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A critical review of mobile learning integration in formal educational contexts

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Abstract

The use of digital technology in the learning process and teaching practices in formal teaching is highly dependent on the ability of teachers of introducing it without jeopardizing the richness of the classroom environment, namely the attention that students need to follow the flow of argumentation and to guarantee the quality of the inquiring.

Although several studies value the importance of technologies in our media-enriched world and the "learn anytime and anywhere" motto associated with mobile learning, we argue that the classroom dynamics are becoming more and more at risk with the addictive dimension brought about by the ubiquitous presence of digital devices and social media in students' lives.

In this article, we will make a critical review of the literature related to mobile learning because there is still a need of more extensive research on the interference of technology in the classroom, especially on how multitasking affects the teacher role in-class as a media orchestrator and learning facilitator.

Finally, we will discuss the use of technology in the formal classroom environment, mainly to stimulate a much-needed discussion about the bright-not-so-bright impacts of technology in the teaching and learning process.

Keywords: M-learning, Formal education, Mobile devices, Attention, Multitasking, Classroom

Introduction

The introduction of digital technologies in the teaching and learning process is a theme that spans the literature on Educational Technology since the 1980s. Highly associated with the emergence and more consensual acceptance of new pedagogies and a renewed epistemological approach about the nature of knowledge and of its construction, technologies are often depicted as a set of tools that bear in themselves several solutions to the problems of education.

This optimistic view of digital technology came about with the introduction of the personal computer, then the Internet mainly in the 1990s and is still echoed and very much amplified with the possibilities brought by the pervasive and ubiquitous access to mobile devices and social media platforms in the 2000s.

These latter devices and media frame the emergence of a new learning modality, mobile-learning (m-learning), that was defined as "the processes of coming to know

through conversations across multiple contexts among people and personal interactive technologies" (Sharples, Taylor, & Vavoula, 2007: 224).

The definition of m-learning has evolved in different ways and directions since the first decade of the 2000s. According to Baran (2014: 18), the evolution of these definitions has mainly highlighted m-learning positive characteristics such as "mobility (Sharples et al., 2009), access (Parsons & Ryu, 2006), immediacy (Kynäslahti, 2003), situativity (Cheon, Lee, Crooks, & Song, 2012), ubiquity (Kukulska-Hulme et al., 2009), convenience (Kynäslahti, 2003), and contextuality (Kearney, Schuck, Burden, & Aubusson, 2012)".

These different emphases reflect the expected but also the unexpected impacts of the introduction of these digital technologies in the learning process. In the history of m-learning, initial definitions were more device-driven (focusing in immediacy, convenience, access and mobility) while the latter ones are more personal and social-driven, exploring affordances that relate to new technological features of mobile devices such as location awareness, motion detection and augmented reality (Baran, 2014: 18).

Although, theoretically, these definitions encompass the formal, non-formal and informal contexts in which learning occurs, Cheon et al. (2012) argue that they reinforce the learning that occurs in real settings, i.e., that are not limited to classrooms contexts. But is m–learning supporting or jeopardizing learning in classrooms?

To be able to critically explore these issues is the main aim of this article. We will begin by a brief review of the literature about m-learning research in order to try to understand the undeniable positiveness related to the use of these devices (Al-Zahrani & Laxman, 2016; Wu et al., 2012). Following, we will discuss the place and value of mobile devices and social media applications in today's learning, confronting our optimism about this issue with other opinions which question the fit of mobile devices in some educational contexts.

In the following section, we will present some of the teaching and learning impacts associated with the use of these devices in classroom contexts, namely the issues that result from multitasking and that may be troublesome for the students but also the orchestration issues that arise for the teacher in a multidevice and multimedia classroom. Finally, we will discuss different perspectives related to digital technologies integration in the classroom, trying to provoke a necessary and reality-based discussion about these issues.

