally, Wang notes that the variable of culture in m-learning satisfaction. Since m-learning has the potential to be cross-cultural, designers must account for the potential that learners from different cultural backgrounds will access the same m-learning content and courses. This is an important consideration and a point that is underdeveloped in other models such as Koole's FRAME.

Insights from m-Learning in Developing Countries

To clarify the point of culture in m-learning design further, the following review reveals several issues that designers should consider when designing m-learning for learners from around the world. These issues relate to research into the use of m-learning in developing countries and point to guidelines for designing m-learning for a global audience.

Proponents of m-learning see one of its benefits as the opportunity to bring education to remote and undeveloped regions of the world. By using mobile phones and other electronic devices, people in these regions might access educational resources they would not have, given the lack of resources and technological infrastructure. The question is whether m-learning can be successful in this endeavor.

Valk, Rashid, and Elder (2010) reviewed the results of six m-learning pilot programs in Asian countries ranging from the Philippines to India. The authors concluded there was clear evidence that the use of mobile phones increased access to education in developing countries, but the evidence in the pilot studies was less clear about whether learning occurred. The pilot programs were learner-centered and included opportunities for learner interaction between teachers and other learners, but there was limited evidence of learning in all but one program. The authors note a possible reason for this was a lack of prior knowledge. What this points to is that designers may need to consider traditional teaching methods that would be more successful in some contexts.

Another study reviewed efforts to bring education to rural areas of India. Sampangi, Vighnesh, and Ray (2010) examined efforts to bring education via m-learning to rural areas that traditionally have little or no access to public services. The authors identified one of the biggest challenges to the use of m-learning as overcoming the belief that the technology will destroy the moral foundations of the society. They state, "There is a strong need to strike a balance between adoption of technology and preservation of cultural values, resolving the conflicts in creating a conducive learning environment for social development" (p. 355). This points out that designers of m-learning must understand the cultural beliefs of their target audience and be prepared to address them.

Turning from Asia to Africa, Brown (2005) considers why rural regions such as Africa are a fit for m-learning. Typically, people think of m-learners as members of the first world, highly literate in information and communication technology, employed full-time, and have a preference to learn at their own pace and schedule and in the location of their choosing. He notes that if this were the only target audience for m-learning, Africa would not be a place for it. However, a large and growing percent of the population has a mobile phone. This is the key to access for m-learning in Africa, and it is this fact that justifies the development of m-learning in rural and remote areas. There are two points to take away from this discussion. The first is that m-learning designers should be aware of the type of technology that learners will use, a point that reflects the prior principle identified by Xiao and his colleagues (forthcoming) regarding designing to the

lowest common denominator. Second, designers should not assume that the m-learners are only the employed and have the time and resources to engage in study.

This review of m-learning frameworks and insights from studies on m-learning in developing countries reveals two additional guidelines. First, m-learning design must clarify the roles and rules of the social relationships that exist within the m-learning environment. These roles and rules provide a foundation for the interactions that will occur within the learning environment. Second, designers need to be especially cognizant of cross-cultural considerations. Since m-learning is available to individuals in a variety of cultures and societies beyond that of the designer, it is necessary to recognize how different cultural beliefs, uses of language, and other elements of different cultures will impact learner understanding and interactions. These guidelines are summarized in Table 3.

1. Social roles and rules	clarify the rules and roles for learners and integrated opportunities for learner interactivity
2. Cross-cultural considerations	be cognizant of the how learners from different cultures will perceive and understand learning content, resources, and expectations

Table 3: Cultural guidelines

Discussion

As this review of recent literature indicates, it is possible to identify relevant guidelines for designing m-learning. Categorizing these into two sets of guidelines related to the technology and learner issues provides clear insights into elements for effective m-learning. In this section we will argue that by viewing them from a perspective of how they relate to the idea of transactional distance provides a foundation for understanding how m-learning is not merely an evolution of e-learning and how research into m-learning might be better focused.

Moore (1997) identifies three sets of variables that determine the scope of transactional distance in a learning environment: learner autonomy, structure, and dialogue. To reduce the transactional distance between learner(s) and instructor, these variables must be in balance. See Figure 1 for an illustration of this.

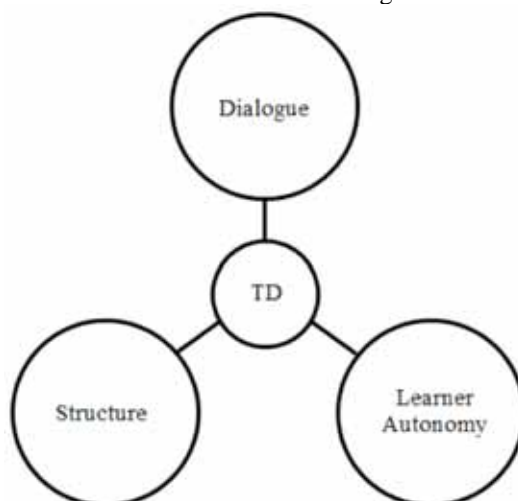


Figure 1: When the variables of structure, learner autonomy, and dialogue are balanced, transactional distance (TD) is reduced.

