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MOBILE LEARNING AND MOBILE TECHNOLOGIES IN ACADEMIA: A CASE STUDY

Abstract: *Mobile learning technologies have a huge potential in bringing more efficiency to the learning process. In the last decade the usefulness of mobile technologies for many fields of activity has been emphasized. This paper intends to analyze the behavior of a student population from both the undergraduate and the graduate level with regards to mobile learning and technologies. The survey was administered in the University of Economic Studies in Bucharest, Romania. A combination of exploratory research techniques and a survey methodology was used for studying the academic behavior of students when facing the potential implementation of mobile devices in their learning process. A set of procedures were used for gathering and analyzing more than 300 observations from a heterogeneous population. The results show that from a technological perspective mobile learning is feasible, however, a lack awareness and understanding about this new way of learning still hinders the effective implementation of mobile learning. Furthermore, the results reveal several issues that need to be resolved in order to achieve the effective integration of mobile technologies and for implementing a mobile learning system. Based on these insights, this paper offers several contributions with respect to understanding and creating a link as well as closing the current gap between students' learning process and mobile technologies.*

Key words: *mobile learning, educational system, social survey, mobile technologies, data analysis, mobile devices.*

JEL Classification: D83, I21

1. INTRODUCTION

Mobile learning is an instrument for learning activities that is complementary to the range of instruments that teachers can employ in the educational system. Amongst other things, mobile learning system allows students to take online courses and exams and to submit feedback and projects from their mobile devices.

In order to determine all the requirements for the development and implementation of a mobile learning system, all participants in the learning process—*i.e.* both providers and recipients of education—need to share their opinions related to the implementation and use of mobile learning systems in education. Hereto, this study administered a survey among undergraduate and graduate students. The aim of this survey was to: (1) find out whether students are prepared for mobile learning in terms of mobile technologies (including software and hardware); (2) identify students' skills related to using mobile technologies; (3) assess students' level of knowledge regarding mobile learning; (4) identify the perceived importance of several characteristics of mobile learning applications.

Pocatilu and Boja (2009a) analyzed various technologies that are used for mobile learning. We will draw on some of these technologies to analyze the potential for implementing a mobile learning system at the Faculty of Cybernetics, Statistics and Informatics at Bucharest University of Economic Studies. Hereto, we need to obtain a better understanding of existing mobile technologies; define minimal standards for user hardware and software; estimate implementation and maintenance costs; identify the degree to which participants are ready to use a mobile learning system.

Before designing the survey, we reviewed existing surveys in the field of mobile technologies in education. For example, Rau, Gao, and Wu (2008) study the impact of mobile and Internet technologies on student learning motivation, pressure, and performance. Pocatilu and Boja (2009b) identified several quality metrics related to mobile learning processes based on a survey that took place at the Faculty of Economic Cybernetics, Statistics and Informatics in Bucharest. The study identified numerous factors that influence the learning process, including mobile learning. They analyzed the quality criteria taken into account for mobile learning applications. Danail and Hristov (2006) describe ubiquitous characteristics and technological aspects of mobile learning. Chang (2010) proposes an informal learning-agent-based system called (CoLeP) that allows students to discuss and solve problems in a collaborative way. Ivan and Boja (2004) present several statistical methods and techniques applied on software qualitative and quantitative analysis. Some of them are used in this paper for data analysis.

A study by Sharma and Kitchens (2004) revealed that along with the recent advances in technology, a change in terminology also followed. The transition from e-Learning to m-Learning force the users to adapt their language in order to describe better the objects used in their daily life, as depicted in Table 1.

Table 1 – Terminology shifting

e-Learning	m-Learning
Computer	Mobile
Multimedia	Objects
Interactive	Spontaneous
Hyperlinked	Connected
Collaborative	Networked
Bandwidth	GPRS, 3G, UMTS, Bluetooth

Besides the technological influences that drive users in one direction or another, the scientific community also experienced an important reaction to the preoccupations in the field of m-Learning how, a study by Krassie and Chun (2009), revealed by identifying a number of 25 scientific manifestations from which 18 of them were journals and the rest were conferences events. Also is worth to mention the scope of these events categorized in general events, who approach the field of m-Learning, debating basic notions about mobile technology and applications, and specific events, exclusively dedicated to mobile learning.

The importance of modern technologies in education (like mobile and cloud computing) is emphasized in Batagan (2011) where the educational system is seen as a core area for future smart cities.

