Mobile Learning and Education: Synthesis of Open Access Research

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Abstract

In a global and mobile society characterized by the possibility of portability, mobile devices are no longer accessories, but they are rather resources that we cannot do without. In fact, nowadays no one seems willing to give up these tools recognizing its potential in various fields. For instance, they allow not only to shorten various distances but also to respond to different situations of our daily life, and also, of course, they provide moments of leisure and entertainment. Thus, combining all these attributes and to benefit from them in education seems obvious.

However, to what extent and how are mobile devices integrated in education? Is mobile learning or m-learning a reality? Or a fiction, instead? Therefore, the present study aims at clarifying these issues through a literature synthesis of research available in online databases.

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In this state of the art, m-learning is briefly characterized, namely, by describing some of its particular types and environments and also by a SWOT analysis. Students and teachers' perceptions and practices on m-learning were also identified. We further identified determining factors that both students and teachers consider important in the use of mobile devices and in the acceptance of mobile learning.

In short, the systematization of the analyzed literature summarizes experiences that promoted changes in both the alphabetization and digital literacy of the whole participating school communities. One can conclude that m-learning is a research area with a recent past, a dynamic present, and a promising future.

1 Introduction

The Horizon Report foresaw six emerging technologies that could revolutionize the current framework of the teaching of scientific research and the economy of countries until 2015 (New Media and Corsortium EDUCAUSE (Association) 2010). Among these emerging technologies and according to this report, mobile computing and open content were soon to reach the maximum point of use. As a result of the evolution of mobile technologies, education is entering in the so-called third wave technology called mobile learning (Sarrab and Elgamel 2013). Thus, a new area of research arose to determine how these technologies can be used as learning tools (Kukulska-Hulme 2009), with the first projects emerging in the second half of the 1990s (Traxler 2005).

There is evidence to suggest that mobile learning is growing in visibility and importance. Firstly, in the last decade several studies have been developed on m-learning experiences, in formal and informal contexts, reporting positive results in the process of teaching and learning with relevant levels of adherence with regard to the acceptance of these technologies by the students (Attwell 2007). Secondly, we are witnessing an increase of workshops and conferences on the subject at all latitudes of the planet. As an example, there is the growing interest that mLearn conferences – Conferences on Mobile and Contextual Learning – are having within the scientific community, with successive meetings since 2002, being the last congress held in Istanbul. Thirdly, the community now has a peer-reviewed academic journal, the *International Journal of Mobile and Blended Learning*, as well as a professional research organization, *the International Association for Mobile Learning*.

Hence, the mobile learning has gained clarity on the main issues, a well-defined research agenda, and a greater awareness of the need for the existence of guidelines and ethical frameworks. Nevertheless, it is still a field in which practice has not yet been standardized in terms of research, mainly in terms of methods and tools (Traxler 2005). Therefore, it is appropriate to summarize the current state of knowledge and research on the subject, so as to identify potentialities and constraints of this type of learning.

Table 1 Online databases searched for defining the corpus of this literature review, © Teresa Cardoso and Renato Abreu

Online journals and databases	Impact factor	Uniform resource locator (URL)
Educational Media International	–	http://www.tandfonline.com
Revista de Educación a Distancia	–	http://www.um.es/ead/red/red.html
Journal of Educational Technology & Society	0.824	http://www.ifets.info
eLearning Papers	–	http://www.openeducationeuropa.eu/pt/elearning_papers
Distance Education	0.725	http://www.tandfonline.com
Computers & Education	2.630	http://www.journals.elsevier.com/computers-and-education
Learning, Media and Technology	–	http://www.tandfonline.com
RIED. Revista Iberoamericana de Educación a Distancia	–	http://ried.utpl.edu.ec
The International Review of Research in Open and Distance Learning	–	http://www.irrodl.org/index.php/irrodl/index
Open Praxis	–	http://openpraxis.org/index.php/OpenPraxis/index
Comunicar	–	http://www.revistacomunicar.com
Informática na educação: teoria & prática	–	http://www.seer.ufrgs.br/index.php/InfEducTeoriaPratica/index
The Internet and Higher Education	2.048	http://www.journals.elsevier.com/the-internet-and-higher-education
American Journal of Distance Education	–	http://www.tandfonline.com
Repositório Científico de Acesso Aberto de Portugal (RCAAP)	–	http://www.rcaap.pt/

