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Mobile Distance Learning with Smartphones and Apps in Higher Education

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Abstract

In this paper, the results of researcher' ongoing activities regarding the use of smartphones and a specific subject-app used at the Spanish National University of Distance Education (UNED) have been reported. The purpose of this trial is to assess the app's didactic use and potential to enhance student learning in university subjects in ubiquitous environments and developing generic competencies according to the European Higher Education Area (EHEA). To this end, a scale has been developed and validated to identify these factors based on the participation of 388 students from the class "Curriculum design and innovation" within the "University Degree in Pedagogy" program. This study has been developed through two perspectives; the first being through a descriptive methodology in which the current researcher has detailed the creation process of an app. The second perspective being through a quantitative methodology in which students' perceptions regarding the capabilities of smartphones and apps for improving learning processes in university subjects were assessed. The conclusions indicate that the use of apps developed specifically for following university subjects is highly valued by students as a new format which both supports and enhances learning practices while also providing not only further opportunities to establish connections and relations with their subjects, but also fostering collaborative work among students and professors. Therefore, it is recommended that universities continue developing new didactic strategies to connect both formal-informal and face-to-face ubiquitous learning settings.

Keywords

Apps, Distance Education, Generic Competencies, Higher Education, mLearning, Smartphones.

Smartphones and other mobile digital devices, such as tablets, can be surprisingly useful didactic resources for developing subjects in both distance and face-to-face university studies. They may, moreover, be used as an instrument conducive to educational and personal interaction, fostering relationships between students and their professors (Bedall-Hill, 2010; Chayko, 2008; Franklin, 2011; Johnson, Adams Beker, Estrada, & Freeman, 2014; Oulasvirta, Wahlström, & Ericsson, 2011; UNESCO, 2013). Both traditional and new ways of teaching based on Learning Management Systems (LMS) and educational platforms developed by universities can be enhanced by the use of personalized apps which can be used in a collaborative way to develop curricular content. They may also be used to improve new ways of developing generic and specific competencies of university degrees within the framework of the European Higher Education Area (EHEA).

Nowadays, students experience digital environments in a very tactile and personal way through a wide variety of mobile devices (i.e., smartphones and tablets) whose uses can be

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converted into collaborative learning practices. Smartphones are increasingly becoming ever-present, penetrating and transforming everyday social practices and space. These practices can be complemented with text documents in different formats, audiovisual contents with mini-videos, microblogging applications, and social networks (Twitter, Facebook, Linkedin, etc.). Smartphones are no longer only a tool for communication, but in many cases have become an instrument of people's social and work life, and possibly, a powerful instrument in academic life. Therefore, middle and higher education in developed and developing countries are now trying to adopt the use of smartphones in the learning process from different perspectives and teaching methods (Johnson et al., 2014; UNESCO, 2013).

Looking at the wider context of mobile learning, mobile devices are responsible for new forms of art, employment, language, commerce, and learning. Nowadays, there is no separation between real and digital life: staying in online contact with friends and colleagues, working virtually on international projects, writing an online text, or researching recommendations for interesting locations nearby; digital communication enriches the real world (Eteokleous & Ktoridou, 2009; Norris, Hossain, & Soloway, 2011). Although mobile learning support is rare in classroom settings, research on faculty support regarding how mobile technologies can be used for teaching in Higher Education is even scarcer. Therefore, more research is needed to investigate mobile teaching and learning strategies and how these strategies are being implemented to engage students in the learning process (Chen & deNoyelles, 2013).

m-Learning through Smartphones and Apps

Mobile learning (mLearning) refers to the capabilities that mobile technology devices have brought to a physical classroom context as well as to the activities of students as they participate in learning institutions (Bedall-Hill, Jabbar, & Al Sheri, 2011; Dixit, Ojampera, Nee, & Prasad, 2011; El-Hussein & Cronje, 2010). There is an ever increasing amount of mobile learning research focusing on feasibility combined with data on user experience (Fisher & Baird, 2007; Triantafillou, Georgiadou, & Economides, 2008; Vázquez-Cano, 2012). The existence of nearly 7 billion active mobile phone subscriptions worldwide dramatically illustrates the huge potential for the mLearning market and its use in education (Delfino, Dettori, & Lupi, 2009; Johnson et al., 2014; UNESCO, 2013). Mobile technologies are playing an increasingly important role in college students' academic lives. Devices such as smartphones, tablets, and e-book readers connect users to the world instantly, increasing accessibility to information and enabling users to interact with each other. With the reality being thus, using mobile technology for teaching and learning has become a rapidly evolving area of educational research (Collins, 1996; Dyson, Litchfield, Lawrence, Raban, & Leijdekkers, 2009; Frohberg, Göth, & Schwabe, 2009; Johnson, Means, & Khey, 2013; Vavoula, Pachler, & Kukulska-Hulme, 2009). For this reason, mLearning may be considered as an avenue for content distribution (Muyinda, Lubega, & Lynch, 2010), as a facilitator of reflective processes (Corlett, Sharples, Bull, & Chan, 2005), and as a basis for developing and deploying mobile games based on learning (Dahlstorm & Warraich, 2013). Authors such as Cochrane and Bateman (2010), and Dyson et al. (2009) have emphasized that the benefits of mobile learning stem from the portability, flexibility, and context of mobile technologies, which facilitate learning, promote collaboration, and encourage both independent and cooperative learning for life.