Mobile learning research overview

This integrative literature review follows some of our previous work in this area, namely developed by Aresta, Pedro & Santos (2015) but in this one we focused our analysis on the review of meta-analytical studies about m-learning published since 2010 in order to present a snapshot of the existing research in this field. The keywords used in searching articles in the SCOPUS database were *m-learning* and *meta-analy** and we limited the search to articles from 2010 to 2017. A staged review was conducted, beginning with an initial review of all the abstracts, followed by an in-depth review of selected articles according to the relevance of the journals in which they were published. This review shows that the m-learning is an emerging field of research, showing a steady increase in terms of number of publications since the beginning of the 2000 decade. Some meta-analytical papers in the past years (Chee, Yahaya, Ibrahim, & Noor Hassan, 2017; Al-Zahrani & Laxman, 2016; Hung & Zhang, 2012; Wu et al., 2012; Hwang

& Tsai, 2011) show this progression and reveal the focus on studies related to the effectiveness of m-learning followed by m-learning system design (Chee et al., 2017).

These trends and foci are somewhat expected, as pointed out by Hung and Zhang (2012), because they reveal a predictable path since the introduction of a technology to its adoption and integration. According to these authors, "e-learning research is at the early majority stage and foci have shifted from comparing the effectiveness of e-learning to developing models for e-learning environments and for teaching and learning strategies within various e-learning environments. If m-learning articles follow a similar path, we may expect more research studies on strategies and framework (...) in the near future." (Hung & Zhang, 2012: 13).

However, one of the first issues that pretty much every study in this field tries to establish is a stable definition of m-learning. Being a relative new field of study and witnessing some technological breakthroughs in its early existence, several definitions have been suggested since the early 2000s. For instance, some authors identified m-learning as a natural consequence of the e-learning evolution (Georgiev et al., 2004), but more recent definitions position m-learning as a method that intersects mobile computing and e-learning (Chee et al., 2017), that adopts the use of mobile technology to achieve anytime, anywhere, ubiquitous learning (Hung & Zhang, 2012) and that emphasizes learners' mobility and personalized learning (Vázquez-Cano, 2014).

In terms of simple bibliometric data, Hwang and Tsai (2011) reviewed studies about m-learning published in six major research journals related to technology-enhanced learning from 2001 to 2010 and reported that from 2006 to 2010 the number of articles related to MUL (Mobile and Ubiquitous Learning) almost quadrupled in relation to the 2001–2005 period. These figures can be supplemented by the ones developed by Hung and Zhang (2012) and Chee et al. (2017) that conducted meta-analytical reviews of m-learning trends from 2003 to 2008 and from 2010 to 2015. Although these authors used different journal databases, the results also present a parallel evolution pattern in the case of the Hung and Zhang (2012) study and a more modest but still evolutional pattern in terms of number of publications in the time period reported in the Chee et al. (2017) literature review.

In terms of sample groups, both Hwang and Tsai (2011) and Wu et al. (2012) report that published papers show a high prevalence of studies with Higher Education students, followed by elementary school students and K-12 students. Oddly (or perhaps not, as we will argue further) only a few studies in both meta-analyses were related with the use of m-learning from the professors or teachers' standpoint.

Regarding the educational contexts of m-learning studies, Chee et al. (2017) report that when those contexts are revealed, informal learning contexts are predominant, followed by formal contexts and a combination of both. This result is consistent with results reported by other authors, namely by Vázquez-Cano (2014).

Together with the predominance of informal educational contexts in m-learning published research, Hwang and Tsai (2011) also report that most studies do not focus on a particular learning domain but rather present results related to motivation, perceptions and attitudes of students towards m-learning. Once again, the perceptions and attitudes of teachers are seldom found. These results are aligned with the ones also reported by Chee et al. (2017) in a more recent analysis.

Finally, in terms of outcomes, Wu et al. (2012) report that 86% of the studies on m-learning present positive outcomes. This kind of result is also found in Chee et al. (2017: 123) article, which report that "most of the 144 M-Learning studies present positive outcomes. (...) Neutral outcome ranked next and negative outcome ranked the least."

These results are very representative of a general positive attitude towards m-learning that crosses much of the literature in this field.

The not-so-glamorous issues missing in m-learning research

The brief snapshot of m-learning research of the last decade gave us some important clues about the major topics of research in this field but, more importantly, about the issues that are seldom if not considered at all.

Among the latter, we would like to stress two particular ones: the use of m-learning in formal educational contexts and the integration of m-learning from the professor/teacher standpoint which will be developed in the following sections.