Adding another dimension to the learning process can only improve the quality characteristics of it due to its complementary approach. Additional operations made with mobile devices add attributes like mobility, spontaneity, efficiency, easiness and integrability with other e-learning systems, to the learning paradigm.

M-learning comes in students' aid by facilitating access to learning materials, tests and quizzes, access to gradebook, instant messaging between them and instructors. Two aspects must be taken into account when discussing about m-Learning that are: the penetration of mobile technologies in teachers' activities and on the other hand the integration of mobile learning applications among students

The remainder of this paper is organized as follows. Section 2 begins with a clarification of the key concepts regarding mobile learning systems underlying this study in order to provide a clear overview of the state of the art in the researched area as well as to identify the downfalls and niches of mobile learning technologies. Hereto, a literature review of the educational framework and the role of mobile communication technologies in education is conducted.

Section 3 describes the research design of this study including methods for data collection and analysis as well as hypothesis. We also present the survey instrument used to obtain insights about how mobile technologies penetrate education and how well they fit into the educational process at this moment.

The results of the survey are analyzed in section 4 and interpreted in section 5 in order to show how these mobile learning technologies are and could be used in educational process.

Finally, section 6 concludes the paper in which we discuss some of the current limitations of our approach, describe extensions of this study in order to overcome current limitations, and provide novel ideas about potential ways in which mobile learning technologies can contribute to learning activities.

2. THEORETICAL FOUNDATION

2.1 Definition of key concepts

In this paper we provide the following definitions of the core concepts based on Pocatilu and Boja (2009b).

A *mobile application* is a special type of software application particularly developed to be used on mobile processing units with limited processing power, storage and program memory and input capabilities.

Mobile learning, also referred to as m-learning, is the process of delivering educational content to individuals through mobile technologies and devices. The core components of this process are the mobile learning device (MLD), mobile educational software (MES) and mobile learning content (MLC).

Mobile learning devices represent the hardware component underlying mobile learning and include any mobile electronic device that can be configured and has a minimum set of features that can provide support for executing and managing software applications. Mobile devices that comply with these requirements are PDAs, smartphones (with and without touch screens), some mobile phones and tablet PCs.

Mobile educational software is the software constituent of mobile learning. Its role is to deliver information and to interact with the users. MES usually runs on mobile devices, but it can run on any device. In order to provide mobile content software runs outside a mobile device (for example on a server). MES varies and it can be a stand-alone, a web based or a distributed application. The architecture is very important because the functionalities, requirements and costs differ between different types of architectures.

Mobile learning content includes text, graphics and multimedia content like audio, video and animation. MES can deal with different content types and can be either generic (any content type) or specialized.

2.2 Educational framework

A mobile learning system can be seen as a part of a virtual organization. Figure 1 depicts the architecture of an education system model and highlights the various entities involved in this process. The education system is seen as a black box and the figure highlights the multiple information flows within the system. The process of mobile learning involves several entities that interact like in any cybernetics system

Figure 1 – Education system model

During the educational process, the student interacts with the teacher while simultaneously using a computational device (mobile or desktop) equipped with specific m-learning software. The learning content is provided and uploaded by the teacher, albeit by means of an administrator, using dedicated software.

Both e-learning and m-learning systems can share the same learning content. Usually, the mobile learning system needs additional software for content processing to be compatible with mobile device capabilities.

Using mobile technologies in educational process is not exclusive; rather these are complementary to other traditional educational tools and systems.

Using mobile infrastructures in the educational process has several advantages and disadvantages. The main advantages of using mobile technologies in education include: instant, anywhere/anytime access to learning resources from anywhere; the ubiquity of mobile technologies; content personalization through localization, based on geo-location and mobile services.

Despite these advantages, several disadvantages must be acknowledged including: the high costs of devices and services as well as small displays that might not be usable by everyone.

Passey (2008) emphasizes that certain activities in the educational process can be improved using mobile technologies. He considers that the implementation of mobile technologies has to take into account three factors—technical, political and cultural—in addition to the key factor, namely the learning activity.

2.3 Mobile communication technologies in education

It is necessary to identify hardware, software and service requirements for a mobile learning system. From our perspective, the minimal requirements for a mobile learning user are: a mobile device (mobile phone, smartphone, PDA, tablet PC); mobile web browser; Internet access through GPRS/EDGE/3G services, Wi-Fi or a Bluetooth-based network; and students' prior experience with mobile technologies.