To encourage collaboration and reinforce real world skills, universities are experimenting with digital policies that allow for more freedom in interactions between students when working on projects and assessments (Johnson et al., 2014). In this context, many Universities around the world have begun implementing mobile learning with smartphones. For example, students at the University of Phoenix study in over 200 institutions simultaneously as well as online. With the university's mobile app, students can view their course materials, flag and mark posts even when they are offline, and participate in class discussions, gaining required participation points from anywhere. Stanford University, in addition to the standard mobile apps, offers shuttle times, an event catalog, an online directory, and boasts a mobile learning research department, thereby giving students a chance to read case studies regarding mobile learning. The Stanford Mobile Inquiry Learning Environment (SMILE) program, developed by Paul Kim, allows students to use their devices to create, collaborate, and evaluate questions regarding educational topics, essentially becoming a research lab in students' pockets. At Florida International University, by means of one of its apps, students can view the availability of library resources, access video content, and even stay up-to-date with FIU sports teams.

Recent research has explored the patterns of use of a number of mobile services used by students (Ally, 2009; Chen & deNoyelles, 2013; Dahlstorm & Warraich, 2013; Johnson et al., 2013; Milrad & Spikol, 2007; Williams & Pence, 2011). Results of these studies illustrate that smartphone-optimized content is widely used and that there is a clear desire by students for more resources to be made available in this format, including administrative information from universities. It is also important to recognize the need to address the technical requirements of producing and sharing content across multiple types of devices and networks. Results also confirm the importance of designing applications and services for learners that are both easy to use "on the road" and by whose use tasks maybe completed in short periods of time. A challenge in higher education is in designing social technologies that allow for the convergence of different pedagogic goals (control of learning) and ways of communication between different actors in the learning environment. The latter aspects require more than designing mere services connecting individuals and content (Dron, 2007), but also require the creation of new didactic sequences and educational activities that can be used to connect formal and informal learning settings into a congruent whole.

In such a technological context, possessing university generic competencies within EHEA has emerged as one of the fundamental references denoting educational success. By transforming teaching and learning, Information and Communication Technology (ICT) is considered to contribute to the acquisition of many of these key competencies. Students need to achieve an effective level of digital competence to assure their future in academic, personal, and professional fields (Dublin Descriptors, 2005). It is not sufficient simply to teach the handling of digital devices; learners must also be trained in how to learn with the help of ICT (Bosch, 2009; Vladar & Fife, 2010). Today these tools can be directly used as part of classroom activities to promote new methods of teaching and learning. Using portable devices in university degree programs will act to develop new practices, tools, applications, resources, and designing strategies to understand the situations of ubiquitous, pervasive, personal, and connected learning (Caverly, Ward, & Caverly, 2009; Huang, Jeng, & Huang, 2009; Kinsella, 2009). This connection could manifest itself through formal education experiences (attending a workshop, participating in a training session, attending classes, etc.), or through informal education experiences for situated learning (receiving performance support while on the job).

The most important feature of new mobile phone technologies in the area of Education occurs when, due to their portable natures and their abilities to promote additional learning methods, learning continues beyond the classroom (Committee of Inquiry into the Changing Learner Experience, 2009; Dublin Descriptors, 2005). Smartphones provide learning and training support for students through their capabilities, which include the enabling of quick content delivery, enhanced support time in project-based group work, a higher level of student engagement in learning-related activities within a multitude of diverse physical locations, and the enhanced availability and accessibility of information (Clough, Jones, McAndrew, & Scanlon, 2007; Cowie et al., 2009; Falaki et al., 2010). The latest smartphone models area veritable mini-computer providing a myriad of capabilities such as a video camera, telephone, GPS, film player, games, e-books, e-mail, and the facilitation of internet access, music MP3, short messages, and the ability to download a plethora of apps designed for different purposes (Ally, 2009; Herrington, 2009; Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009). Collaborative social networks, such as Facebook and Twitter, accessed via students' smartphones allow students to form groups in order to distribute and share their knowledge with ease, resulting in more successful collaborative learning (Dangel & Wang, 2008; Looi et al., 2010). Not only are smartphones an integral part of how knowledge and its discourse transform, they also create new ways of accessing and sharing knowledge (Saylor, 2012; Wong & Looi, 2011).

Context and Description of the Activity

The goal of integrating the smartphone into university subjects comes from the high penetration of such devices all around the world and its potential didactic use in ubiquitous environments. There are 6.8 billion mobile subscriptions worldwide, estimates The International Telecommunication Union (ITU) (February 2013). Furthermore, mobile devices such as tablet computers and wireless touch-screen readers will be significantly more affordable and accessible in the year 2030. By 2016, Africa and Middle East will overtake Europe as the second largest region for mobile subscribers. Also, the number of apps rises continuously every day, due to the high demand for applications by users. Apps shrink the programs that were once

available only on a desktop computer into versions usable on smartphones and mobile devices; such as stock trades, restaurant reviews, Facebook, streaming radio, photographs, news articles, videos, and educational apps. Analysts estimate that there could be 200 billion downloads in 2017 (Portio Research, 2013). With so many apps available, students and teachers can choose the most appropriate ones for developing new mobile and ubiquitous didactic learning environments; with categories ranging from gaming, lifestyle, news, entertainment, movies, books, and so much more. Thus, educational opportunities for integrating apps are increasing more quickly than ever before. Perhaps, the most striking aspect is the possibility of self-creation, and the ability to bring to life the Chinese proverb: "If you give a man a fish, he will have a single meal. If you teach him how to fish, he will eat all his life" (Kuan-tzu-Chinese Philosopher). Taking all of the above into consideration, the concept applied to our activity was: "Self-content-creation", in other words, as a Professor you can develop and personalized your own app for your subjects under the following principle: "Do-It-Yourself"; using app creation software. The high-tech objects used today to access entertainment and information are no more than black boxes to most of users. Their workings are incomprehensible and, although there are capabilities in some of them enabling users to draw pictures, make videos, and so forth, they are not, in and of themselves, creative media. In other words, most people cannot create the apps that run on these gadgets.