The guidelines identified above can be broadly understood as fitting in these three variables. In general, the technical requirements relate to the variable of structure which the designer and instructor have control over, the majority of the learner guidelines relate to learner autonomy, and the guidelines related to the social roles and cultural elements of m-learning connect most closely with the variable of dialogue. This arrangement of guidelines is illustrated in Table 4.

What needs to be stressed is that there is an interrelationship between various guidelines; some guidelines may impact other variables. For example, the guideline of usability relates primarily to the structure of the course design since it addresses the need to design for small mobile devices. However, this guideline will impact learner autonomy by placing limits on the types of learner centric activities that are possible. The point

of viewing these guidelines from this perspective is not to give a rigid framework for m-learning design but to provide a basis for understanding why m-learning is not a mere evolution of e-learning.

Structure	Learner Autonomy	Dialogue
1. Choosing technology 2. Usability 3. Platform and format 4. Tools and user interface 5. Design of content 6. Range of User Technology	1. Learner centric 2. Learner environment	1. Social roles and rules 2. Cross-cultural considerations

Table 4: organization of guidelines based on Moore's theory of transactional distance

In discussing the efforts to undertake research of mobile learning, Traxler (2009) raises the possibility that current research efforts on m-learning have only been partially successful because of “*a mismatch between the (implicit) ethos of much mobile learning and the (implicit) philosophy of its research (and specifically, evaluation) methods.*” (p. 153) He makes this claim within the context of the idea that current research is grounded in modernism while m-learning is reflective of a post-modern society. Contemporary society is mobile and, as a mobile society, this impacts the way people communicate and relate to each other. Given this view of the contemporary society and the way m-learning reflects this view, the movement toward m-learning may be understood as more than a simple evolution of e-learning. Two factors can provide a preliminary justification for this understanding of the development of m-learning will show the direction of this line of thought.

If m-learning is merely an evolution of e-learning it would seem to be possible simply replicate e-learning to the mobile environment. But similarly to Traxler's claim of a disconnect between the assumption of evaluatory research and the post-modern mobile society, there are areas of disconnect between elements of e- and m-learning. The first of these is in the area of communication, or dialogue, to use Moore's terminology. One hope for communication in m-learning is the use of social networking to facilitate dialogue. This faces a serious limitation in that most social networking and mobile communication is short, limited communication. This does not facilitate effective dialogue between learner and instructor, but effective dialogue is a key variable in reducing transactional distance. Communication in e-learning has a variety of options that are, at best, limited in m-learning. Because of this change in communication, it will be necessary to reconsider how to ensure effective dialogue in m-learning.

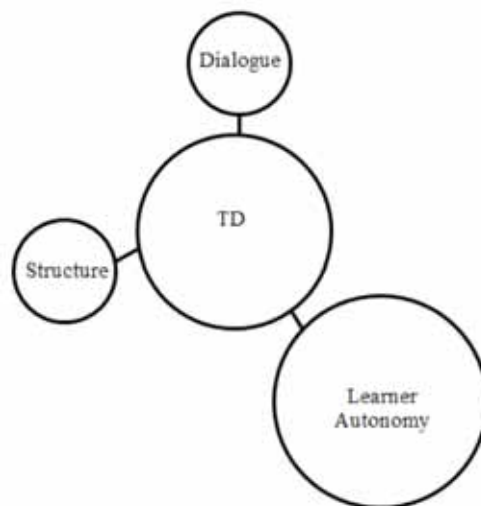


Figure 2: Transactional distance will increase if designers simply implement e-learning approaches to dialogue and structure in an m-learning environment.

A second factor and source of disconnect, relates to the structure of m-learning. One of the great advantages of m-learning is that the learner has immediate access to information and resources in any place and any time which enhances learner autonomy. This is an advantage shared by e-learning, but because the learner

is mobile in m-learning, it is easier for the learner to go outside of the structure implemented by the instructor and designer. Structure in an instructional design is by its nature rigid, but m-learning is more fluid. Therefore, the challenge of balancing structure in an m-learning environment may require a different approach than found in the design of e-learning. By considering these factors, it is possible to see how the variables related to transactional distance may become unbalanced and increase transactional distance (Figure 2).

The point of this discussion has been two-fold. First, the discussion shows that using the theory of transactional distance can provide an organization structure for the present guidelines for the design of m-learning. Second, and more significantly, it provides an entry into a discussion of whether m-learning is best understood as merely an evolution of e-learning. From this discussion, there appears to be reasons to consider that given the nature of mobile technology and the post-modern world, they reflect m-learning may be something more than just an evolutionary step of e-learning. This preliminary discussion suggests that m-learning is not a species of the genus of e-learning but that they are both genera of learning in general, although closely related.

Conclusions

Review of available literature has revealed that it is possible to identify three distinct yet closely related areas for directing the development of m-learning.