The costs related to implementation and use of a mobile learning system include user and institutional costs, which include both fixed and variable costs. User costs include the cost of purchasing mobile device and services (e.g. Mobile Internet). Institutions costs encompass implementation and maintenance costs. Implementation costs are related to facilities, hardware, software and manpower (work). Hardware costs, in turn, are compound by the costs of mobile learning server, testing devices, network infrastructure, while the cost of software includes the cost of operating system, mobile learning platform, database server and other applications. Finally, costs are associated with the development, implementation, and maintenance of the system as well as the actual learning content (copyright).

3. RESEARCH METHODOLOGY

3.1 The methods used for data collection

This study builds on a survey that was administered as part of an existing research project (Pocatilu et al, 2010) of which some initial results were presented in (Pocatilu and Ciurea, 2011). The survey was performed among the students in order to identify: existing conditions of hardware and software available on students' mobile devices; students' usage patterns for mobile services and applications; and students' perception of the use of mobile devices in education.

The survey encompassed 20 questions related to the following topics: general information, existing mobile hardware and software, services and applications used, and the use of mobile learning services.

The general information questions included amongst others questions regarding student age, gender, and year of study.

The questions regarding hardware and software characteristics of existing mobile devices aimed to identify existing infrastructure, to establish if the existing mobile devices are ready to be used with mobile learning applications. Based on these insights, hardware and software requirements for different levels of mobile learning functionality are proposed and existing configurations are compared against the different levels of mobile learning functionality to check the degree of complexity.

Each mobile device has a number of capabilities of which more or less are used. Hence, the questions regarding how existing mobile services and applications are important in order to identify which capabilities are used and what factors limit or block the user to use the device at full capacity.

The questions regarding how mobile services are used in education via mobile learning are aimed to study if students currently know about and use mobile learning applications, their perception regarding the characteristics a mobile learning application must implement, advantages and disadvantages of using mobile learning on a regular basis and preferred ways of delivering mobile learning content to the end-users.

The methodology used is relying on primary collected data by means of a collective survey which contains a mixture of closed and opened ended questions.

3.2 Participants

The survey collected data from 333 students from the University of Economic Studies in Bucharest. The students attended one of the faculties of Marketing, Commerce and Cybernetics, Statistics and Economic Informatics. The students came from the first, second, third and fifth year of study. All students have in common that they attended on classes of economic informatics, multimedia and mobile device programming.

The mean, the average value that is the most important and relevant measure, is calculated using the sum of all observations, divided by the number of observations, as:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

where:

- x_i – the i observation of the sample, with $i = \overline{1, n}$;
- n – the dimension of the sample.

Using the mean value, the variance value is calculated. It describes the degree of observations scattering, computing the sum of the square differences between the values of the sample and the mean, divided by the number of observations.

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}$$

The variance is a measure that can take values between $[0, \infty)$. If $s^2=0$, the lowest variance characterizes a sample of observations which has all the values equal to the mean value. If $s^2 \to \infty$, the highest value characterizes a sample of observations that are widely spread.

The amplitude, A value, also characterizes the sample of observations, measuring the differences between the maximum and the minimum value, using the formula:

$$A = x_{max} - x_{min}$$

where:

- x_{max} – the maximum value of the sample of observations, $x_{max} = \max_{i=\overline{1,n}} x_i$;
- x_{min} – the minimum value of the sample of observations, $x_{min} = \min_{i=\overline{1,n}} x_i$.

The sampling method is very important in data analysis. Ruxanda and Smeureanu (2006) present several sampling methods, of which simple random sampling and stratified sampling are mentioned here.

If simple random sampling is used, every set of n individuals (the sample) selected from the population (N) has the same chance to be chosen. The sampling could be with replacement or without replacement.

The stratified sampling is used when the population is divided into K groups (strata). The stratification could be proportionate or disproportionate. In order to maximize the survey precision (Neyman allocation), the optimal sampling size for k^{th} stratum (T_k) is given by the formula:

$$T_k = \frac{w_k \sigma_k}{\sum_{i=1}^{K} w_i \sigma_i}$$

where:

w_k – sample allocation;
σ_k – standard deviation of stratum k.

The sampling method applied for this research was a random sampling without replacement. Determining the sample size takes into account the parameters presented in Table 2, based on Titan, Ghita, Tranda (2005).