Mobile learning often takes place outside a formal learning environment, tending to become personalized via users' personal mobile devices. As a result, one major challenge for mobile research in higher education is to adapt university subjects to a specific usage with mobile devices. Mobile apps are considered as a key emerging technology in higher education. These technologies find their ways onto campuses because people are using them, rather than the other way around (NMC Horizon Report, 2014). As professors teaching the subject "Curriculum design and innovation" as part of the coursework of the program "University Degree in Pedagogy" at the Spanish National University of Distance Education (UNED), the current researcher has developed, over a period of five months, a mobile subject-app with audiovisual content, .pdf files, and which can be used for sharing comments in a specific channel of microblogging with Twitter. Setup was developed following the "App Inventor" website that is freely available for anyone to use. "App Inventor" is an open-source, Web-based system developed by Google that allows people to create Android apps without having to know how to code. Instead of writing code, the Android mobile app can be visually designed with this program. In App Inventor, amateur developers create the user interface, selecting components for the mobile application in a browser by using the "designer" and then program it with a drag-and-drop "blocks editor" that runs on the computer using "Java Web Start." App Inventor comes with an emulator alleviating even the need of an Android device to test the application. A free Google account is needed to install Java and the Android SDK on the computer in order to use this program. For Windows-based computers, if the user wants to install the apps on his/her phone, all s/he needs to do is to install a device driver for his/her phone. The idea behind such "App Inventor" is that professors can use it to write educational apps tailored specifically to their subjects. We developed the following simple app below (Figure 1).

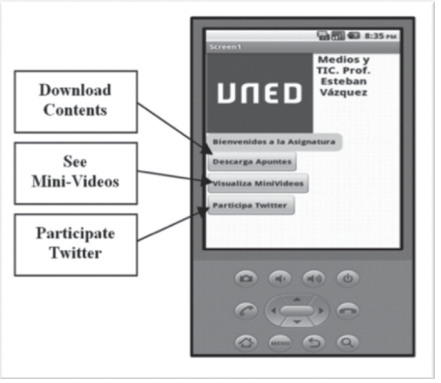

Figure 1
App for "Curriculum Design and Innovation" Subject

This app was created as an optional resource for students with "Android smartphones." We have more than 600 students studying this subject and our university has developed an LMS called aLF in which all subjects are monitored with the support of web 2.0 tools: chat, forums, video, podcast, etc. However, since there is no mobile version, this LMS is currently only available for PCs and laptops. As a solution to this problem, this app was developed and used for more than 400 students' tablets and smartphones, and it was intended for students studying in distance education, most of whom work or have other duties during the day. With this app, students have access to audiovisual and text content

of the subject anytime, anywhere and can share tweets for academic purposes through a specified channel in Twitter.

The app was called "App media and ICT" and has the following characteristics:

- It is a system to support and develop the LMS-aLF.
- It is organized in three categories: (1) .pdf files with curricular content from the subject, (2) mini-videos with professors' presentations, and (3) demonstrations.
- It includes a Twitter account for professors and students participation and interaction discussing subject themes.

This approach is in line with the discussions among members of the 2014 Higher Education Expert Panel which indicated that the advent of mobile voice and video tools was not only increasing the number of interactive activities between online instructors and students, but also greatly improving their quality. Our strategy to develop a more remarkable didactic use for smartphones was to decompose our subject curriculum into small pieces of curricular content. For this purpose, we redesigned the .pdf files and text materials accordingly so that they may be accessed via mobile devices, adding mini-videos to develop audiovisual content and the possibility to participate in a specific Twitter channel for the subject. Student access and their use of mobile technologies also have implications for instructor development. Although students expect instructors to use technology to engage them in the learning process, only a little over half (54 percent) of U.S. students stated that their instructors provided training for technology used in their courses (Chen & deNoyelles, 2013).

Purpose

The purpose of this study is to assess the didactic use of smartphones and apps (software mobile applications) to promote enhanced student learning through modular audiovisual and text content in the subject "Curriculum design and innovation" as part of the coursework for the program "University Degree in Pedagogy" at the Spanish National University of Distance Education (UNED). The researcher attempted to investigate the students' opinions about the didactic use of smartphones and a subject-app in university studies. The research questions take into account the answer of the follow two specific objectives:

Objective 1: To determine whether smartphones have a positive impact on students' academic learning by assessing students' opinions and experiences with the use of this device in a university subject.

This objective attempts to answer the following research questions:

a- Do students consider smartphones useful tools for learning at University?

b- Do students consider smartphones useful to increase their academic productivity at University?

c- What type(s) of academic activities contribute to the growth of students with smartphones at University?

Objective 2: To determine which app features are regarded by students as contributing significantly toward the learning process (text files, mini-videos, social network of microblogging).

This objective attempts to answer the following research questions:

a- Do students consider a subject-app for developing the learning process at University useful?

b- Do students consider app capabilities for practicing generic competencies according to EHEA useful?

Method

Research Design

Research on the "Technology Acceptance Models" has led to an internal modification that now incorporates both human and social variables and which is now called the "Unified Theory of Acceptance and Use of Technology" (UTAUT) model (Venkatesh, Morris, Davis, & Davis, 2003). The UTAUT model has been demonstrated to be up to 70% accurate at predicting user acceptance of information technology innovations. Within the pedagogical foundations of this model, the current researcher has developed and implemented a version called "Scale of Factors that Foster Innovation with Smartphones "(SFFIS) funded by the Spanish Ministry of Education (EDU2010-17420-Sub EDUC). Data were collected from the students using a structured questionnaire delivered digitally through a University Learning Management System-aLF. The questions are quantitative in nature, and thus the quantitative research method was used. It was organized using

