Chapter 44
Teaching and Learning Physics with Smartphones

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ABSTRACT

The use of mobile technologies is reshaping how to teach and learn. In this paper the authors describe their research on the use of these technologies to teach physics. On the one hand they develop mobile applications to complement the traditional learning and to help students learn anytime and anywhere. The use of this applications has proved to have very positive influence on the students' engagement. On the other hand, they use smartphones as measurement devices in physics experiments. This opens the possibility of designing and developing low cost laboratories where expensive material can be substituted by smartphones. The smartphones' sensors are reliable and accurate enough to permit good measurements. However, as it is shown with some examples, special care must be taken here if one does not know how these apps used to access the sensors' data are programmed.

INTRODUCTION

The last forty years have shown an increasing association between technology and education. One consequence of this linking is that the inclusion of technological elements in everyday learning activities has grown with an increasing pace, parallel to that of the improvement in technology capabilities and availability. While in the seventies or first eighties the necessary technological resources were available only for a limited number of institutions and students, nowadays there is a nearly worldwide access to

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a much capable and Internet connected technology. As a consequence, along these last years the use of computers in education has dramatically evolved following the change in computers capabilities and their availability from schools to universities. Moreover, the worldwide spread of wireless technologies has produced a shifting from computer-assisted learning to web-based learning to mobile learning (Vavoula and Karagiannidis, 2005). The ease of access to telecommunication technologies, as well as the, more or less, affordable cost of mobile personal devices and communication connections has had as a consequence the rise of the so-called mobile learning (mLearning) (Caudill, 2007; de Castro, 2014; Keegan, 2002, Prieto, Migueláñez and García-Peñalvo, 2014b), that together with the MOOCs (massive open online courses) (Kellogg, 2013; Mackness, Mak & Williams, 2010) has risen the aim of a personalized, nearly ubiquitous and permanent learning for the new educational demands. All these circumstances also ease the evolution of learning towards conditions in which the students contribute actively to the design of their own virtual learning environment for the new educational demands where schools or universities were no longer the only center of information (Molnar 1997). Furthermore, the interest of students in mobile technologies as well as their expertise using those devices can be used as a powerful tool to reinforce their interest in learning and to ease their access to learning resources.

There is a general agreement that mLearning facilitates the access to education but, besides, some characteristics of mLearning can contribute to change the way in which we teach or learn. An important feature of mLearning is that one of its goals, different from those of a traditional transfer of knowledge from teacher to student, is to empower students to actively participate in the construction of their own learning (de la Pena-Bandalaria, 2007). Also, mLearning can facilitate designs of real learning by targeting problems of interest to the learner (Traxler, 2007), as well as ease lifelong learning by supporting learning that occurs during the many activities of everyday life (Sharples, Taylor and Vavoula, 2005). About the inclusion of mLearning within a formal learning environments, teacher involvement occupies a fundamental position as has been analyzed in recent works (Prieto, Migueláñez and García-Peñalvo, 2014b). Concerning physics learning, mobile devices are not only mere intermediate tools between the learner and the teacher or the available contents. Smartphones can also be used for learning physics by allowing the students to do experiments using the smartphones' sensors as measurement devices. In this way the students can play a really active role in their own learning.

Different works have explored the use of mobile technologies in the learning environment. Some of these works analyze the framework and effectiveness of mLearning while others propose activities based on mobile technology to improve the teaching. Within the first group, Liu *et al.* (Liu, Wang, Chan, Ko & Yang, 2003) propose that the integration of mobile devices in the classroom can make them a way to attract students to learning, ease their communication and collaboration and even follow their advances by the teacher, being the benefits of class computers enhanced in the highly interactive classroom (Wang, Liang, Liu, Ko, & Chan, 2001). A different case is the work by *Gay* et al. (Gay, Stefanone, Grace-Martin & Hembrooke, 2001) who studied the change of student's computing behavior when using wireless computing in a collaborative learning environment. Their results showed a trend that has increased with the use of mobile technologies and that may be a turning point in the evolution of learning technologies: wireless technologies facilitate social relationships that can potentially transform the learning community, blurring the boundaries between where and when collaborative work can take place. Another works exploring and encouraging the interactivity between students using mobile devices are described in (Markett, Sánchez, Weber & Tangney, 2006; Scornavacca, Huff, & Marshall, 2009). In those works improved learning environment in the classroom, increased student engagement and participation and improved teacher awareness of student difficulties were facilitated by using short message service (SMS),