1. Specific guidelines for designing and developing m-learning content that correspond to the categories of technical/device issues and learner issues.
These guidelines point to considerations related to technical and device issues. There are significantly more of these guidelines because much of the research on technical issues of e-learning in general appears to be applicable for m-learning. Additional guidelines related to learner and learning environments will be useful, but this area is a relatively new consideration because of the recent change in focus of in defining m-learning.
2. Learner-based guidelines for creating learner centric m-learning.
It is clear that learning that occurs in an m-learning environment, like all learning, is best when learners are the center of the learning and actively engaged in the learning. This calls for design guidelines that integrate this approach.
3. Culture guidelines for m-learning
One of the great promises of m-learning is to bring educational opportunities to regions of the world that currently have little or no access to these opportunities due to the lack of resources and infrastructure to deliver e-learning. Whilst initial studies on the deployment of m-learning in the third world have been encouraging they also reveal several research issues that need to be studied further such as the effect of the macro context (eg culture) and the need for complementary educational activities to support m-learning.

As these guidelines were explored, it became evident that an organizational structure based on Moore's theory of transactional distance helped to identify how m-learning can be understood to be more than a mere evolution of e-learning. While these ideas are preliminary they have identified an alternative to conceiving m-learning as an evolution from e-learning, and point to the need for examining the nature of m-learning in and of itself. Further articulation of this idea could create principles that will reduce transactional distance in m-learning thereby leading to new design guidelines that produce better m-learning systems. Our longer-term hope is that this approach might lead to more effective ways of understanding, researching and evaluating m-learning.

References

- Brown, T.H. (2005). Towards a model for m-learning in Africa. *International Journal on E-Learning*, 4(3), 299-315.
- Caudill, J. G. (2007). The growth of m-learning and the growth of mobile computing: parallel developments. *International Review of Research in Open and Distance Learning*, 8(2), retrieved from <http://www.irrodl.org/index.php/irrodl/article/view/348>

- El-Hussein, M. o. M., & Cronje, J. C. (2010). Defining mobile learning in the higher education landscape. *Educational Technology & Society*, 13(3), 12-21.
- Frommer, D. (2011, March 3). *Chart of the day: 99.7% of people still haven't bought a tablet yet*. Retrieved from <http://www.businessinsider.com/chart-of-the-day-heres-how-huge-the-tablet-market-could-get-2011-3>
- Koole, M., McQuilkin, J., & Ally, M. (2010). Mobile learning in distance education: Utility or futility? *Journal of Distance Education*, 24(2), 59-82.
- Low, L. & O'Connell, M. (2006). *Learner-centric design of digital mobile learning*. Presentation at the OLT Conference Learning on the Move, Queensland University of Technology, Australia.
- Moore, M. (1997). Theory of transactional distance. In D. Keegan, D. (Ed.), *Theoretical Principles of Distance Education*. Retrieved from <http://www.aged.tamu.edu/research/readings/Distance/1997MooreTransDistance.pdf>
- Peng, H. & Chien, C. (2007). Mobile computing as a cognitive tool for middle schools: connecting curriculum and technology. *International Journal of Instructional Media*, 34, 301-310.
- Sampangi, R., Vighnesh, V., & Ray, A. (2010). Reaching the Unreached: A Study on Mobile Learning in India. Proceedings from *The International Conference on e-Learning*. Universiti Sains Malaysia, Penang, Malaysia, 350-357.
- Traxler, J., & Kukulska-Hulme, A. (2005). Evaluating mobile learning: Reflections on current practice. Proceedings from *mLearn 2005: Mobile technology: The future of learning in your hands*. Cape Town, South Africa: Open University.
- Traxler, J. (2009). Mobile learning evaluation: The challenge of mobile societies. In G. Vavoula, N. Pachler, and A. Kukulska-Hulme (Eds.), *Researching mobile learning* (pp. 151-165). Oxford: Peter Lang.
- Traxler, J. (2010). Distance education and mobile learning: Catching up, taking stock. *Distance Education*, (31)2, 129-138.
- Vavoula, G. N., Lefrere, P., O'Malley, C., Sharples, M., & Taylor, J. (2004) Producing guidelines for learning, teaching and tutoring in a mobile environment. *Proceeding from 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education*. Washington, D.C., United States of American: IEEE.
- Wang, M. J. (under review). A Comprehensive Model for Designing Mobile Learning Materials and Activities. *Journal of Computer-Assisted Learning*.
- Xiao, J., Wang, M. J., Callaghan, V., Chen, X. Y., & Zhao, X. L. (forthcoming). Message design for mobile Learning (submitted), *British Journal of Educational Technology*.
- Valk, J., Rashid, A. T., & Elder, L. (2010) Using mobile phones to improve educational outcomes: An analysis of evidence from Asia. *International Review of Research in Open and Distance Learning Volume 11(1)*, 117-140.
- World Wide Web Consortium (1999). *HTML 4.0 Guidelines for Mobile Access*. Retrieved from <http://www.w3.org/TR/NOTE-html40-mobile/>
- Zurita, G., & Nussbaum, M. (2007). A conceptual framework based on activity theory for mobile CSCL. *British Journal of Educational Technology*, (38)2, 211-235.