a 6-point Likert scale (a grading scale in which the "somewhat disagree" item was eliminated in order to render negative Likert items more visible than in the UTAUT Model), where 1 represented strong disagreement and 6 corresponded to strong agreement to the statement. The questionnaire was structured in three sections: A- biographical Information (A1: gender and A2: age); B- Mobile learning (B1: opinions and B2: experiences), and C- Smartphones and educational Apps (C1: Subject App opinions and C2: App capabilities to develop university subjects and generic competencies). The data collected were analyzed using version 19 of the SPSS statistical software package. First of all, the questionnaire's statistical guarantees were studied. The item-total correlation of the dimension was analyzed in order to eliminate those items with a correlation coefficient of below 0.2. Also, the reliability of the scale was analyzed using the Cronbach's Alpha test. The test was applied to the scale in order to statistically prove that the items either assessed or diagnosed the real situation regarding the different constructs being studied. Next, a factor analysis of principal components was conducted in order to determine the internal structure of the questionnaire. However, before carrying out the analysis, and as a prior statistical requisite to guarantee its correct application, a series of other tests was performed. Firstly, Bartlett's test of sphericity, used to test the hypothesis that the correlation matrix obtained is not an identity matrix, and secondly, the KMO (Kaiser-Mayer-Olkin) index, which measures sampling adequacy (data suitability) in order to carry out the factor analysis, were performed. Finally, the reliability of the factors extracted from the questionnaire was analyzed, both individually and as a whole.

This study analyzed data using descriptive statistics, a median test/Wilcoxon's signed rank test, a Chi-square test, a Friedman test (non-parametric ANOVA), and lastly, the binomial test for the study findings and results (Cohen, 1988; Singleton & Straits, 2004). In order to reach Objective 1, Section B was analyzed by taking the median values of the section's items. To reach Objective 2, Section C was analyzed using a Friedman test (Non-parametric ANOVA) designed for the study. A Chi-square test was employed for the cross-tabulation of Statements B1-C1 and Statements B2-C2 with students' age and gender. Cross-tables were developed for Sections B and C. Finally, in order to test whether there exists a significant association between smartphone capabilities with student gender and age, a Chi-square test was performed.

The main hypotheses are as follows:

- Null hypothesis: Students consider that their smartphones and educational apps are not useful learning tools for the development of university subjects as well as generic and specific competencies.
- Alternative hypothesis: Students consider that their smartphones and educational apps are useful tools for academic learning and powerful instruments whose use enables them to access curriculum content and to participate both with teachers and other students.

Evidence supporting the hypothesis (that smartphones enhance students' learning and help to develop both specific and generic competencies) will motivate management decisions to incorporate mobile learning services on campus and for subject development using students' mobile phones combined with support by special software applications (apps).

Universe and Sampling

The sample was contextualized for the subject "Curriculum design and innovation" for the program "University Degree in Pedagogy" at the Spanish National University of Distance Education (UNED). Each student participating in the class "Curriculum design and innovation" and who was using the app-subject was invited to participate through a digital version of the questionnaire. A total of 388 completed questionnaires were received, representing 62.31% of the total student population targeted. Two moderating factors were included (Table 1. Gender; and Table 2. Age), each having varying influence on the primary constructs:

Table 1
Gender Distribution of the Sample

	Frequency	Percent
Female	193	51.33
Male	195	48.66
Total	388	100.0

Table 2
Age Distribution of Students

Gender	18 21	22 25	26 29	30 33	34 37	38 41	<42	P.s R.	P. Val.
Male	16.0	15.5	21.6	19.0	10.8	11.8	5.3	.009	.871
Female	14.5	19.0	23.2	19.1	11.7	10.5	2.0	.071	.113

The largest percentage of respondents, 22.4%, belonged to the 26-29 year age group, followed by 19.5% belonging to the 30-33 year age range. The lowest percentage of respondents (3.6%) belonged to those aged 42 years and above.

Results

The results obtained in the statistical tests applied to the questionnaire attest to its internal consistency and construct validity. None of the items were eliminated as a result of the low discriminatory power or low correlation with the dimension as a whole. Bartlett's test of sphericity (p=.000) and the Kaiser-Mayer-Olkin sampling adequacy measure (.791) were found to be suitable when analyzing the factorial structure of the scale using the Varimax with Kaiser Normalization method for the principal component analysis.

The principal component factor analysis identified four under lying factors in the questionnaire, with a total explained variance of 71.31%. Each of the factors identified is described below:

— Factor 1. Mobile learning (Smartphones' opinions): The items of this factor, as they are formulated, indicate students' opinions about smartphones' didactic uses within university studies. In this sense, such opinions may influence professors' involvement in ICT innovation projects. A high level of reliability was obtained in this subscale with these five items (Cronbach's alpha = .811).

— Factor 2. Mobile learning (Smartphones' experiences and uses): The six items of this factor reflect certain ways of looking at ICT and mobile learning as well as its impact on teaching practice. Both current digital context in relation to smartphones' experiences and their uses may be viewed as an element which facilitates the teaching process and which is a useful complementary resource in the learning process, an attitude which considers the incorporation of digital mobile devices into University educational practice as the duty of many professors, and a challenge which must be met and overcome. It may also be a means of shaking professors up, breaking old moulds and habits. The subscale which assesses this factor has a Cronbach's alpha = .783.

— Factor 3. Smartphones and educational apps' opinions: University students are very receptive to using both smartphones and a specific subject-app as a complementary resource for studying university subjects.

The five items which make up this subscale have a reliability level of alpha = .792.

— Factor 4. Smartphones and educational apps' capabilities: The ten items which compose this subscale refer to the app's capabilities to develop generic competencies according to the European Higher Education Area (EHEA) and the specific competencies required to be awarded a degree in education at UNED. This subscale has a mid-level reliability index (Cronbach's alpha = .803).