Table 2 – Parameters used when estimating minimum sample size

Parameter	Symbol	Value
Confidence level 100*(1-α)	P(α)	90.00% (α=0.1)
Accepted error margin	d	5.00%
Variance	s^2	0.25
Population size	N	10000

The minimum sample size is given by:

$$n_{min} = \frac{z^2_{\frac{\alpha}{2}} * s^2}{d^2 + \frac{z^2_{\frac{\alpha}{2}} * s^2}{N}}$$

where

- n_{min} – the minimum computed sample size based on the chosen parameters;
- $z_{\alpha/2}$ – the tabbed value of z for a certain á value;
- s^2 – the estimated variance of the population (maximum is chosen);
- d^2 – the squared accepted error;
- N – the target population size for the results to be representative.

For the chosen parameters n_{min} = 264. As the considered sample has more than 264 data points the validity of the results is assured for the considered parameter values. Further, the error given by the considered sample size for a confidence level of 90% is 4.43% and for a confidence level of 95% would be 5.28%. We consider that the sample is representative for the faculties that students represent.

By gender, the sample population is distributed as presented in Table 3. There are more female students than male students, which is representative of the general population.

Table 3 – Sample distribution by gender

Gender	Proportion
M	39.00%
F	61.00%

By years of studying, the distribution of the sample population is presented in Table 4. There were no students in the fourth year of study. Also, the majority of students were in their third year.

Table 4 – Sample distribution by year of study

Year of study	Volume
I	31
II	12
III	269
V	21

The years I to III correspond to undergraduate studies and years from IV and V correspond to graduate studies.

Furthermore, the survey results showed that all the students had mobile devices.

4. RESULTS FINDINGS/RESULTS SUMMARY

The study addressed three main topics, for which the results are presented below, namely: hardware and software mobile device characteristics, mobile services usage, and mobile learning propagation.

Category I – Hardware and software mobile device characteristics

The first set of survey items relates to the **existing hardware and software conditions**. In this respect, the survey revealed that all the students had mobile phones. By manufacturer, the distribution is found in figure 2.

Figure 2 – Mobile device distribution by manufacturer

The population studied consisted of young male and female students with a distribution stated in table 2. The paper also wishes to determine the significance of the study with regards to the separation of students by gender. By aggregating the results for each different category, we can conclude further if there are any differences between male and female students in their use and knowledge about new mobile technologies in general and mobile learning technologies in particular.

Having more female students than males is representative for the population from which the sample was drawn and therefore does not influence the reliability of the results.

As ways of accessing mobile telephony services, 66% of the students use prepaid services whereas 34% use post-paid services.

Regarding the operating system installed on the devices, the distribution is presented in figure 3. As it can be observed, more than half students do not have knowledge about this aspect.

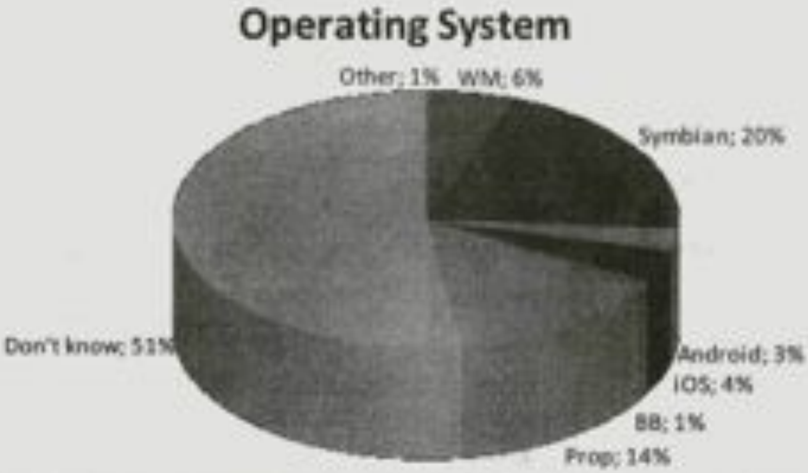

Figure 3 – Mobile OS distribution

Regarding the input method, used to interact with the device, 65% of the students have numerical keyboard, 11% have QWERTY type keyboards and 24% have virtual keyboards on their touch screens.

The output screen is color in 98% and monochrome in 2% of cases.

Storage capacity is in 46% of cases less than 1GB, in 32%of cases between 1 GB and 3 GB, 10% of cases between 3 GB and 8GB, in 7% of cases between 8 GB and 16 GB and in 3% of cases more than 16 GB.

