

THE ROLE OF MOBILE TECHNOLOGIES IN THE TEACHING/LEARNING PROCESS IMPROVEMENT IN PORTUGAL

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Abstract

Over the past few years, there has been a large investment in information and communication technology in the teaching/learning process. In this context, mobile technologies, including smartphones and tablets emerge as an innovative tool associated with different methods and strategies. Mobile technologies are technological products and, nowadays, a very representative number of so-called "digital generation" own and use them in our day-to-day, in recreational and educational activities. In this way, the mobile technologies contribute to a teaching/learning process more motivating and personalized. The students' motivation increases when this technology is used, leading to greater participation, and, consequently, better and faster acquisition of concepts/skills. Collaborative actions and cooperation between student/student, student/teacher and student/class are increased when mobile devices are used in the classroom context. The use of mobile technologies and their implications for the teaching/learning process are some of the challenges that teachers face today as promoters and "drivers" in this process. To use the tools effectively an understanding is essential and therefore there are implications in teacher training not only for the use and application of technology, but for the underlying concepts and support. This paper examined the evolution of mobile technologies in Higher Education Institutions in Portugal between 2009/2010 and 2014/2015.

Keywords: Mobile learning, Bring Your Own Device, BYOD, M-Learning, Teaching.

1 INTRODUCTION

The society is undergoing a radical change in the way they communicate and act, since many activity sectors (financial, education, healthcare, ...) are adopting the use of mobile technology to deliver services. For example, in the financial sector, customers have now access to banking services using mobile technology [1], while libraries are being digitized and information formatted for access using mobile technology [2]. The healthcare system is also employing mobile technologies to deliver training to healthcare professionals and services to patients [3]. With communication technology, learners can use mobile technology anywhere and anytime to access educational resources [4], and consequently these technologies are changing the way we live and how we access education.

There were 6 billion mobile subscriptions globally by the end of 2011 and in developing countries a majority of people access the Internet from their mobile devices [5]. Canalys [6] reported that smartphones numbers overtook PCs clients in 2011. This has provided educators an opportunity to deliver meaningful learning via the mobile device.

By 2020 digital technology will be embedded and distributed in most objects. Personal artefacts such as keys, clothes, shoes, notebooks and newspapers will have devices embedded within them, which can communicate with each other [7].

According to [8], IDC indicates that in 2016 there will be 480 million smartphones worldwide and 65% of these devices will be used to BYOD. Additionally, it is estimated in 2020 to be used 10 billion mobile devices, when the world population is not more than 8 billion. It is still expected to grow by 181.39 billion dollars in the Bring Your Own Device (BYOD) market in 2017, when this market was worth only 67.21 billion dollars in 2011, i.e. an increase of 200% in six years.

Information and communication technologies (ICT), integrated into the teaching/learning process (TLP) are revealed fundamental ways to build the student's knowledge. Making use of these technologies stimulates the interest in learning of the content taught, becoming a promoter factor of significant learning that leads to formation of competent students with open horizons and predisposed to invest in innovation [9], [10]. Ross et al. [11], among many others, encourages their integration in the classroom. Kenney [12] states that since technology is so present in the daily lives of teenagers, a class without their use would be completely uninteresting.

Over the past decades, it has been recognized the added value of the use of technological tools in the classroom and, since then, efforts have been made by different stakeholders in the field of education, including scientific community and governments in order to generalize its use and consequently improve the TLP [13]. Shrivastava and Shrivastava [14] state that *“while the emerging political economy of higher education suggests an increase in the diversity of educational contexts, technology assisted learning could indeed offer an important toolkit with which to increase choice and respond to the needs arising.”*

With the numerous technologies available, teachers and students can access a multitude of information and make use of it, exploring their potential. The use of these technologies in the classroom provides a closer relationship between teacher and student, promotes their interaction and leads to a joint and more active learning. The constant presence of tools awakens in students greater interest in looking for new ways, allowing a larger and more consolidated acquisition of knowledge [10]. However, [15] and [16] indicated that ICT is rarely used by most teachers in their teaching practices even though, as noted, today's students - "digital natives" - daily use digital media and especially mobile technologies.

ICT developments, particularly of mobile technologies, has revolutionized the world as we know it, and devices such as tablets, available since 2010, have gained popularity so quickly among the public and in various age groups [17] that is impossible not to try to imagine what such devices can lead to being introduced into the education.