Table 3
Matrix of Factors Extracted by Varimax Rotation and Factor Loadings of Items

Item	F1 (SO)	2 (SE)	3 (SAO)	4 (SEC)
Are useful tools for student learning at University.	.831			
Enable me to accomplish the curricular goals of a subject.	.799			
Increase my productivity.	.801			
Make it easier to access information anywhere and anytime	.834			
Reinforce my effectiveness when I study.	.501			
Operate with smartphones is easy for me.		.790		
Smart.are useful for receiving academic and administrative university information.		.851		
I know how to use smartphones to develop academic activities.		.503		
I use internet and email on my smartphone for to academic purposes.		.671		
I use my smartphone to share academic information.		.401		
Performing operations with smartphones takes too much time in relation to academic purposes.		.634		
The use of the app created for this subject has been very positive.			.805	
I like the idea of using smartphones to prepare my subjects.			.736	
The app of the subject makes the academic activities more interesting.			.621	
I find the app to sufficiently be flexible to interact with.			.579	
Using the app on my smartphone reduces study time.			.425	
With the app I can study and interact with other students.				.813
App's file texts capability is useful to read curricular content.				.706
App's mini-video in streaming capability is useful for understanding curricular contents.				.845
App's Twitter capability is useful for sharing curricular content, comments, and doubts.				.731
App has the capability to develop specific competences of the subjects.				.734
Smart. & app have the capability to develop *Self-regulated learning competence*.				.671
Smart. & app have the capability to develop *Higher cognitive Competencies*.				.301
Smart. & app have the capability to develop *Communicative Competencies*.				.777
Smart. & app have the capability to develop *Instrumental Competencies in Knowledge Society*.				.656
Smartphone and app have the capability to develop *Interpersonal Competencies*.				.615
Cronbach's alpha α	.811	.783	.792	.803

Mobile learning (Smartphones' opinions) (SO); Mobile learning (Smartphones' experiences and uses) (SE); Smartphones and educational Apps' opinions (SAO); Smartphones and educational Apps' capabilities (SEC)

Pearson's correlations tests were also carried out between the factors making up the questionnaire. The data obtained by taking the means of each factor's items provide information regarding construct validity, indicating that all four factors contribute to measuring the dimensions of the construct on innovation with smartphones in a university setting. In short, just as positive and significant ($p< .01$) correlations were observed between the factors, so were higher correlations found in the "Smartphones and educational Apps' opinion factor in relation to the subscales "Mobile learning (Smartphones' opinions/r = .445) and Mobile learning (Smartphones' experiences and uses/r = .421).

The results from this scale have been organized according to the objectives of the study and research questions. Figures and tables were chosen to represent the results of Sections B and C.

Results Section B: Mobile Learning (B1: Opinions and B2: Experiences)

This section was structured with 11 items, the results of which are referred to Objective 1 of the research. The main hypotheses are as follows: Alternative hypothesis (H1): students consider that smartphones and mobile digital devices are useful tools for academic learning. Null hypothesis (H0): students consider that smartphones and portable digital devices are not useful learning tools. The results from students' opinion regarding the learning potential of smartphones and his/her experiences using smartphones for academic purposes are presented in Tables 4 and 5.

Table 4
Results Section B1- Students' Opinions on Learning with Smartphones

Section B1-Items Opinions. Smartphones	% Cases	P-Vl.	Bootstrap Median 95%	Standard deviation
1. Are useful tools for student learning at University.	77.57	0.000	4	0.17
2. Enable me to accomplish the curricular goals of a subject.	71.64	0.000	4	0.15
3. Increase my productivity.	77.83	0.000	4	0.17
4. Make it easier to access information anywhere and anytime.	79.89	0.000	4	0.17
5. Reinforce my effectiveness when I study.	71.39	0.000	4	0.18

In Section B1, P values are 0.000 for Items 1 to 5, the medians are significantly higher than 4; (Item B1-1 n=301-77.57%), (Item B1-2 n=278-71.64%), (Item B1-3 n=302-77.83%), (Item B1-4 n=310-79.89%), and (Item B1-5 n=277-71.39%). Therefore, more than 70% of the students either "somewhat agree" or "moderately agree" with the statements proposed; their opinions are especially relevant in regards to the goodness for accessing information, learning at University, and as devices which enhance productivity. The 95% confidence intervals support this conclusion because none of the intervals include a value of 3 (neutral).

Table 5
Results Section B2- Students' Experiences on Using Smartphones for Academic Purposes

Section B2-Items Experiences and uses	% Cases	P-Vl.	Bootstrap Median 95%	Standard deviation
1. Performing operations with smartphones is easy for me.	76.77	0.000	4	0.14
2. Smartphones are useful for receiving academic and administrative university information.	81.08	0.000	4	0.15
3. I know how to use smartphones to develop academic activities.	77.06	0.000	4	0.14
4. I use internet and email on my smartphone for academic purposes.	77.31	0.016	4	0.21
5. I use my smartphone to share academic information.	54.22	0.210	2	0.18
6. Performing opperations with smartphones takes too much time in relation to academic purposes.	53.45	0.223	2	0.14

In Section B2, because the P values are 0.000 for Items 1 to 3, results show that the medians are significantly higher than 4; (Item B2-1 n=298-76.77%), (Item B2-2 n=314-81.08%), (Item B2-3 n=299-77.06%), and (Item B2-4 n=300-77.31%). Therefore, more than 70% of the students "somewhat agree" or "moderately agree" with these statements. The 95% confidence intervals support this conclusion, as none of the intervals include a value of 3 (neutral). For Items 5 and 6, the median values are lower than 3, meaning that more than 70% of the students do not use his/her smartphone for sharing academic information (Item B2-5 n=210-54.22%) and that they believe that it takes too much time to use smartphones for academic purposes (Item B2-6 n=207-53.45%). The opinions about the capabilities of smartphones for receiving academic and administrative information and the ease of use of these devices are relevant. These results should take into account other recommendations of recent

studies: *[smartphones] provide access to online resources such as libraries, references, glossaries, exams, databases, and to course planning tools and calendars* (Chen & deNoyelles, 2013).