The mobile technologies implemented in students' mobile devices show that such devices are able to perform complex tasks. Wi-Fi permits access to wireless networks and if such networks are further connected to the Internet, then Internet access is obtained bypassing the data service of the GSM network. Wi-Fi is found on 30% of the devices. Bluetooth permits close range connections between devices. Various services and applications such as file sharing or hands-free use data exchange via Bluetooth. Bluetooth is found in 92% of the devices. IrDA is an older form of close range connection between devices. It lacks the speed and the usability of Bluetooth as devices exchanging data must comply to physical restrictions such as perfect alignment of infrared emitters and receptors. IrDA is found in 17% of the devices. 3G is a set of telecommunication standards that once implemented offer improved transfer rates over the GSM network. 3G is found in 44% of the devices. GPS allows precise geographical localization of the device. GPS offers the basis for location-based applications and is found in 31% of the devices.

Based on the findings regarding hardware and software characteristics, a profile of the common mobile device used by the students in this sample may be derived. The average device has a numerical keyboard, color screen, storage space larger than 1GB, photo and video camera as well as Bluetooth connectivity. This mobile device profile is important when designing mobile learning applications to ensure effective usage of such applications by students.

Table 5 – Phones distribution among students

		PHONES										
		Others	Motorola	LG	Nokia	Samsung	Sony E.	Apple	Sagem	Black Berry	HTC	Total
Gender	M.	1	3	5	71	14	21	8	0	1	5	129
		0.78	2.33	3.88	55.04	10.85	16.28	6.20	0.00	0.78	3.88	100.00
	F.	1	2	24	100	38	29	3	1	3	3	204
		0.49	0.98	11.76	49.02	18.63	14.22	1.47	0.49	1.47	1.47	100.00
Total		2	5	29	171	52	50	11	1	4	8	333
		0.60	1.50	8.71	51.35	15.62	15.02	3.30	0.30	1.20	2.40	100.00

Table 5 provides more detailed insights into the phone distribution among young male and female students.

Category II – Mobile services usage

The second set of survey items relates to the **different uses of mobile services by students**. An important service for accessing information is the Internet. With respect to the main uses of the Internet on mobile devices, 32% of the students answered they use the Internet for navigation, 22% for accessing email, 17% for entering social network sites, 10% for watching movies and/or listening to music. Furthermore, nearly half of all respondents (46%) do not use the Internet at all and 20% of all respondents do not have Internet services enabled.

Another important aspect of usage is offline applications provided by the mobile device. Of the students, 17% use chat features, 38% use organizers, 95% use SMS service, 19% use MMS, 44% use Voice services, 70% listen to offline music, 46% play games, 64% view pictures, 19% use navigation and 2% use mobile banking services.

During their everyday usage, students become aware of limitations and drawbacks of mobile devices, such as: The small screen, which limits the viewing of complex graphical representations and also involves significant eye effort for reading (as mentioned by 26% of the students). Lack of sufficient knowledge regarding technical elements such as device engineering or technical terms affects usage according to 11% of the students. Mobile devices are built on low power consumption principles and this negatively influences processing power; a concern mentioned by 32% of the students. The difficult configuration of services is a drawback for 17% of the students. Devices are mostly dependent on the GSM network and a low level of signal negatively affects usage according to 34% of the students. Many data services such as Internet access imply high costs, thereby further impeding widespread usage according to 41% of the students. Finally, standby time—which is necessary from the perspective of rapid battery power consumption—hence low autonomy negatively affects 25% of the students

Students furthermore assessed wireless infrastructure, revealing that 33% use Wi-Fi, 27% have devices capable of connecting to Wi-Fi networks but do not use it and 40% do not have wireless Internet access.

Beside the built-in software that comes with the phone, installed directly by the supplier, there is the possibility to install compatible software created by other developers. The students installed third party applications—i.e. applications that are not preinstalled on the device, like instant messaging, navigation, dictionaries etc. on their phones in 44% of cases whereas 55% did not.

Based on the sample population, the study aims to disentangle how much time is usually spent on using mobile technologies in different sorts of activities. The data were aggregated based on the four choices available for this question and Figure 4 presents the results regarding the distribution of students per hour interval (a) and the means (b).