The advent and use of mobile technologies has led to the emergence of the concept of Bring Your Own Device (BYOD). The concept of BYOD has emerged in 2007 in a business context as "the practice of allowing employees of an organization to use their own computers, smartphones or other devices for work purposes" [18]. Such a practice exceeded organizational barriers and started widespread use. For the first time in human history, connected mobile devices exceeded, in mid-2013, the number of people on planet earth [19]; while the number of smartphone and tablets surpassed PC sales globally [20].

To use the tools effectively an understanding is essential and therefore there are implications in teacher training not only for the use and application of technology, but for the underlying concepts and support. This paper examined the evolution of mobile technologies in Higher Education Institutions (HEI) in Portugal between 2009/2010 and 2014/2015.

2 MOBILE LEARNING - ANYTIME, ANYWHERE... ANYTHING

The evolution of mobile technology originated in the last decade, and consequently the emergence of Mobile Learning (m_Learning) has given rise to new forms of learning in different contexts [21], [22]. With the development of wireless networks the m_Learning presents itself as a new milestone in e_learning [13], and allows access to any type of information (anything) [24], at any time (anytime) and anywhere (anywhere) [25].

The physical boundaries of the classroom and time for learning no longer prevail because the content is ubiquitous (can be accessed from anywhere), students can communicate with teachers, other students and anyone else [18] to satisfy their need for knowledge using the new generation of mobile devices – digital media players (including iPods and iPod Touches), smartphones (including iPhones, Android phones, BlackBerrys and Windows phones), personal digital assistants (PDAs), and tablet computers (including iPads).

Vavoula and Sharples [26] state that m_Learning is a social rather than technical phenomenon of people on the move, constructing spontaneous learning contexts and advancing through everyday life by negotiating knowledge and meanings through interactions with settings, people and technology. According to [27], m-Learning is perhaps the fastest growth area in the whole field of ICTs in education. It covers any form of learning that is mediated through a mobile or, more precisely, mobile handheld, device.

Many HEIs are implementing m_Learning to provide flexibility in learning [28]. Using mobile devices to reach students will benefit higher education by increasing enrolment and having a broader student population, since students in different age groups will be able to access course materials anywhere and anytime [29].

The m_learning is one of the dominating trends of educational applications for new technologies [30]. While the definitions of m_Learning differ, it is obvious that not only technology but also people can be

mobile. The m_Learning can be defined as a form of learning that makes use of mobile technologies and gives students the ability to learn anything, anywhere and at anytime. This definition is based on the definition given in [31] *“Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies.”*. Quinn [32] defined m_Learning as *“the intersection of mobile computing and e-learning and includes anytime, anywhere resources; strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment”*. Stevens and Kitchenham [33] described m_Learning as *“meaningful learning that occurs through the use of wireless handheld devices such as cell phone, personal digital assistant, mini-computer, or iPod”*. Contrary to other types of learning activities, the TLP with mobile devices began with the assumption that students are always on the go and have activities according to the context in which they are. In [34] it is shown that teaching/learning environments using mobile devices provide opportunities for innovation. Thus, as shown in [35] in the TLP, in which students have an active role, and teachers and students interact in a collaborative way, the construction of knowledge is facilitated. Mobile applications help coordinate learning resources and students, and may also help to improve the educational activities that are part of this process [36].

3 STATE OF THE ART

According to the literature the use of mobile devices for educational purposes using different methods and devices has been conducted around the world. All across the globe, students from elementary school through high school are increasingly engaging with advanced wireless devices to collaborate with peers, access rich digital content, and personalize their learning experiences. Always-on, always-connected, smartphones and tablets provide today's students with a ubiquitous gateway to a new ecosystem of information, experts, and experiences, regardless of the physical assets and resources in their own communities.

Baran [37] presents a study with a review of research on mobile learning in teacher education where 37 articles were analyzed. In the analysis the following categories were considered: subject domain, type, method, data sources, reliability, validity and trustworthiness report, mobile technology used and country context. From this study it was possible to conclude that there is no study on mobile technologies in education, particularly in Higher Education Institutions, in Portugal thus making it relevant and justified.

4 RESEARCH METHODOLOGY

The purpose of this section is to describe the procedures used to collect data that are the basis for this research. The main feature of the scientific method is an organized research, strict control of the use of observations and theoretical knowledge. The present study was based on quantitative research methodology.

Data collected for a quantitative research using questionnaires, requires special care because it is not enough to collect responses on the issues of interest, but also, how to make a proper statistical analysis to validate the results.