Source: Data collected for this study

In this text, the result of a literature review on m-learning is presented, considering documents available on the Internet at specialized electronic databases in education. A methodology focused on the criteria proposed by Rosenberg and Donald (1995) for the research of scientific evidence was adopted, thus claiming the comparability with the medical sciences, which have the largest collection of electronic databases on the Internet (McVeigh 2004). In addition, the selection of the analyzed publications was made in view of the recognition by experts in the field, their scientific committees, and, when possible, their impact factor as indicated in Table 1.

The last criterion considered to constitute the corpus of analysis for this study was the temporal filter defined between 2010 and 2014. This option was due primarily because of the speed of technological innovation when it comes to computers and therefore in the evolution of mobile devices, and also so as to take into account the technical update and progress of m-learning.

2 Mobile Learning and Education: An Emergent Field of Research

M-learning is still an emerging research field. So, different actors and several factors are involved in conceptualizing it (Traxler 2007). This will determine the perceptions and expectations in its evolutionary process towards the future (Traxler 2009). Therefore, it is not surprising that various definitions arise, although one can already highlight the attributes shown in Fig. 1.

Thus, based on the attributes of Fig. 1, we can define m-learning as the connected, interactive and personalized use of portable devices in classrooms, in collaborative learning, field work, advice and guidance for students (Traxler 2011). This definition means that mobile learning can include the following technological options: personal digital assistants (PDAs), mobile phones with SMS, smartphones, tablets, game consoles, iPods, and wireless infrastructures (Traxler 2005). However, this is still one characterization among others. It is, perhaps, technocentric, maybe unstable and focused on the set of hardware devices previously mentioned (Traxler 2005). It is therefore important to explore other approaches to this contemporary phenomenon.

M-learning is also a reality in online education, and knowing the latter results from the evolution of e-learning, it is also important to note that online education is expanding at great speed in primary and secondary education as well as in higher

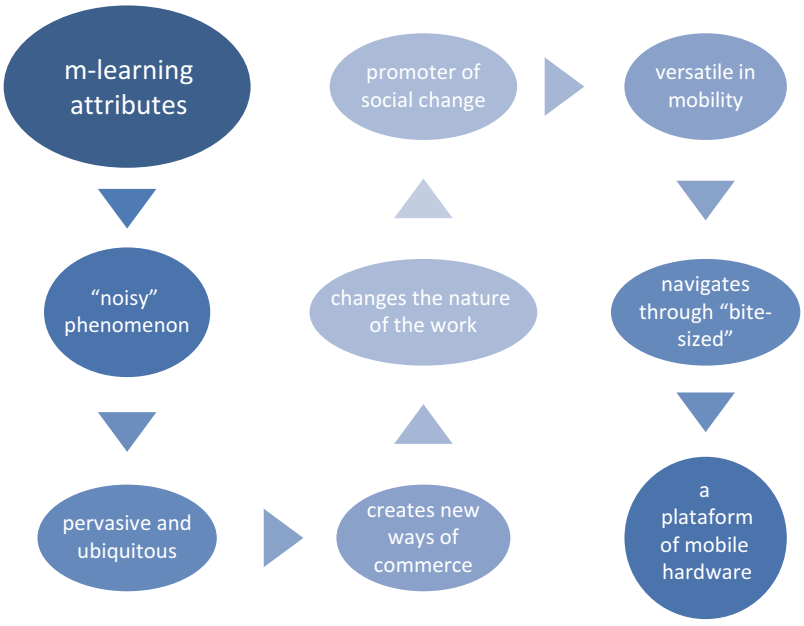

Fig. 1 M-learning attributes (Source: Based on Traxler 2009), © Teresa Cardoso and Renato Abreu