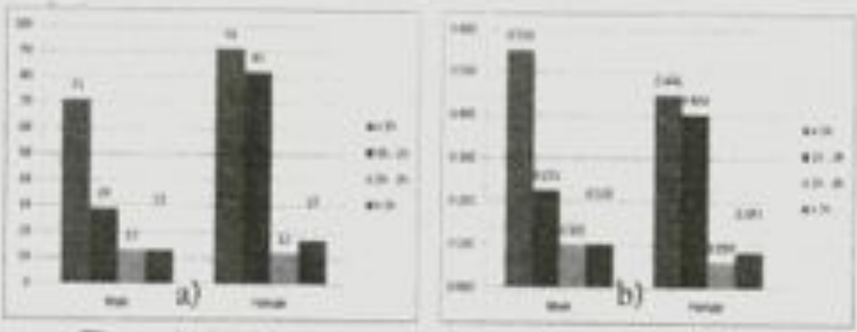

Figure 4 – Mobile device spent time repartition (a) and (b)

The values presented in Figure 4 were computed based on the total number of responses per student category (a) – male and female – after which the aggregated values were determined using the following formula:

$$UH_j = \frac{\sum_{i=1}^{n_j} p_j}{n_j},$$

where:

UH_j – the normalized value representing the total number of hours of category j;

n_j – the number of observations per category j;

p_j = {0, 1}; 1 if the value belongs to the j category.

Studying how students use the devices and the mobile services shows the degree to which device capabilities are used. As the results indicate, the most important factor that limits access to higher functionality is the cost implied by Internet services.

Category III – Mobile learning services distribution in the academia

The third set of survey items relates to **how mobile technologies can be used in education**, in order to understand students' expectations regarding mobile learning applications.

The first question assessed if students are aware of mobile learning. The results show that 21% heard of it through the Internet, 26% knew of it from inside the university, 3% knew about it from traditional press sources and 56% did not know the concept at the time of the survey.

When asked what domains mobile technologies can be useful for 52% considered that those are useful in school, 63% considered that they are useful for self-study and 29% said they are useful at work. They were given a definition of mobile learning before asking these questions.

The actual implementation of mobile services in an academic context and in particular for educational purposes depends on a set of mobile service features. The survey aimed to determine the significance and eventual correlation of each of these service features. Figure 5 presents the average values for each of the features included in the survey and a histogram representing the most common values for each feature.

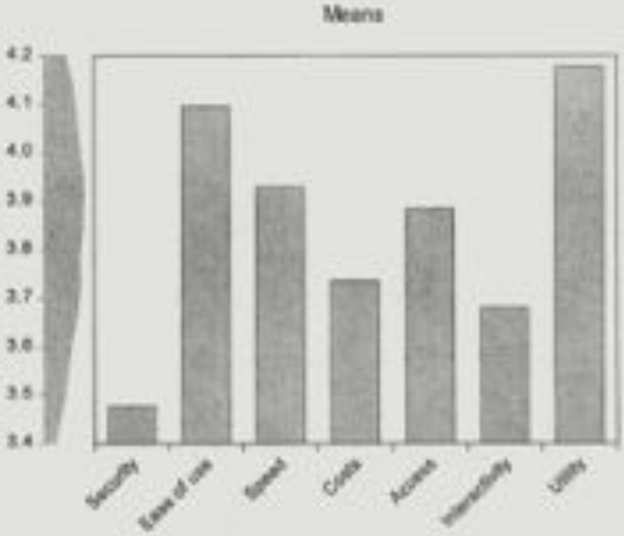

Figure 5 – Mobile service features in academia

The seven characteristics analyzed are tested using the ANOVA F-test for the equality of means between series (Neter, J, et. al, 1996). ANOVA F-test is used for determining the differences between means for different populations under the assumption that the population variances are equal. Let U_1 and U_2 be independent random variables, having $U_1 \sim \chi^2(n_1)$ and and $U_2 \sim \chi^2(n_2)$. Then, as in Wackerly et. al (2008):

$$\frac{U_1/_{n_1}}{U_2/_{n_2}} \sim F(n_1, n_2)$$

The F-test statistic is calculated based on the between group variance, S_b^2 and the within group variance, S_w^2 for the population group analyzed:

$$F = \frac{S_b^2}{S_w^2}$$

or

$$F = \frac{(n-k)\sum n_i(\hat{Y}_{i.} - \hat{Y}_{..})^2}{(k-1)\sum (n_i - 1)s_i^2}$$

where:

$$\bar{Y}_{i\cdot} = \sum_{j=1}^{n_i} \frac{Y_{ij}}{n_i}, \bar{Y}_{\cdot\cdot} = \sum_{i=1}^{k} \frac{n_i * \bar{Y}_{i\cdot}}{n}$$

and

$$s_i^2 = \sum_{j=1}^{n_i} \frac{(Y_{ij} - \bar{Y}_{i\cdot})^2}{(n_i - 1)}$$

Under H_0 and assuming variance homogeneity, the statistic test has a distribution of $F_{k-1,n-k}$ (Neter, J, et. al, 1996).