M-learning and formal education contexts

Regarding digital devices use in education, Gikas & Grant (2013: 18) acknowledge that "(...) there is little applied research into how these tools are actually being used to support teaching and learning with few descriptions of how mobile computing devices and social media are used by university students".

Being widely regarded as both a formal and informal method or set of practices, it is curious that only a few studies report the use of mobile devices or m-learning strategies in formal educational contexts. We noticed that some authors prefer to see m-learning as a shot to bridge formal and informal learning opportunities, valuing, among others, its context-awareness and situated features. Obviously, we also share this opinion and some of our previous work is precisely related to that (Pedro, Aresta, Santos & Almeida, 2015). We also agree with Gikas and Grant (2013) claim whereas much of the literature has been focusing on the affordances of mobile devices to replicate old methods, strategies, and practices that are mainly teacher-centered and transmission-oriented. We find it very difficult to disagree with these findings. As mentioned by Tess (2013), we also believe that bringing more scholarship into the implementation of technology as a learning resource is necessary.

Nevertheless, it is curious that apparently only a few studies report the results of the use of these devices in the context of class-activities such as a lecture, for instance. Gikas & Grant (2013: 23) report in their study that "(...) traditional college-aged students (...) felt that at times the device could be distracting. The allure of social networking applications that were not being used for class potentially threatened their concentration" but don't elaborate further on that, presenting next a claim that "(...) older students (...) emphatically stated that the devices were not distracting." Could this issue be related to the age of students? These authors also report a finding that "(...) while there is not a preponderance of data to support this final implication, there were data to suggest that the student participants also blurred the lines between their personal identity and their mobile computing device. The student participants recognized their need to be constantly near their device." The tone used on the discussion of this

result is, again, very positive. Gikas & Grant (2013, 25) report that being always connected with their mobile devices allowed students to access course information and also gave them the opportunity to interact with the content, potentially contributing to tear apart the existing barrier between learning and real life. Could it be the case that we may be missing something? According to Lepp, Barkley, and Karpinski (2015), some recent findings suggest a careful consideration of the relationship between cell phone use, and foremost the use of social media, and academic performance.

And what about the overall suitability of mobile devices and social media applications in formal education? Friesen and Lowe (2011: 184), for instance, are outsiders in this optimism game, questioning the suitability of social media for education, claiming that just as "commercialism ultimately render television beyond the reach of education, we conclude that commercial pressures threaten to limit the potential of the social Web for education and learning."

Reflecting on the commercial priorities of most social media applications, Friesen and Lowe (2011) argue that the use of these applications could harm education, precisely because they are positively bounded to likeness and agreement, possibly jeopardizing important learning strategies that imply critical inquiry, confrontation, disagreement and dissent. They argue that the "adoption of these platforms would threaten educational dialogue as a process that is central to collaborative learning. The sequence, rhythm, and flow functions of commercial social media present, to use Raymond Williams (1974) phrasing, 'a formula of communication, an intrinsic setting of priorities'. The difference separating these priorities (in new social technology) from those of education is clear in the form of social networks, if not also in some aspects of its content." (Friesen and Lowe, 2011: 193).

M-learning integration from the teacher's standpoint

As mentioned before, although many teachers are looking up to technological devices and applications to enhance their classes and promote active learning practices in their students, there are not so many studies that try to understand the integration and the actual results of m-learning practices from the teacher standpoint.

Baran (2014), for instance, reports on the use of m-learning in teacher education which is a good sign but, still, reports more on preservice teacher's perceptions and attitudes and not on the integration of m-learning by real practitioners on the field. As argued by Tess (2013: 66), a "(...) reason that may explain the paucity of studies is that SNS (social networking sites) integration is a choice made at the instructor level rather than an institutional decision. As a result, the implementation may be more of a trial that lends itself to action research and ultimately to more questions."

However, we think that besides the real implementation issues that come about in practice there is an underlying problem to be solved related to the lack of theoretical and pedagogical foundations regarding the implementation of mobile-learning in educational contexts.