Aspects such as the sample size the way the questionnaire is prepared, the formulation of questions, data analysis, margins of error, the process of selection of individuals, who should compose the sample, among others, are important and must be taken into consideration for any investigation.

For the present study, we used the methodology of quantitative research, since it is more appropriate to determine the opinions and attitudes of the respondent based on structured questionnaires. In this approach, data is collected through structured questionnaires, and clear goals in order to ensure uniform compression of the respondents and a consequent standardization of results.

The method of the questionnaire, according to [38], is recommended when you want to know a population, to analyze social phenomena and, in cases where it is necessary to inquire a great number of people about a certain subject. The questionnaire before being delivered was subjected to the evaluation of four experts in the field. The objective of this study was to obtain answers that will measure the influence of the utilization of mobile devices in HEI. The quantitative study was based on a questionnaire with 16 questions. As a matter of space we will just present the analysis of the 4 questions.

5 USAGE MOBILE DEVICES (BYOD) BY STUDENTS IN HIGHER EDUCATION

The students sample is composed of 151 individuals in the academic year 2009/2010 and by 273 individuals in the year 2014/2015 distributed by Engineering courses, Economics/Management and Law of higher education institutions in the north of Portugal (Fig. 1). In both school years the percentage of male gender students is approximately 60%.

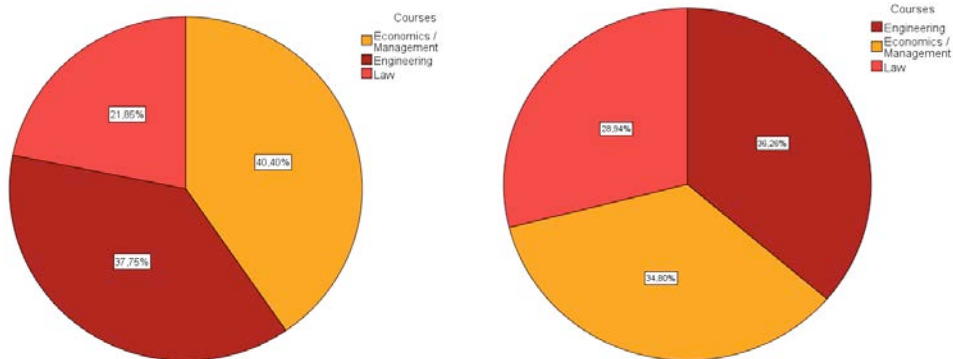


Figure 1 - Distribution of students for each course in the school years 2009/2010 and 2014/2015

Concerning the age of the students, when we observed the Tab. 1, we found that in 2014/2015 there is a percentage increase of younger students and decrease the older students (20 or more years).

Table 1 - Age distribution of students in the school years 2009/2010 and 2014/2015

	Frequency 2009/2010	Percent 2009/2010	Frequency 2014/2015	Percent 2014/2015
18	7	4,6	69	25,3
19	29	19,2	55	20,1
20	46	30,5	70	25,6
>20	69	45,7	79	28,9
Total	151	100,0	273	100,0

Fig. 2 demonstrates that there was a clear trend of use of mobile devices in the teaching-learning process.

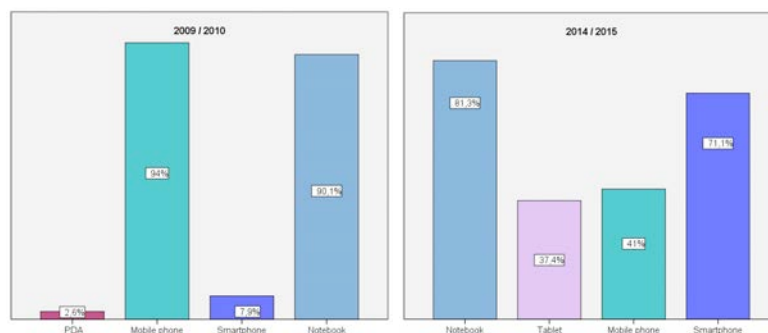


Figure 2 - Frequency of use of mobile devices in the school years 2009/2010 and 2014/2015

It should be noted that in the academic year 2009/2010 it is not evident a predisposition to change the use of mobile devices in education according to sex and / or the course that the student attends.