Table 6 presents the results of the ANOVA F-test showing that all seven characteristics are statistically equal.

With a probability of 0.002, we conclude that based on the F-test value calculated above and on the tabled value for F-test, the test for means equality showed that statistically there is no significant difference between the mean values of each feature. The statistical test also reveals that students do not significantly distinguish between these characteristics.

The students were asked to identify advantages of using mobile devices in the educational process and 74% answered that anytime/anywhere accessibility is a major advantage. Furthermore, efficiency (26%) was considered an important advantage of using mobile devices in the learning process. Besides these notable advantages, 9% of respondents answered that they were unaware of advantages at that time and 2% claimed that there are no advantages to mobile learning.

Table 6 – ANOVA F-test for equality of means

Included observations: 287

Method	df	Value	Probability
Anova F-test	(6, 1989)	15.17137	0.002

Variable	Count	Mean	Std. Dev.	Std. Err. of Mean
Security	284	3.475352	1.204860	0.071495
Ease of use	285	4.094737	0.983029	0.058230
Speed	284	3.929577	1.067661	0.063354
Costs	286	3.737762	1.132196	0.066948
Access	284	3.883803	0.975251	0.057871
Interactivity	286	3.681818	1.015745	0.060062
Utility	287	4.177700	0.992872	0.058607
All	1996	3.854709	1.078351	0.024137

Regarding disadvantages, 46% emphasized the small screen size as a major drawback and another 26% claimed that low processing power is a disadvantage of mobile devices. Another 1% of the students mentioned other disadvantages such as the lack of knowledge related to mobile technologies. Besides these notable disadvantages, 11% indicated that they were unaware of disadvantages and 8%

claimed that there are no disadvantages.

A number of mobile learning services were identified, and students had to pick those they considered most useful in their education process. 76% of the students argued that mobile learning services are most useful for accessing courses and study materials, 51% considered sending/receiving homework via mobile devices useful, 41% indicated access to discussion forums as useful, 18% considered mobile devices useful for evaluation, 57% would use mobile devices for reviewing their marks and 44% considered mobile devices useful for student-instructor interaction.

Finally, students were asked to choose what type of content should be provided if they were to use mobile learning applications. 54% of students preferred office type documents (word processing, spreadsheets, presentations etc.) followed by PDF documents (45%), web pages (36%), tutorial video clips (26%) or stand-alone, dedicated applications (11%).

5. DISCUSSION

Based on the abovementioned results, several conclusions can be drawn regarding the implementation and usage of mobile devices in the learning process.

First of all, the mobile device type is relevant because of the relation between the mobile technologies' stage of development and the implementation of mobile learning in academia.

From these results it can be concluded that both male and female student population are using primarily Nokia mobile devices, with figures well detached from the rest of the fleet. Furthermore, more young men than women use Nokia devices. Among female students, other devices, like LG phones, are more common, which may be related to the fact that women value design and other features more than performance. Another important aspect is the cost of mobile devices which is not fully justified from the results obtained from the survey.

Let *CMD* be the cost of mobile devices which includes: existing technologies like WAP, GPRS, GPS, 3G, Wi-Fi, Bluetooth, IrDA or features like: photo camera, polyphonic sounds, touch screen, and operating systems.

Let *CPD* be the positive cost which includes the technologies and features that are intensively used and CND be the negative costs which includes the costs of technologies and features that are not often used when dealing with mobile devices where:

$$CPD+CND = CMD$$

In this case, let *UMD* be the usability of mobile device defined as the ratio between the positive costs of total features and technologies used in a mobile device and its market price including all the existing features:

$$UMD = \frac{CPD}{CMD}.$$

The usability metric takes the following values: $UMD \in [0,1]$. If $UMD = 1$

than all mobile device's technologies and features are intensively used and the price per unit is at its best level, otherwise if UMD = 0 than the mobile device's technologies and features are not used at full capacity.

The characteristics used to describe the importance of mobile services implemented in education included all kinds of aspects which can be considered important, namely:

- security – the feature that makes a mobile service safe and less vulnerable; security represents the manner in which mobile education services give reliable and accurate information to users;
- ease of use – the characteristic which helps users understand and work faster and correct with mobile services in education;
- speed – represents the characteristic that tells us how fast a mobile service is working, e.g. how fast it answers users' requests;
- costs – is the price of using the mobile service (energy cost, monthly fees, time) and the price of implementing it, of having it (acquisition price, the price for a mobile device compatible and which can run those kinds of services);
- access – the feature related to how easily the access to such services can be provided; if users need special attributes, special skills to use it;
- interactivity – the characteristic which makes users to enjoy using the service and access it regularly;
- utility – utility feature is described as the usefulness perceived by the end user with regards to the operations made by using the mobile device in the mobile learning environment implemented in academia.