education. Most of the educational institutions are aware that change is a constant feature in the lives of students. That is why they continuously analyze ways to incorporate change in their practices. However, some traditional higher education institutions are hesitant to introduce e-learning in their teaching methodologies, like m-learning as well. Despite being innovative and technically achievable, incorporating pedagogical benefits, and currently knowing visibility and growing importance in higher education (Traxler 2007), m-learning may eventually have no possibility of institutional large-scale implementation in the near future (Traxler 2010). For m-learning in higher education to become a successful story, it is important to address the social, cultural, and organizational factors involved. These can be formal and explicit and tacit or informal and may vary greatly in all institutions and within each of them (Traxler 2009). Adding to this problem, most of the work done on m-learning in universities is still in a pilot phase testing, which points to considerable difficulties in the support and development of new teaching methodologies (Traxler 2009).

Another political action line for higher education institutions to equate is the desirable availability of open content to the world, that is, the higher education institutions' repositories of open educational resources must adapt their characteristics, so that their contents (at the level of creation, publication, exploration, acquisition, access, use and reuse of learning objects) can be accessed from mobile devices. This action line of open content democratization is reflected in the 2004 and 2010 Horizon Reports, which referred to, respectively, learning objects and open contents, predicting its short-term impact due to the current trend of availability of open contents, free of charge on the Internet, which can be viewed on mobile devices (Tabuenca et al. 2012).

In fact, mobile devices produce almost a universal effect of connectivity between people, data, content, and media. So, we are watching changes and disruptions in learning that are launching the countries to emerge as a knowledge society oriented towards technology. The success of these societies depends on the ability to promote the acquisition of key skills and expand opportunities headed for more flexible and innovative ways of learning for all citizens, including nonformal education. Bearing in mind that in Asia almost everyone has a mobile phone or will soon have one, an Indian researcher argued that Asian countries can establish and use mobile networks for learning. The researcher proposed an "each-one-teach-one" mobile network project as a strategy to access to new knowledge, especially for the Asian countries and in general for all countries of the world. Mobile network proposals will work on the principle that those who want to teach and those who want to learn should have a free and open service to connect and share knowledge (Misra 2012).

In addition, the development of m-learning has often been driven by educational need, technological innovation, and funding opportunities. M-learning should be characterized as a specific project within the education systems, and its strengths, weaknesses, opportunities, and threats are, generally, those shown in Fig. 2.

As shown in Table 2, some information can be added, by further explaining the factors identified in Fig. 2.

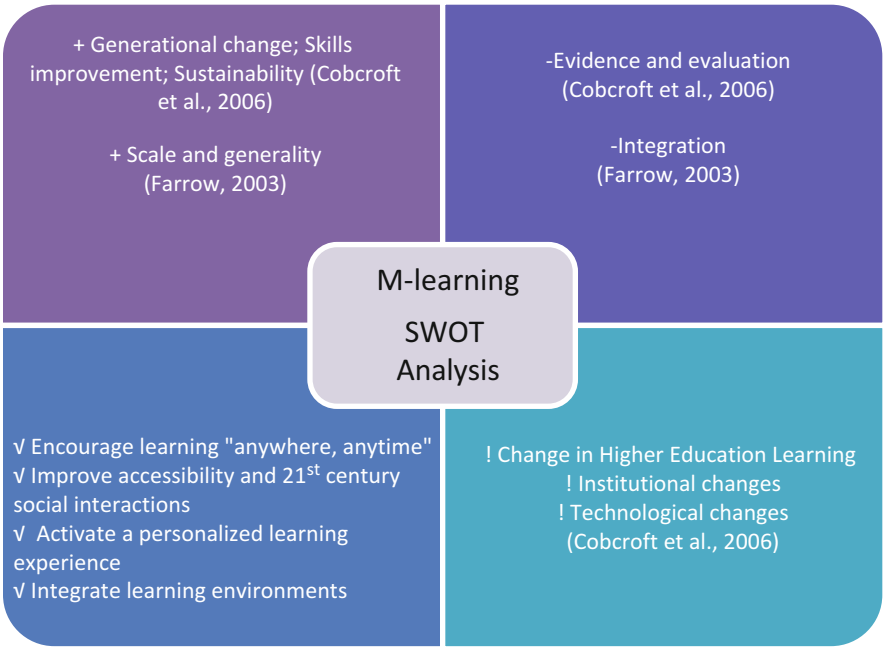

Fig. 2 M-learning SWOT analysis (Source: Data collected for this study), © Teresa Cardoso and Renato Abreu