Although many authors frame this method on socioconstructivist approaches deriving from the work of Vygotsky and in the appeal of the communication features of mobile devices to set up communities of practice and inquiry and foster

collaboration, the fact is that what is participatory and collaborative in any human endeavour is people and not devices or media (Jenkins, Ito & Boyd, 2016). Therefore, it seems that, beginning in the teachers themselves but also encompassing students and the overall learning community, there is a lack of true and meaningful participatory culture of mobile devices users that can propel the full promise of technology.

Eijkman (2008) proposes the term 'non-foundational network-centric learning spaces' precisely to define this conundrum. He argues that the use of technology in education is still pretty much centered on an information-driven paradigm and that to fulfill the promise of new media and the devices that support them it is needed, from the part of the teacher and students, a novel approach, centered on collaborative knowledge construction and on a participatory-driven paradigm. This is a major problem because, as reported by Tess' (2013) review of literature, the former kind of perception and attitude is still dominant in our schools.

This conundrum has obvious effects in practice. Tess (2013) reports several studies which suggest that training and guidance is needed for teachers to feel secure to implement this method. Accordingly, Baran (2014: 23) curiously goes a step back and proposes that the problem really begins before, with teachers' educators, stating that "(...) the literature needs to establish pedagogical and theoretical models that can guide teacher educators in designing mobile learning experiences for preservice and in-service teachers. These models need to present strategies for equipping teachers and teacher educators with methods for integrating mobile learning into classrooms as well as supporting professional learning with mobile tools."

These are major problems and, in the regular teaching and learning process, we still have not reached the classroom. There, these problems increase in magnitude and several studies report that students rarely used social media for educational purposes (Jones et al., 2010), communication regarding coursework was least on the list (Roblyer, McDaniel, Webb, Herman, & Witty, 2010) and only 24% of the faculty used SNSs in their courses (Ajjan & Hartshorne, 2008).

As stated before, the discussion of the challenges of real integration of m-learning in classrooms is minimal (Baran, 2014) and, for instance, there are studies that alert to the fact that the integration of certain practices in classrooms can run, for instance, into a non-existent or incompatible curriculum (Price et al., 2014).

Challenges of mobile devices use in the classroom

Digital devices as a distraction in the classroom

Shirky (2014), in a lengthy essay on Medium, argued that, although he is an advocate of the use of technology in the classroom, he asked his students to put their laptops, tablets and phones away in classes. The author claims that this decision was made considering that the levels of distraction is his classes were growing despite the existence of two constants: the teacher and the students, which were selected using approximately the same criteria each year. Shirky, then, attributed the cause of this increase of distraction to the pervasive and ubiquitous presence of technological devices in his classroom.

However, this line of thought is not new. Almost 10 years ago, Fried reported this concern referring laptops as likely sources of cognitive overload and distraction and

referencing a set of studies that suggested that "[t]he orientation and visual nature of laptops, along with pop-ups, instant messages, movement and lighting of text, and even things like low-battery warnings, make laptops inherently distracting" (Fried, 2008: 908 for more information).

Although some authors (Selwyn, 2010; Siemens, 2006) argue that there is, apparently, a new student in our higher education classrooms that is highly connected, collective, and creative and that social and communicative connections may constitute a new form of knowledge that is no more merely instrumental to the learning process (see Friesen & Lowe, 2011 for an entertaining and thoughtful discussion about these topics), there are also other authors (Warschauer, Zheng, Niiya, Cotten, & Farkas, 2014) that are questioning the benefits of using mobile devices in the classroom, mainly because of the yet to study effects resulting from its integration.

One of those effects is reported by Shirky (2014) and by Sana, Weston, and Cepeda (2013) and it is related with the potential harmful effects on learning resulting from using mobile devices for nearby peers.

According to these authors this effect is particularly serious and Shirky argues that "[t]here is no *laissez-faire* attitude to take when the degradation of focus is social."

As a matter of fact, this may be an irreversible and ever-worst problem if, as claimed by Shirky (2014), digital devices and applications continue to be designed for competing for our attention. In the past years, we witnessed the emergence of very creative forms of notifications in digital environments, beginning in pop-ups and banners, to the most recent badges, roll-ups, and push notifications. These kinds of effects have been suggested in some studies as a possible cause to a negative correlation between electronic media use (including mobile devices) and academic performance as Lepp et al. (2015) suggest in a thorough review on this issue. Some of these studies also suggest that these effects are not only visible in classrooms but also in homeworking tasks and in the overall quality of time spent studying.