In order to investigate Objective 1, the analysis of "Section B" was addressed. Because the data were skewed, a non-parametric test (median test/ Wilcoxon's signed rank test) was used for analysis. To determine whether Objective 1 was reached, two hypotheses were constructed and tested; these hypotheses being H0: median rank ≤3 vs. H1: median rank > 3. The results show that the median rank assigned to Statement B was significantly higher than 3, indicating that students consider smartphones to have a positive impact on their learning. This was concluded from the *p*-value of 0.000 on nine items. Due to the 95% confidence interval for the rank being (4.00-5.00) using a bootstrap method, this interval supports the statement that "Students consider smartphones to be useful tools for their academic learning," as also evidenced by the rank assigned corresponding either to "somewhat agree" or "moderately agree." The study confirms the alternative hypothesis. Further analysis was performed using an association test (Cohen, 1988). This was done to determine whether a significant association existed between students' opinion regarding statements on "Section B" and their age and gender (Wang, Wu, & Wang, 2009).

Table 6
Section B- Chi-square Test (Gender and Age)

Smartphones are useful tools for students' learning	Pearson Chi-Square	df	P-value (2-sided)
Gender	3.985[a]	4	.409
Age	3.997	4	.410

Both the P-values were greater than 0.05; hence, there was no significant association between students' opinions, uses, and experiences of "Section B" and the gender and age at the 5% level of significance. Students consider smartphones to useful for their academic learning regardless of age and gender.

Results Section C: C1: Subject App Opinions and C2: App Capabilities to Develop University Subjects and Generic Competencies

This section was composed of 15 items, whose results are referred to "Objective 2" of the research. The main hypotheses are as follows: Alternative hypothesis (H1): Students consider smartphones and apps applied to their subjects to be useful tools both for academic learning in subjects and for developing generic competencies within the EHEA. Null hypothesis (H0): Students consider smartphones and app not to be useful learning tools for this purpose.

Table 7
Results Section C1- Students' Opinion on a Didactic App

Section C1-Items Subject. App opinion	% Cases	P-Vl	Bootstrap Median 95%	Standard deviation
1. The use of the app created for this subject has been very positive.	81.02	0.000	4	0.21
2. I like the idea of using smartphones to prepare my subjects.	79.32	0.000	4	0.25
3. The app of the subject makes academic activities more interesting.	85.12	0.000	4	0.19
4. I find the app to be sufficiently flexible to interact with.	67.12	0.000	4	0.18
5. Using the app on smartphone reduces study time.	73.19	0.000	4	0.20

In Section C1, P-values are 0.000 for Items 1 to 5, and the medians are significantly higher than 4; (Item C1-1 n=314-81.02%), (Item C1-2 n=308-79.32%), (Item C1-3 n=330-85.12%), (Item C1-4 n=260-67.12%), and (Item C1-5 n=284-73.19%). Therefore, more than 70% of the students either "somewhat agree" or "moderately agree" with these statements. The 95% confidence intervals support this conclusion, as none of the intervals include a value of 3 (neutral). Further analysis was performed using a Chi-square test in order to determine whether there exists a significant association between the students' opinion regarding statements on "Section C" and their age and gender.

Table 8
Section C- Chi-square Test (Gender and Age)

Smartphones are useful tools for students' learning	Pearson Chi-Square	df	P-value (2-sided)
Gender	3.985[a]	4	.409
Age	3.997	4	.410

Both the P-values were greater than 0.05, hence, there is no significant association between students' opinions, uses, and experiences of "Section B," and gender and age at the 5% level of significance. Students consider smartphones to be useful for students' academic learning regardless of their age and gender.

Table 9
Results Section C2- Students' Opinion on Didactic App Capabilities

Section C2-Items App capabilities		% Cases	P-Vl.	Bootstrap Median 95%	Standard deviation
1.	With the app I can study and interact with other students.	88.51	0.000	4	0.21
2.	App's file texts capability is useful to read curricular content.	68.53	0.001	4	0.25
3.	App's mini-video in streaming capability is useful for understanding curricular contents.	79.01	0.000	4	0.19
4.	App's Twitter capability is useful for sharing curricular content, comments, and doubts.	42.02	0.017	2	0.20
5.	App has the capability to develop specific competences of the subjects.	75.18	0.000	4	0.15
6.	Smartphone and App have the capability to develop Self-regulated learning competence.	78.04	0.000	4	0.23
7.	Smartphone and app have the capability to develop Higher cognitive Competencies.	80.01	0.000	4	0.25
8.	Smartphone and app have the capability to develop Communicative Competencies.	87.18.	0.000	4	0.21
9.	Smartphone and app have the capability to develop Instrumental Competencies in Knowledge Society.	86.12	0.000	4	0.19
10.	Smartphone and app have the capability to develop Interpersonal Competencies.	84.07	0.000	4	0.21

In Section C2, P-values are 0.000 for all items, except for "item 4.". The values in generic competencies show that more than 70% of the students either "somewhat agree" or "moderately agree" with these statements, what implies a remarkably high result. The "App Twitter" application should be reconsidered and applied for different purposes in order for it to provide benefits the learning process. Therefore, the 95% confidence intervals support this conclusion since only one of the intervals includes 3 (neutral). These results reinforce the opinion and potential of the app in smartphones being used for developing curricular content, interaction, and generic competencies according to the philosophy proposed in the EHEA. Figure 2 represents the smartphone and app capabilities by plotting the average ranks combined with a 95% confidence interval. The intervals are generated using a bootstrap method. Most participants agreed that the subject-app increases access to learning.

Here, it can be observed that the average ranks interval supports the conclusion that students regard the capability of both smartphones and the app, when applied to a specific subject, as a means to enhance their learning not only in this particular subject, but also their generic competencies according to Dublin Descriptors (2005).This is further evidenced by the fact that all ranks correspond either to good or excellent. Although certain capabilities have higher average ranks than do others, these differences are not significant. Further analysis was performed using an association test (Wang et al., 2009) in order to determine whether a significant association exists between students' opinion regarding statements on "Section C" and their age and gender.