3 Mobile Learning and Education: A Knowledge Systematization

As a result of scientific research, there is nowadays a vast repository of case studies, essays, and pilot studies publicly available, which enable to identify three main types of m-learning: personalized, situated, and authentic (Traxler 2007). The personalized m-learning is defined as the learning that resorts to different pedagogical approaches and that acknowledges social, cognitive, and physical differences and diversity in designing contents, interfaces, and mobile devices. The situated m-learning occurs during the learning activity, in rather specific contexts. Finally, the authentic m-learning is the learning that uses real-world problems and projects that are relevant and of interest to the student. This typology may be further differentiated, when instilled by the correct applicability of the available mobile technologies. This, in turn, enables constant changes of educational contexts or environments (Nash 2007), thus facilitating the integration by the student of the real world into the world of tools or devices and successfully showing achievement of the learning goals. Hence, it is possible to create different m-learning environments characterized by different aspects (Traxler 2009):

Table 2 Detailed m-learning SWOT analysis, © Teresa Cardoso and Renato Abreu

Strengths(S)	Weaknesses(W)
± ***Generational change***: the identification in today's young people of the desire to be creative, to collaborate, and thus gain celebrity status is seen as belonging to the "Generation C." This trend indicates a movement towards the DIY (do it yourself), which is presented as the creation of content and the dissemination of knowledge led by the users themselves (Cobcroft et al. 2006) ± ***Skills improvement***: the mobile devices can help improve literacy and numeracy skills; encourage independent and collaborative learning experiences; identify areas where students need assistance and support; mitigate resistance to change using ICT; engage reluctant learners, allowing that they stay more focused for longer periods; and promote the self-confidence and self-esteem (Cobcroft et al. 2006) ± ***Sustainability***: the sustainability of m-learning pilot studies and experiences in educational settings tends to achieve a balance between costs, on the one hand, and the creation of financial profitability and social capital, on the other hand (Cobcroft et al. 2006) ± ***Scale and generality***: the m-learning community is excited to understand how some pilot studies, projects, and experiences in educational settings successfully can be applied on a larger scale in order to find the balance between the possible generality and the specificity (Farrow 2003)	- ***Integration***: the integration of mobile learning in other learning systems based on technology and institutional and organizational processes has not been a top priority (Farrow 2003) - ***Evidence and evaluation***: the scientific community should give signs of greater relevance, meaning, and impact on the evaluation of m-learning, as it has presented more intrinsic problems than the evaluation of e-learning (Cobcroft et al. 2006)
Opportunities (O)	**Threats (T)**
The **opportunities** commonly associated to m-learning are essentially the following: *Encourage learning "anywhere, anytime"* *Improve accessibility and the twenty-first-century social interactions* *Activate a personalized learning experience* *Integrate learning environments* However, the enthusiasm for the incredible potential of the mobile devices must be tempered by the functional, cognitive, and social considerable challenges, which are identified within m-learning (Farrow 2003)	***! Change in higher education learning***: the predisposition for an increasing availability of mobile and wireless devices has direct implications on the blended learning environments, which combine physical and virtual strategies. These environments have in turn implications for students (learning experience) and teachers (practices) and for the planning of technology and sustainability. Thus, these are critical aspects in the implementation of m-learning in higher education institutions (Cobcroft et al. 2006) ***! Institutional changes***: the reference model to determine the most suitable technological choices in implementing m-learning should include criteria such as adequacy and access, easiness of use and reliability, costs, new trends in pedagogy, interactivity, organizational issues, innovation, speed, and alignment with the institutional goals. Consequently, the institutions should understand that the adoption of m-learning is in need of a strategic approach to risk management, with an assessment of the adequacy, quality, compatibility, and cost of the devices. Otherwise, it will be very difficult to keep the resources and minimize the change fatigue (Cobcroft et al. 2006) ***! Technological changes***: the wide availability of technology is essential but by itself it is not enough for learning environments to be considered effective (Cobcroft et al. 2006)