Lepp et al. (2015: 7) argue that more research is needed in these topics because relationship between these variables has been proved but relationship does not mean, necessarily, causality: "[f]uture research should examine the many potential underlying reasons for the negative relationship identified here, including time spent studying and multitasking".

In the next section, we will present and discuss one of these topics - multitasking - and its effects in educational contexts.

Multitasking and its negative effects on learning

An aspect that is commonly presented as a downside of the introduction of mobile devices in the classroom is the possibility of students engaging in multitasking behaviors with (and within) said devices.

Multitasking has been defined by the American Psychological Association as occurring in those situations "when someone tries to perform two tasks simultaneously, switch from one task to another, or perform two or more tasks in rapid succession". When multitasking with the use of one medium or more media is considered, the term evolves to "media multitasking", characterized by Wallis (2010) as a possible threefold event: (a) between medium and face-to-face interaction; (b) between two or more

media; and (c) within a single medium. Baumgartner, Weeda, van der Heijden, and Huizinga (2014), on the other hand, define it as an activity involving interaction with two different types of media or between one type of media and a non-media related activity, while a bare bones definition by Wang and Tchernev (2012) presents media multitasking as "multitasking involving at least one media-based stimulus or response".

A more recent take on media multitasking offered by Patterson (2017) indicates that "media multitasking can take on many forms, such as multiscreen media multitasking with two or more media devices at once, such as using a smartphone or tablet while other digital media is simultaneously consumed" on a single device. The author differentiates between the terms "digital media" and "digital device" pointing out that "many different modalities of digital media can be consumed on most digital devices".

Not being a new phenomenon, multitasking has been highly potentiated by the development of digital - especially mobile – devices (Brasel & Gips, 2011; Wang & Tchernev, 2012; Cardoso-Leite, Green, & Bavelier, 2015; Schutten, Stokes, & Arnell, 2017). While the behavior itself is, as mentioned, not novel, "what is new are the number and types of digitally based activities in which people can now engage in simultaneously" (Wood et al., 2012).

Most of the current university students belong to one of the two highly technological generations: the "Millennials" (the first generation to grow up with digital technology) and the "Centennials" (who have never known a world without computers and cell phones, which they were able to fully integrate into their daily lives), both usually described as tech-savvy and highly engaged with digital technologies which they use for long periods of time and in different combinations. Therefore, digital media consumption and the use of multiple devices apparently does not represent a problem in terms of students' digital literacy. However, the problem seems to reside in the multitasking effect that results from these multiple uses.

Ophir, Nass, and Wagner (2009) recorded an average use of four digital media at a given time by the study-participating Stanford students. Patterson (2017) reports a median level of five different technologies used by students while preparing for an exam. Students also engage in prolonged multitasking behavior for long sittings: in a study conducted by Judd (2013), 3372 computer sessions of students engaged in self-directed study within an open-access computer laboratory were captured, segmented and analyzed, with the author stating that "multitasking was much more common than focused or sequential behaviors" and was "present in more than 70%, was most frequent in over 50% and occurred exclusively in around 35% of all sessions".

These are high values but it is worth noting that respondents tend to underestimate the amount of multitasking they engage in (Brasel & Gips, 2011), usually self-reporting less multitasking than the recorded through observation, so one can wonder whether these values are still underrepresenting an extensive phenomenon.

While the ability to multitask has traditionally been viewed as a positive attribute and multitasking behavior seems to be on the rise in terms of popularity, several studies have been questioning how multitasking impact learning in a higher education context, taking into consideration that "doing more than one task at a time, especially more than one complex task, takes a toll on productivity" (APA, 2006). Distraction – or shared attention – is key in this assessment, since "when we talk about multitasking, we are really talking about attention: the art of paying attention, the ability to shift our

attention, and, more broadly, to exercise judgment about what objects are worthy of our attention" (Rosen, 2008), which can be affected when new digital technologies are introduced in the classroom.