Table 7 describes the correlations between each characteristic taking into consideration the faculty to which students belonged (Faculty of Economic Cybernetics, Statistics and Informatics, Faculty of Commerce, Faculty of Marketing). The table depicted below shows that there is no difference between the students from different faculties with respect to assessing the importance of each of the characteristics included in the survey.

Table 7 – Mobile services correlation features and faculties

	Security	Ease of use	Speed	Costs	Access	Interactivity	Utility	Faculty
Security	1.0000	0.3363	0.4010	0.3495	0.2283	0.1793	0.2173	-0.0582
Ease of use	0.3363	1.0000	0.4941	0.3666	0.3442	0.3313	0.4480	-0.0388
Speed	0.4010	0.4941	1.0000	0.5015	0.3342	0.2587	0.3821	0.0366
Costs	0.3495	0.3666	0.5015	1.0000	0.3045	0.1900	0.2483	0.0188
Access	0.2283	0.3442	0.3342	0.3045	1.0000	0.5012	0.4446	0.0172
Interactivity	0.1793	0.3313	0.2587	0.1900	0.5012	1.0000	0.5502	0.0438
Utility	0.2173	0.4480	0.3821	0.2483	0.4446	0.5502	1.0000	0.0004
Faculty	-0.0582	-0.0388	0.0366	0.0188	0.0172	0.0438	0.0004	1.0000

The study revealed that many students are not aware of the possibility of integrating mobile technologies in the educational process despite the fact that their mobile devices do not lack the performance capabilities to support mobile learning. Most of the students answered that they were not aware of the term mobile learning until this study.

By analyzing raw results from the survey several conclusions can be drawn. First, the hardware and software conditions for mobile learning implementation are met; most devices have input - output – processing – connectivity that would enable access to mobile learning resources. Second, students, despite the performance capabilities of their mobile devices, do not use their devices at full capacity. Third, costs is a significant barrier toward full employment of functionality such as Internet access; yet, this obstacle can be easily overrun if Internet access is obtained via the wireless network of the university where the applications are to be implemented. Fourth, another impediment is the lack of technical knowledge or interest (51% of the students were not aware about their operating system and about 11% of the students indicated this as an important impediment to mobile learning). Finally, students are willing and motivated to use mobile devices in their educational process to improve their general knowledge and technical skills.

The final part of the survey shows that students are open to the new technology. Even if the concept of mobile learning is not widely known, students already hold impressions and expectations regarding the use of mobile devices in education and furthermore already partially employ these devices for individual preparation. Furthermore, students indicated clear preferences regarding content types and are aware of advantages and disadvantages related to this novel education technology.

Given the lack of technical savviness on the side of the students, perhaps we need to first implement courses that enhance students' awareness of the potential of mobile learning and teach them how to use their mobile devices for educational purposes.

Furthermore, given the readiness and willingness of students to use mobile devices for learning, yet, the impeding role of technology, designers of mobile devices and mobile learning applications should make these devices and applications as intuitive and simple as possible so that students can focus on the learning process instead of figuring out how to use their devices and applications.

Although not directly addressed through this research, the biggest obstacle toward changing educational systems is cultural and political in nature. People often do not want to change the status quo out of fears for loss of authority etc. and a change to more open lateral forms of education (such as m-learning) often does not fit the mindsets of lecturers. These represent important topics for future research to explore in order to assess the feasibility of m-learning in any higher institution before implementation.

6. CONCLUSION

Based on the findings of a survey study among students from the Bucharest University of Economic Studies we found that students are motivated to use mobile technologies in the educational process. The ubiquity of mobile devices has enabled the widespread integration of these devices into every aspect of our lives and all sorts of human activities. Mobility was and will be the engine that propels us to the very end of our momentary capacities.

From the industrial revolution when the invention of steam engine, car or plane made us travel and reach the far places of our planet, continuing with the digital revolution that enabled communication between geographically dispersed individuals, mobile technologies have the potential to enhance performance and efficiency throughout all human activities, including education.

Whereas this study assessed the readiness of students to use mobile devices in the learning process, future work should focus on academic staff in order to identify their readiness for mobile learning.

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