Source: Data collected for this study

- *Oriented technology* – some innovations in mobile devices are implemented in the academic environment to determine the technical feasibility and the pedagogic features of such devices.
- *Portable miniaturization of e-learning* – learning using mobile technologies is much more flexible and replaces with great efficacy the static technologies of desktop computers, taking into account the privileged environment of e-learning.
- *Connected classroom* – the same technologies are used in the classroom to support collaborative learning, together with other technologies, such as interactive whiteboards.
- *Additive technology* – the mobile technologies are enhanced with additional functionalities, for instance, video capture, to improve the educational experience, which would otherwise be difficult or impossible to achieve.
- *Just-in-time training* – mobile devices are used to improve the productivity and efficiency of the workers in geographic mobility, providing just-in-time information and support.
- *Environment and development* – technologies are used to cope with challenges regarding environment and infrastructure, supporting conventional education, in places in which it would be difficult to implement e-learning technologies.

In these educational scenarios, it is useful to analyze students and/or teachers' perceptions and practices regarding m-learning and the ownership of mobile devices by either or both of them. This will be done in the following sections, on the basis of a synthesis of some of the examples included in the open access research corpus of this study.

3.1 Students' Perceptions and Practices

Lowenthal (2010) carried out a study in which he analyzed the factors or determinants of the behavioral impact that explain the adhesion of students (51 men; 62 women) to m-learning at a university in the USA. These determinants included the expectation of performance and the expectation of the effort and self-management of learning, all mediated by age, gender, or both. The regression coefficients showed strong significant relationship between the expected performance and the expected effort and behavioral willingness to use a mobile learning strategy. Researchers have shown also that the age and sex had no impact on mediation.

Two years later, Firmin et al. (2012) reported on the results of a qualitative research study carried out with 3,000 students of the American University, located in the Midwest, on their phenomenological perspectives (perceptions and motivations) with regard to using the BlackBerry. Three key aspects inductively emerged during the interview process: the students described the motivations that influenced their decisions of buying and using the BlackBerry, including the rather quick and convenient access to the e-mail and the Internet that these smartphones offer; all

students compared their BlackBerry with the iPhone, valuing their mobile phones as only moderately "cool" and technologically less advanced; students reported specific perceptions related to the use of the BlackBerry, which included a financial stigma and a stereotype of entrepreneur.

More recently, Gikas and Grant (2013) studied not only the students' perceptions regarding learning using mobile devices but also the role that these play in virtual communities. This qualitative research study focused on eight students of three universities of the USA. These students used the mobile devices on their courses for at least two semesters. The main data collection method used to assess the students' perceptions was the focus group. Two specific themes emerged from the data of the interviews: benefits and frustrations regarding students' learning related to the use of mobile devices. Participants in this study acknowledged the changes that occurred in learning, regardless of the limitations they identified, including the phobia of incorrect functioning of technologies, small keyboards that difficult typing, and the possible potential of distraction that these technologies offer. It is, however, important to mention that the participants that volunteered to share their experiences did so because they believed that mobile devices had an impact on their learning.

Another study, both quantitative and of transversal observation nature, was carried out by researchers from a Dutch university with the participation of 3,132 students. They answered an online survey on ownership and use of laptops, tablets, and smartphones, as part of a strategy by the university, called bring your own device (BYOD), to promote learning improvements resorting to mobile computational devices. The survey included the sociodemographic characterization of the students, information about parents' earnings (indicator of the socioeconomic status of the student), and questions regarding the usability of the mobile devices. The results showed that 96 % of the students owned at least one mobile device (laptop, tablet, or smartphone). By using an econometric model, it was perceived that the students' earnings, their family earnings, and typology, gender, and immigration have a statistically significant effect with regard to having a mobile device. The high percentages of mobile device ownership are, however, not associated by any means to the support given to the classes attended by the students. In this study, the students did not seem much enthusiastic to bring their mobile devices to the classes, choosing rather to leave their laptops at home. In general, the students only brought the laptop to the university once every 4 days, as they felt it was too heavy to carry. As a consequence, the students were not keen on the BYOD strategy despite the didactic benefits that this could provide to their education. Therefore, it seems that the strategy defined by that university was hampered (Kobus et al. 2013).