A reduced efficiency in task completion has been reported when one multitasks in the classroom, with several studies pointing out that tasks performed concurrently require more time for completion and are conducted less accurately than tasks performed sequentially. Bowman, Levine, Waite, and Gendron (2010) conducted a reading experiment involving undergraduates asked to read a 3828-word passage on a computer monitor, split in three groups: one engaged in instant messaging (IM) before reading the passage, a second group engaged in IM while reading the passage and a third group who did not engage in IM at all. The students who engaged in IM while reading took between 22% and 59% longer to read the passage than the other groups, even after deducting the time spent messaging. The underlying concept is that there is an added time needed to switch back and forth between the tasks. Subrahmanyam et al. (2013) conducted one experimental study focused on the exploration of the effect of medium and opportunities to multitask while reading two different passages (on paper, tablet, or laptop) and while multitasking or not. The authors report that while the reading medium did not have a significant statistical impact, "those who multitasked took longer to read" and "it may simple be less disruptive if one multitasks on a medium/device that is separate from the reading medium".

Therefore, multitasking with digital devices (mobile phones, tablets or laptops) can have negative impacts on the learning outcomes, leading to a poorer academic performance, while further studies have highlighted how a high use of social media has negative impacts on academic engagement. Wood et al. (2012) tried to assess the learning outcomes of 145 University students, divided into 3 groups (paper-and-pencil note-taking, word processing note-taking and a natural use of technology condition) following off-task multitasking with social media and communication tools (Facebook, MSN, email and texting) when learning from classroom lectures. The authors concluded that the participants who chose not to use technology or used minimal amounts outperformed the participants who opted to engage in intensive multitasking. Furthermore, the participants involved with off-task activities with both Facebook and MSN engaged in more off-task activities than the two tasks assigned to them and more than the other participants, which the authors link with the somewhat attractive, engaging and interactive character of the activities provided by both platforms. Junco (2012) investigated the relationship between the frequency of multitasking with some ICTs and academic performance measure by semester grade point average (GPA), concluding that while multitasking with Facebook and text messaging with cell phones negatively predicted overall semester GPA, multitasking with other ICTs (such as email, information search, or instant messaging) did not. The author links this to either the "characteristics of the technologies themselves or by qualitative differences in how the technologies were used by the students", with Facebook, messaging and texting being used mostly for social purposes and emailing and searching for academic ones.

However, multitasking behaviors with media devices have the potential to affect not only users but also nearby peers. In a couple of experiments, Sana et al. (2013) investigated whether multitasking with a laptop would hinder learning of both multitaskers and their peers. In the first experiment, 44 undergraduates were asked to attend a

university lecture and take notes with their laptop and further instructed to complete a series of non-related online tasks at any point during the lecture, mimicking the typical student web browsing habits. A post-lecture comprehension test containing 20 questions to evaluate simple knowledge and a further set of 20 question to evaluate application of knowledge was conducted with the purpose to measure learning. The authors concluded that participants who multitasked on the laptop scored significantly lower in the post-lecture comprehension test than the ones who did not multitask. In a second experiment, a new set of participants (38) was asked to take notes of the lecture using paper and pencil, some seated in view of multitasking peers and others with a distraction-free view of the lecture. The participants who were in view of multitasking peers scored significantly lower in the comprehension test, than the ones who were not. All these detrimental effects associated with multitasking - affecting not only students who willingly multitask but also those nearby - raise a significant challenge for instructors: can the advantages brought about by the inclusion of mobile devices in a classroom setting still be harnessed, while avoiding the potential for distraction they may pose, and how? The aforementioned studies report also on multitasking practices with non-digital devices. Therefore, more research is needed in order to find if these results are transferable to m-learning cases and if, as Selwyn (2009: 368) puts it, "(…) digital technologies may be contributing to an increased disengagement, disenchantment and alienation of young people from formal institutions and activities. For example, young people are derided as being more interested in using digital technologies such as the internet or mobile telephony for self-expression and self-promotion than for actually listening to and learning from others".