Table 10
Pearson Chi-Square, Relationships between Students' Gender and Age and App Capabilities

Section C2-Items Gender/Age	Pearson Chi-Square Gender/Age	Df Gender/Age	P-Value (2 sided) Gender/Age
C2-1	3.501[a]/3.333[a]	4/4	.397/.456
C2-2	4.003[a]/3.999[a]	3/2	.145/.203
C2-3	5.312[a]/4.883[a]	4/4	.592/.541
C2-4	.402[a]/.500[a]	3/2	.116/.117
C2-5	5.103[a]/6.002[a]	4/4	.585/.589
C2-6	6.213[a]6.945[a]	4/4	.801/.798
C2-7	7.101[a]/7.002[a]	4/4	.745/.613
C2-8	6.999[a]/6.345[a]	4/4	.589/.543
C2-9	5.117[a]/5.332[a]	4/4	.628/.621
C2-10	8.111[a]/7.118[a]	4/4	.777/.654

All P-values are greater than 0.05, hence, there are no significant associations between gender and age and the app capabilities for the development of curricular contents and specific and generic competencies (at the 5% level of significance). Thus, although students' opinions on app capabilities are independent of gender, two intervals are conditioned by age (C2-2 and C2-4).Specifically, the older students (<34) encountered more difficulties in establishing relationships and sharing comments and opinions on the Twitter function on the app and in using smartphones it for reading texts.

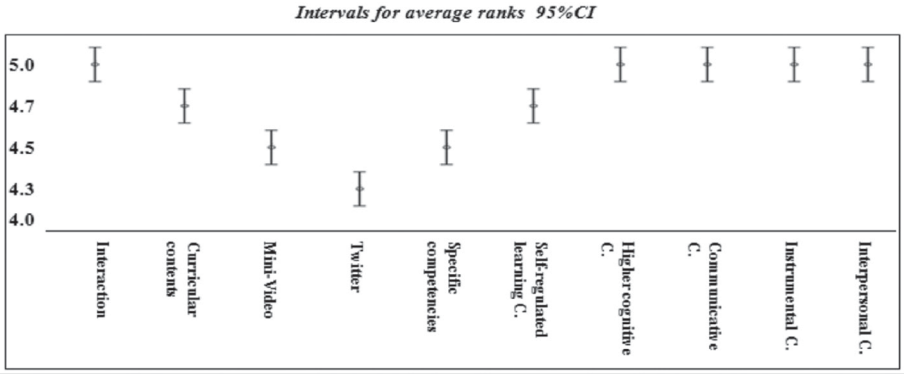

Figure 2

Intervals for App capabilities for Developing University Subjects and Generic Competencies

Discussion

According to the results obtained, the current researcher found, in reference to Section B1 (Students' opinions on learning with smartphones), that not only did students generally find it satisfactory to have their course content available for study on the smartphones, but that they perceived smartphones' didactic functionality in an university setting to be high. This supports findings in previous studies which illustrate that the main advantage of mobile and ubiquitous learning is that it increases flexibility for students studying both in face-to-face and distance learning contexts (Ally, 2009). The current study's findings are consistent with the findings of the ECAR study in which it was found that tablets have emerged as a potentially powerful mobile device in academia (Dahlstorm & Warraich, 2012). Although in order to capitalize on the advantages of mobile technologies, both professors and students need to be trained to successfully incorporate them into pedagogical practice. It was furthermore found that the development of platforms or software allowing professors and students to create and tailor mobile content should be encouraged.

In relation to Section B2 (Students' experiences on using smartphones for academic purposes), it is necessary that students must be allowed to submit assignments, and that both professors and tutors must be allowed to comment on, and return, students' assessments using mobile devices. New mobile approaches must ensure that educational resources and content, including existing online repositories, are easily accessible via mobile devices. This can be accomplished by creating new formats supporting the use of open educational resources in smartphones.

The results in section C-1 regarding the functionality of the subject-app are very positive among students, corresponding with other studies where students agreed that "m-learning increases quality," that "objectives can be met by m-learning," that "accessing course content and communication with the tutor was easy," and that "m-learning is convenient for communication with other students" (Bradley, Haynes, Cook, Boyle, & Smith, 2009; Rekkedal & Dye, 2009; Vázquez-Cano, 2012). Using small video clips worked very well as no problems were reported in accessing either picture or audio files and since most participants reported them to be a high quality resource. The results also indicate that students require further support in learning how to use mobile technologies in the educational process. Therefore, in order to capitalize on the advantages of mobile technologies, professors and students need to be trained to successfully incorporate them into pedagogical practice. Similar trends have been observed in the academic use of other emerging technologies (Nortcliffe, Middleton, & Woodcock, 2011; Rekkedal & Dye, 2009).

Finally in section C-2, most students agreed that the subject-app increases access to learning and to the development of generic competencies according to EHEA. The outcome of this study, coupled with separate discoveries made by the current researcher, indicate that very rich pedagogical techniques can be achieved on smartphones. This often requires adaptation at the media level, such as replacing explanatory text with speech and video. However, these presentation level adaptations do not detract from the pedagogical richness of the learning object, and in some instances, actually enhance it. Activities with apps obviously have certain other features, such as the ability to produce situationally-specific learning, which provides opportunities not

easily made available on desktop devices and which also contribute to develop progressive, collaborative learning, which in turn produces graduates highly skilled in communication, quantitative reasoning, and teamwork (Huang et al., 2009; Nielsen & Webb, 2011).