In Spain, research was carried out to analyze the use and the concept of mobility of the information and communication technologies (ICT) of a group of 67 postgraduate students participating in an experiment of m-learning at the IL3 Institute for Life Long Learning of the University of Barcelona. During the online postgraduation course, designed from a traditional e-learning perspective, the students had access to a tablet (iPad) to work and for professional and private life use, as well. Before and after the course, an original survey was applied; it was

designed to analyze the students' attitudes, opinions, and habits. Trends in the use of mobile devices and the participants' perceptions, from exams, goals, grading, as well as the integration with other technologies and genuine applications in the students' personal, social, and professional life, were analyzed. The research aimed at answering five questions; the first question was "for what purposes do students usually use the Internet before and after the e-learning experience?" The authors concluded that the use of the Internet is mainly focused on the participation in social networks in order to produce information (and not necessarily only from a perspective of collecting information). The answers to the second question – "for what purpose do students use mobile devices in the framework of their formal/professional education before and after the m-learning experience?" – enabled them to state that the use of mobile devices changed significantly. Thus, the authors emphasize the students' tendency to focus the attention on multifunction mobile devices and on using the tablet as an extension of the computer. Regarding the third and fourth questions ("what use is made of the mobile device in their daily life before and after the m-learning experience?" and "does your evaluation of the Internet and of the mobile devices change after the e-learning experience?"), the results show that the introduction of the iPad led to a change in the habits of connection and use of technology. This caused direct implications in the students' daily, personal, and professional life, and a key change on the processes of accessing information was witnessed. Finally, with the sample of their study, the researchers were unable to prove that the Bernoff profiles were reproduced (Oró et al. 2013).

For Aish and Love (2013), the successful implementation of m-learning in higher education is essentially based upon the acceptance of the users. Hence, taking into account the unified theory of acceptance and use of technology (UTAUT), coined by Venkatesh, they proposed a model to identify the enhancing factors of m-learning acceptance. They also studied whether the previous experience with mobile devices affected the m-learning acceptance. A model of structural equations was used to analyze data gathered from 174 students of the Brunel University. The results indicated that the performance and effort expectation, the influence of the teachers, the quality of the service, and the capacity of personal innovation are significant factors that affect the behavioral intention of adhering to m-learning. With regard to previous experience with mobile devices, this was also considered an important factor in the behavioral intention.

To summarize, it can be inferred that the determinant factors of the behavioral impact that explain why students adhere to m-learning are the following:

- Expectation about performance, effort, and learning self-management
- Influence of the teachers
- Quality of the mobile service
- Personal ability to innovate
- Key changes on the processes of accessing information
- Previous experience with mobile devices

Summarizing now the factors regarding the use of mobile devices, the following were perceived:

- Rather quick and convenient access to the e-mail and the Internet
- Students' earnings, their family earnings, and typology, gender, and immigration

3.2 Teachers' Perceptions and Practices

In this section some factors that determine the adhesion of teachers to m-learning and their attitude towards it are contextualized, as it is deemed important also to understand whether teachers define their mediated activities by mobile devices. Firstly, it is considered a study developed by four Spanish researchers who analyzed the feasibility of the incorporation of mobile technological support in educational practice, assessing the level of acceptance of this innovative measure. The sample of the surveyed population included 50 participants, grouped into three distinct sets: teachers of the University of Alcalá, specializing in technology; students who had their master's in teacher education at the same university, in the school year 2011/2012; and former students. The results revealed a broad acceptance of the incorporation of mobile devices, as well as a high degree of awareness of some of its effects. Different levels of teachers' former training needs were also perceived (Álvarez et al. 2013).