Orchestration: The need of a new skill for the teachers' role

When discussing the effects of integrating mobile devices with teaching and learning on students' learning performance, Sung et al. (2016: 266) bring about the concept of orchestration as an important topic. They define it as "the efforts of building harmonious relationships among components to enable compatible, efficient, and effective technology-enhanced teaching and learning environments". The components mentioned by Sung et al. (2016) were previously proposed by Dillenbourg (2013) and Dimitriadis, Prieto, and Asensio-Pérez (2013) and include technological components (hardware and software), educational context components (for instance, learning and teaching processes in different settings) and finally components related to users (teachers and students).

This is an old discussion. Many technological implementations in the past were not very successful because of a lack of attention to one or more of those components. One of the causes that is traditionally suggested for this problem is the lack of preparation of teachers. Solutions, therefore, point to the inclusion of mobile-enhanced instruction modules in teacher education programs (Sung et al., 2016).

While we agree with this claim it is our opinion that, perhaps once again, we may be overlooking the complexity of this issue by overvaluing technological issues. Theoretical, pedagogical and methodological issues related to the integration of these devices in educational contexts should be more valued. Educational contexts are ecological by

nature and the addition of one more element does not mean that we have the old environment plus one element. The whole environment changes so all the elements of the ecosystem must adapt to the new conditions (see Gibson, 1986 for a thorough discussion of this topic). When this new element is technological this ecological nature is even more visible. Media devices are very powerful in terms of its appeal and bring about new spaces, times and geographies to the classroom. Teachers, but also students and the overall community, must be prepared to integrate these devices to extend learning opportunities but not forgetting that, in order to learn, along with discovery learning methods there must be inquiry, debate but also explanation and lecturing.

Regarding the role of the teacher, as stated by Shirky (2014), "[t]his is, for me, the biggest change — not a switch in rules, but a switch in how I see my role. Professors are at least as bad at estimating how interesting we are as the students are at estimating their ability to focus. Against oppositional models of teaching and learning, both negative - Concentrate, or lose out! - and positive - Let me attract your attention! - I'm coming to see student focus as a collaborative process."

Dimitriadis et al., 2013: 497) sum up this discussion with a definition of orchestration that encompasses both the ecological nature of technology in the teaching and learning process and the new skill of the teachers' role: "From these discussions we can see a new trend raising, which we believe lies in the heart of the use of the orchestration term: that of how teachers (and/or students) appropriate and integrate in their practice the different technologies at their disposal (either digital or paper-based, generic or intended for orchestration)."

The orchestration of devices, methods and the constant adaptation to the reality of students and the class dynamic is an ongoing and collaborative process. Maybe teacher education programs should also be.

Conclusions

In this article, we tried to present a critical analysis of a reality that is pretty much alive in every education context nowadays, related with the use of mobile devices in the classroom.

The literature review points in two very different directions regarding this issue. On one hand, as Kuznekoff, Munz & Titsworth (2015: 344) argue, "one of the biggest challenges instructors face in the 21st-century college classroom is the struggle of retaining student interest and engagement while students remain connected to the outside world through their mobile devices". Several studies show that students which use mobile technologies for the purpose of texting, emailing and social networking are "generally outperformed by those students who abstain from these behaviors". O'Bannon and Thomas (2014)mention in their study important barriers to using mobile phones in the classroom which include the possibility of disruption, cheating, cyberbullying and accessing inappropriate content on the Internet. Finally, in terms of learning performance, Aaron & Lipton (2017: 10) state that "(…) digital devices and a nonrestrictive classroom policy on the use of those devices contributed to poorer retention of classroom material".

On the other hand, some authors share a clear optimism regarding the integration of mobile devices in the classroom. Sung et al. (2016: 252–253) report that "mobile technologies have great potential for facilitating more innovative educational methods.

Simultaneously, these patterns in educational methods will likely not only help subject content learning, but may also facilitate the development of communication, problem-solving, creativity, and other high-level skills among students". This particular emphasis on innovative methods is stressed when these authors state that "usage in inquiry-oriented learning was more effective than usage along with lectures, self-directed study, cooperative learning, and game-based learning; informal educational environments were more effective than their formal counterparts, and medium- and short-duration interventions were superior to long-term interventions" (Sung et al., 2016: 265).