However, using the statistical test Chi-square with correction of continuity for tables 2 x 2, we conclude that, contrary to what happened at the academic year 2009/2010, at the academic year 2014/2015 there are significant differences in the use of mobile phone and Tablet by students according to their gender (Tab. 2 to 5). The girls use more often the mobile phone and Tablet than boys (p -value = 0.034 < 0.05 and p -value = 0.013 < 0.05 respectively).

Table 2 - The gender variable crossing with the use of mobile phone (2014/2015)

		Use of mobile phone		
		No	Yes	
Gender	Male	106	59	165
		64,2%	35,8%	100,0%
		66,7%	53,2%	61,1%
	Female	53	52	105
		50,5%	49,5%	100,0%
		33,3%	46,8%	38,9%
Total		159	111	270
		58,9%	41,1%	100,0%
		100,0%	100,0%	100,0%

Table 3 - The gender variable crossing with the use of tablet (2014/2015)

		Use of tablet		
		No	Yes	
Gender	Male	114	51	165
		69,1%	30,9%	100,0%
		67,1%	51,0%	61,1%
	Female	56	49	105
		53,3%	46,7%	100,0%
		32,9%	49,0%	38,9%
Total		170	100	270
		63,0%	37,0%	100,0%
		100,0%	100,0%	100,0%

Table 4 - Chi-square test to the intersection of gender with the use of mobile phone (2014/2015)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5,023	1	,025
Continuity Correction	4,470	1	,034

Table 5 - Chi-square test to the intersection of gender with the use of Tablet (2014/2015)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6,832	1	,009
Continuity Correction	6,173	1	,013

We also noted that in the academic year 2014/2015, there are statistically significant differences (p -value = 0.000 < 0.05) on the course that the student attends and the use of mobile devices (Tab. 6). It is curiously found that Law students use most often the Notebook that students of Economics/Management, and practically all students of Engineering also use this device in Education (see Tab. 7).

Table 6 - Chi-square test to the intersection of course with the use of notebook (2014/2015)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32,089 ^a	2	,000
Likelihood Ratio	36,553	2	,000
Linear-by-Linear Association	9,200	1	,002
N of Valid Cases	273		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 14,76.

Table 7- Intersection of course with the use of notebook (2014/2015)

Course		Use of notebook		
		No	Yes	
Engineering		3	96	99
		3,0%	97,0%	100,0%
		5,9%	43,2%	36,3%
Economics / Management		33	62	95
		34,7%	65,3%	100,0%
		64,7%	27,9%	34,8%
Law		15	64	79
		19,0%	81,0%	100,0%
		29,4%	28,8%	28,9%
Total		51	222	273
		18,7%	81,3%	100,0%
		100,0%	100,0%	100,0%

We also note that, as the mobile phone device, the course of Law is using more this device as opposed to Engineering courses where this device is the least used as a teaching and learning tool. Further, the chi-square test can be stated that there are statistically significant differences depending on the course (p-value = 0.000 < 0.05) (Tab. 8 and 9).

Table 8 - Intersection of course with the use of mobile phone (2014/2015)

Course		Use of mobile phone		
		No	Yes	
Engineering		73	26	99
		73,7%	26,3%	100,0%
		45,3%	23,2%	36,3%
Economics / Management		54	41	95
		56,8%	43,2%	100,0%
		33,5%	36,6%	34,8%
Law		34	45	79
		43,0%	57,0%	100,0%
		21,1%	40,2%	28,9%
Total		161	112	273
		59,0%	41,0%	100,0%
		100,0%	100,0%	100,0%

Table 9 - Chi-square test to the intersection of course with the use of mobile phone (2014/2015)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32,089 ^a	2	,000
Likelihood Ratio	36,553	2	,000
Linear-by-Linear Association	9,200	1	,002
N of Valid Cases	273		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 14,76.

Relative to the Smartphone device, there is a clear predominance of the use of this device by the students of Engineering courses (Tab. 10). It should also be noted that, regarding the use of Smartphone in the teaching-learning process, it should be emphasized that exist statistically significant differences in age (p -value = 0.003) and that the use of this device is more prevalent in older students (20 or over) (Tab. 11 and 12).