In the same year, Mifsud et al. (2013) presented different perspectives on the role of the teacher equipped with PDAs (Palm IIIc and iPAQ PPPs) in the classroom, describing four studies in two countries (Norway and the USA). The general aim of those studies was to understand how teachers use the new tools in different educational contexts. The teachers of the Hedland Primary School (Norway) had no experience in the use of PDA in the classroom, but they revealed an assimilation of its functionalities aligned with the historical and chronological development of technology (books, a typewriter, and so on). In other words, teachers took advantage of this connectivity when resorting to the oldest and most familiar ways of planning the classroom activities, using the PDAs as a new form of book. This contrasts with the teachers' attitude of the Midlands Intermediate School (USA), in which these types of mediated actions seem to be in regular use in the classroom. However, these teachers were more experienced in the use of PDA, as it was the fifth year of adoption of the PDA in the classroom, and revealed stronger opinions about the mediation of the PDAs. Finally, Mifsud et al. (2013) stated that it is not enough to introduce a new tool like the PDA in the classroom and wait for the teaching practice to change automatically. That is, teachers need to be aware of the new tool; they need to become proficient in their use, to realize their usefulness, and to be able to reflect on the advantages and restrictions of the tool in the context of learning, so as to take out all the benefits of its use in the classroom.

Another issue to bear in mind as far as the "digital teachers" or "technological teachers" are concerned is the fact that they can be recognized as online tutors.

Indeed, Mathew and Sapsed (2012) suggest that in distance learning programs, both technology and pedagogy are crucial and mutually dependent elements and that the online tutors take on roles that go beyond the traditional scope of teaching. Besides, they are frequently forced to assume roles of adviser that fit more the skills of a counselor or of another professional from a different area.

Of the analyzed studies, it may be suggested that the proactive attitude of teachers towards m-learning involves:

- Assuming the role of online tutors
- Showing a wide acceptance in the use of mobile devices
- Seeking prior training actions for different purposes
- Becoming proficient in the use of mobile devices
- Realizing the usefulness and reflecting on the advantages and constraints of mobile devices in the context of formal learning

3.3 Students and Teachers' Perceptions and Practices

Among the analyzed studies portraying different contexts, there are still those which refer to the m-learning perceptions and/or practices of both students and teachers.

For example, studies on m-learning have also been developed in the field of health research, namely, in the area of self-efficacy, as the case of a research which took place in a nursing college in Canada. The aim of this research was to evaluate the teachers and students' self-efficacy in the use of the full potential of mobile technology, in the process of teaching and learning in educational settings and in clinical practice. Within this transversal study, implemented in two education programs, 100 and 21 teachers and students were interviewed. The results showed a high level of ownership and use of mobile devices among them. The result of the median of the mobile self-efficacy was 75 on a scale of 100, indicating that both the teachers and the students were highly confident in the use of mobile technologies and prepared to engage themselves in mobile learning (Kenny et al. 2012).

Another of the research focus on m-learning, as pointed out before, are the guidelines and practices regarding the use of the mobile phone by teachers and students. This goal was sought after by Obringer and Coffrey in their study, which took place in 2007. For this purpose, a questionnaire was sent at random to 200 directors of the USA High Schools, involving the 50 States. The response rate was 56 per cent from all regions of the country. The main results are summarized to the following:

- The majority of the schools presents guidelines on the use of mobile phones.
- Parents generally support the use of mobile phones at school.
- In the classroom the teachers use mostly their mobile phones to solve issues not related to the school subjects.
- There is disciplinary action for inappropriate use of the mobile phone by the students, varying from a mild admonishment to the confiscation of the mobile phone in school.

Seven years later, a different research had as its starting point the following question: "How can mobile phones be used to improve teaching and learning in science in secondary schools?" In this study, a group of teachers (5 men and 13 women) from Sri Lanka developed four lessons on household chemical products, functions and reactions of a voltaic cell, interactions between organisms and the environment, and the diversity of leaves. These lessons explored the features of mobile phone cameras, instead of its communication functions. A qualitative methodological approach was used to analyze the data collected, from the teachers' planning to observations of lessons, and subsequently interviews were put forward with a number of students. The results showed that the use of images and videos captured by the students with their mobile phones allowed teachers to bring the outside world into the classroom and to provide unbiased data. These enhance the assessment of learning and also allow the teachers to clarify possible misconceptions of the students (Ekanayake and Wishart 2014).