For practitioners, the task ahead is a difficult one. On one side, there is the pervasive and ubiquitous presence of these devices in every student backpack along with "the changing relationship that today's university learner has with knowledge consumption, knowledge construction, and formal education" (Selwyn, 2010) and institutional policies that claim the reduction of face to face instruction and the interest in the use of digital environments to mediate learning activities.

On the other side, there is the traditional classroom, a place in which there is a teacher, and in which mobile devices can be used effectively to extend the learning environment and to promote collaborative practices of knowledge construction.

While it is easy to agree with both perspectives and to say that they are compatible and not necessarily exclusive, the reality is not quite so bright.

As we have shown before, the effects of the use of mobile devices in academic performance are not very promising and the challenges related with multitasking and learning in a complex and rhizomatic world must require a tremendous pedagogical and instructional effort for a successful implementation.

Being this problem ecological in nature, some strategies have been used in order to try to ensure compatibility between the reduction in the attention span time of students and the need for lecturing in Higher Education. Some interesting experiences of micro-teaching (or micro-lecturing) have been reported together with flipped classrooms approaches (cf. Hu, Zhang, & Huang, 2016) as a way to motivate learners and use meaningfully these mobile devices in educational contexts. As stated by Kuznekoff, Munz & Titsworth (2015: 348), these more interactive and student-centred approaches clash with "the traditional mass lecture class, which still remains a mainstay in colleges and universities across the country, students are expected to listen to the instructor and take notes on class material".

These one-to-one or many-to-many communication typologies afforded by mobile devices typically contrast with the one-to-many typology from traditional lectures. A more conversational classroom in which the teacher communication may be complemented with the use of these devices to inquiry and debate activities is being pointed as a potential resolution.

In this line of thought, Prieto et al. (2011: 587) claim that although the term orchestration is "almost invariable used in the context of formal learning, tied very often with the concept of a classroom where there is a teacher or more knowledgeable other", other class configurations can be an interesting testbed for testing new m-learning practices. This approach, that Sharples (2013: 505) claims to be "more disruptive" describes the technology-enhanced classroom as a context in which the new normal "is to share responsibility for orchestration between the teacher, the students and the technology".

This orchestration approach cannot, however, be limited to face-to-face instruction. New learning modalities such as blended and online learning add additional layers of complexity on this issue. The study of the integration of m-learning practices and the resulting orchestrating issues in these learning environments could also be very important and meaningful.

As orchestration is both a design and run-time issue in today's learning environments (Kollar & Fischer, 2013), we argue that – whatever the approach could be - a strong link between research and practice is needed. There is a manifest lack of research related to results of effective implementation of m-learning methods in different educational contexts and this appears to be a vicious cycle. Although some progress is slowly taking place, teachers and students have difficulties finding information on this topic that they can use and adapt, and this inevitably contributes to extend the problem. As Sung et al., (2016: 266) warn, "the investigations into increasing the education of teachers regarding the use of mobile devices have been extremely limited. Therefore, more in-depth experimental research is needed into how teachers reconcile mobile hardware and software, lesson content, teaching methods, and educational goals".

In this article, we presented a critical review of the literature related to mobile learning and discussed some of the more important issues that arise with the integration of mobile devices in today's learning environments, focusing especially on classrooms settings and dynamics. This discussion led to a more detailed discussion of multitasking and orchestration as two aspects that must be considered in a media-enriched learning environment. Finally, we stressed the need for more action research practices that investigate the interference of technology in the classroom, especially on how multitasking and orchestration affect the students' and teachers' roles.

To conclude, in order to provide adequate guidance on best practices for teachers and students that aim to implement m-learning in their teaching and learning, it is suggested that one takes into account the need for: (i) a shift from a data-driven use of m-learning to collaborative-driven practices, (ii) a comprehensive teacher training programme related to the implementation of m-learning practices in the classroom; (iii) student guidance in the process of m-learning implementation; and (iv) adapting practices to the challenges that arise from distraction and multitasking behaviors when using mobile devices. The solution, we claim, is related to the development of media orchestration skills by teachers which will be determinant for an optimised use of m-learning in their teaching practices.

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Authors' contributions
LP conceived the study, developed the paper and conducted the literature review and reflection on mobile learning. CB conducted the literature review and reflection on multitasking. Both authors read and approved the final manuscript. CS developed the first draft of the paper.

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