Professors should adapt resources to their students' context in order to improve didactic activities and to reinforce the traditional learning process in higher education using the principles of mobile learning and ubiquitous digital environments.. Since students' smartphones are always with them, they should be given the opportunity to learn on the move, wherever they are. Such services, through the university's implementation of ubiquitous mobile learning, could also be used as a reminder for students of their educational activities while also providing them the ability to access curricular content or participate with other students anytime and anywhere. University staff could support such a project by designing simple apps which aim to develop collaborative work and curricular content for their subjects and, by doing so, offer more opportunities to access information and promote interaction among students. Sinisalo and Karjaluoto (2009) stated that the introduction of Internet access on mobile phones supports modern education. The design of a didactic and personalized app, which can work on tablets and smartphones with free and simple programs, such as "App inventor," is not a difficult activity for middle- and higher-level teachers and professors.

The current study's findings on smartphones and didactic app capabilities indicate that students not only consider these applications and tools to support didactic mobile activities, but find them especially useful for their learning both by enhancing the subject's development, and by fostering collaborative work regardless of a student's age and gender. Students agreed that the always-online mobile solutions increase the flexibility of distance learning. To a large extent, they also agreed that mLearning solutions and apps increase the quality of course arrangements. Therefore, the main conclusions in relation to the two objectives developed in this study are:

- According to Objective 1, students "moderately agree" to Statements B1 and B2. The study's findings revealed that students consider smartphones and personalized apps for the development of the subject's "Curriculum design and innovation" to be useful for their learning and assessment to reinforce traditional resources, and to complement the University's LMS, since it has been proposed as an integral tool aiding students in understanding and developing their competencies in the subject.

- According to Objective 2, that students consider didactic and personalized apps for academic purposes supports and encourages curriculum innovation as well as the development of university subjects. It is remarkable that students consider smartphones and subject-apps both to be useful in promoting the development of generic competencies within the EHEA and to foster interaction among students and professors. Far from heightening isolation, mobile learning allows individuals increased opportunities to cultivate the complex skills required to work productively with others.

Smartphones and subject-apps can help students to pose and answer questions, to complete collaborative projects, and, more generally, to engage in the social interactions foundational to learning. Yet, for this purpose, the app must be a part of an LMS so that it supports both the mobile client as well as traditional clients. Research has shown that having a clearer understanding of students' mobile practices encourages the university to implement more student-centered support and services. However, technical training and skill development emerge as important factors, with students perceiving both as more important than the technology itself. Therefore, to capitalize on the advantages of mobile technologies, professors and students need to be trained to successfully incorporate them into pedagogical practice. In many instances, a government's investment in teacher training is more important than its investment in technology itself. Without guidance and instruction, professors will often use technology to "do old things in new ways" instead of transforming and improving approaches to teaching and learning (UNESCO, 2013).

In line with UNESCO's Mobile Learning Policy (2013, p. 20), since educational resources and information about a learner's progress are stored on remote servers rather than on the hard drive of a single device, students can access similar material from a wide variety of devices (including desktop computers, laptops, tablets, and smartphones). Each one is suitable for different academic purposes; while computers with a large screen and full-sized keyboard might be better for composing essays and conducting extensive internet research, a mobile device might be superior for inputting bits of information collected in the field and

noting exploratory ideas. Since software is able to synchronize work across multiple devices, students can pick up on a mobile device where they left off on a desktop computer and vice versa, thereby ensuring continuity of the learning experience. Also, because computing is increasingly "moving to the cloud" (storing data online instead of on a computer's local hard disk), devices do not necessarily need expensive processors to utilize sophisticated software; they simply need to provide the learner with a connection to the internet. Smartphones and apps in this digital context within higher education should be more than an emerging technology, they should be a useful daily resource.

Limitations and Further Research

The findings of this study will be useful both to professors as subject designers as well as to university management teams. Teachers and professors could use this information to design higher quality didactic applications targeting university students. The management within tertiary education institutions can use the findings in designing programs that incorporate smartphones and apps as a learning and communication tool. Since the content for which smartphones can be useful in regards to students' learning varies, future research should explore appropriate content that smartphone technology can be used for in order to facilitate and improve students' learning.

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APPENDIX A: Questionnaire

These are the statements included in the questionnaire. It was organized using a point Likert scale where 1 represented strong disagreement and 6 corresponded to strong agreement with the statement.

SECTION A- Biographical Information

- Age.
- Gender.

SECTION B- Mobile Learning with Smartphones

B1- Opinions. Smartphones

1. Are useful tools for student learning at University.
2. Enable me to accomplish the curricular goals of a subject.
3. Increase my productivity.
4. Make it easier to access information anywhere and anytime
5. Reinforce my effectiveness when I study.

B2- Experiences and uses

1. Performing operations with smartphones is easy for me.
2. Smartphones are useful for receiving academic and administrative university information.
3. I know how to use smartphones to develop academic activities.
4. I use internet and email in my smartphone in relation to academic purposes.
5. I use my smartphone to share academic information.
6. Performing operations with smartphones takes too much time in relation to academic purposes.

SECTION C- Smartphones and educational Apps.

C1- Subject APP opinion.

1. The use of the App created for this subject has been very positive.
2. I like the idea of using smartphones to prepare my subjects.
3. The App of the subject makes academic activities more interesting.
4. I find the App to be sufficiently flexible to interact with.
5. Using the App on smartphone reduces study time.

C2- App capabilities to develop university subjects and generic competencies (EHEA-Dublin Descriptors, 1995).

1. With the App, I can study and interact with other students.
2. App file texts capability is useful for reading curricular content.
3. App mini-video in streaming capability is useful for understanding curricular contents.
4. App Twitter capability is useful for sharing curricular content, comments, and doubts.
5. App has the capability to develop specific competences of the subjects.
6. Smartphone and App have the capability to develop *Self-regulated learning competence*.
7. Smartphone and App have the capability to develop *Higher cognitive Competencies*.
8. Smartphone and App have the capability to develop *Communicative Competencies*.
9. Smartphone and App have the capability to develop *Instrumental Competencies in Knowledge Society*.
10. Smartphone and App have the capability to develop *Interpersonal Competencies*.