Still in the scope of the use of a mobile phone in an educational setting, more specifically in Portuguese primary and secondary schools, Carrega (2011) developed a case study on the representation of students and teachers of the 9th and the 12th grade. The results of the survey to 179 students and 88 teachers of these grades indicate that students and teachers have different representations, but the majority of them are not very receptive to using mobile phone in educational contexts. The students of the two grades stated that they were unable to indicate a situation in which teachers could teach better a subject by using a mobile phone. They could neither imagine a situation in which they could learn better a subject by using a mobile phone. As for teachers, a significant percentage of them did not recognize pedagogical advantages in using a mobile phone.

A process that created great controversy in the past few years was a study on the impact of the efforts of m-learning implementation in the Estonian school system. The results showed different reactions by students, school leaders, and teachers. Although all of them have almost all the needed tools and skills, teachers showed an almost total lack of motivation on promoting mobile learning. Researchers presented some positive and negative scenarios and predicted huge problems if the teachers' training remains unchanged and if the policies of Internet security (e-safety) are not adequately developed (Lorenz and Kikkas 2013).

4 Future Directions

The m-learning community has been focused on pedagogy and technology proving to be able to strengthen, broaden, enrich, and validate concepts of the learning activity itself, as well as to challenge and defy it, now and in the near future. However, the advances achieved in m-learning are not exempt from the risks of learning massification and industrialization (Traxler 2010).

M-learning has the potential to convey the learning process to people, communities, and isolated countries, offering students the opportunity to take control of

their learning experiences in a different way. Thus, students will have the ability to engage themselves in information and discussion activities, as part of real life, by becoming instruments of social policy. However, one cannot forget that mobile technologies used to teach may eventually turn out to be dysfunctional. This can be the case when they are vehicles of a certain culture or a spare and undesirable social luggage or just when they are empty containers loaded with unnecessary and inadequate expectations (Traxler and Agnes Kukulska-Hulme 2006).

Research on m-learning should question and deepen wider learning theories that include new fields of knowledge such as cognitive psychology, bioinformatics, nanotechnology, and artificial intelligence. Research on motivation levels generated by m-learning should be further studied by the scientific community in order to become a universal truth, since to this date the evidence is scarce (Traxler 2011).

In general it is possible to call m-learning to any form of learning through mobile devices, energetically autonomous and small enough to go along with people anywhere and anytime (Roschelle 2003). Currently students inhabit a social, cultural, and technological environment, where knowledge is built and shared, as part of a social process. Mobile technologies, managed effectively, can withstand constructivist approaches in learning and can be observed as tools to expand the discussion beyond the classroom and provide new ways for students to collaborate and communicate within their class or "around the world," creating their own learning contents (Cobcroft et al. 2006). This reflects the need to validate a conceptual framework of m-learning to improve quality, increase flexibility, and customize and centralize the learning process on the student. This conceptual framework should be based on four fundamental principles (Cobcroft et al. 2006): engage students, recognize the context of learning, challenge students, and provide practical activity.

The crucial factor to consider all integrating aspects of the m-learning development, including its conceptual framework, is the identification of the "turning point" in which the adoption of mobile and wireless technologies will gain a critical mass that will force the institutions to adopt effective and efficient plans and approaches in m-learning.

5 Cross-References

- ▶ Augmented Reality and 3D Technologies: Mapping Case Studies in Education
- ▶ Adoption of Mobile Technology in Higher Education: Introduction
- ▶ Characteristics of Mobile Teaching and Learning
- ▶ Design of Mobile Teaching and Learning in Higher Education: Introduction
- ▶ Learning to Teach with Mobile Technologies: Pedagogical Implications In and Outside the Classroom

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