Table 10 - Intersection of course with the use of Smartphone (2014/2015)

Course	Use of Smartphone		
	No	Yes	
Engineering	12	87	99
	12,1%	87,9%	100,0%
	15,2%	44,8%	36,3%
Economics / Management	32	63	95
	33,7%	66,3%	100,0%
	40,5%	32,5%	34,8%
Law	35	44	79
	44,3%	55,7%	100,0%
	44,3%	22,7%	28,9%
Total	79	194	273
	28,9%	71,1%	100,0%
	100,0%	100,0%	100,0%

Table 11 - Intersection of age with the use of Smartphone (2014/2015)

Age	Use of Smartphone		
	No	Yes	
18	24	45	69
	34,8%	65,2%	100,0%
	30,4%	23,2%	25,3%
19	25	30	55
	45,5%	54,5%	100,0%
	31,6%	15,5%	20,1%
20	15	55	70
	21,4%	78,6%	100,0%
	19,0%	28,4%	25,6%
>20	15	64	79
	19,0%	81,0%	100,0%
	19,0%	33,0%	28,9%
Total	79	194	273
	28,9%	71,1%	100,0%
	100,0%	100,0%	100,0%

Table 12 - Chi-square test to the intersection of age with the use of Smartphone (2014/2015)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14,166 ^a	3	,003
Likelihood Ratio	13,983	3	,003
Linear-by-Linear Association	8,363	1	,004
N of Valid Cases	273		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 15,92.

Analyzing the devices with which the student spends more time, we find that in the academic year 2009/2010 spent more time with the mobile phone (73.3%), followed by the Laptop (43.3%) and finally the Smartphone (5.3%) with a reduced use (Tab. 13 to 15). In contrast, at the academic year 2014/2015, the Smartphone device that was the least used in the academic year 2009/2010, at the academic year is this more relevant with a rate of utilization of 51.8% (Tab. 15).

Table 13 - Frequency of spending more time with the mobile phone (2009/2010)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	40	26,5	26,7	26,7
	Yes	110	72,8	73,3	100,0
	Total	150	99,3	100,0	
Missing		1	,7		
Total		151	100,0		

Table 14 - Frequency of spending more time with the Notebook (2009/2010)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	85	56,3	56,7	56,7
	Yes	65	43,0	43,3	100,0
	Total	150	99,3	100,0	
Missing		1	,7		
Total		151	100,0		

Table 15 - Frequency of spending more time with the Smartphone (2009/2010)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	142	94,0	94,7	94,7
	Yes	8	5,3	5,3	100,0
	Total	150	99,3	100,0	
Missing		1	,7		
Total		151	100,0		

As at the academic year 2009/2010, the laptop has an outstanding position, but continues to be the second device with which students spend more time (41.3%) (Tab. 16).

Table 16 - Frequency of spending more time with the Notebook (2014/2015)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	158	57,9	58,7	58,7
	Yes	111	40,7	41,3	100,0
	Total	269	98,5	100,0	
Missing	Invalid response	3	1,1		
	No response	1	,4		
	Total	4	1,5		
Total		273	100,0		

Finally and as expected, the mobile phone that assumed in the academic year 2009/2010 a leading position in the academic year 2014/15 has low usage (28%) (Tab. 17).

Table 17 - Frequency of spending more time with the mobile phone (2014/2015)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	195	71,4	72,0	72,0
	Yes	76	27,8	28,0	100,0
	Total	271	99,3	100,0	
Missing	Invalid response	1	,4		
	No response	1	,4		
	Total	2	,7		
Total		273	100,0		

In this context, we can conclude that students regardless of their age, course and sex, spend more time with the devices they use most at the teaching-learning process (a result that confirms the expected).

6 CONCLUSIONS

The mobile technology is used more as a tool than as a teaching methodology. From the research carried out, there is a consensus that this technology does not ensure by itself success in learning, however, when used as part of an effort to support the involvement of an active learning there evidence that they can lead to increase students' motivation and satisfaction.

The introduction of BYOD in the classroom aims, from the students' perspective, to involve students in learning, leading them to participate more actively as well as ensures that the learning is most effective; on the teacher's perspective it allows to "personalize" and motivate students in the teaching/learning process taking into consideration that this process can and should be considered beyond the classroom.

In order to understand the developments in the use of mobile devices in higher education in Portugal a research was carried out in two separate academic years, separated by five years (2009/2010 and 2014/2015), in very heterogeneous courses (Law, Management/Economics and Engineering). As previously discussed the result clearly shows a high growth rate of the use of mobile technology in higher education institutions in Portugal just like other countries already studied.

The goal of future work within the same target (higher education institutions in Portugal) is to identify and analyze the introduction of mobile technologies and tools in the teaching/learning process and its advantages and disadvantages.

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