Mobile Device as a Support Tool in Student Learning

Sussy Bayona-Oré
Dirección de Investigación
Universidad Autónoma del Perú
sbayonao@hotmail.com

Dayana Pizarro Chavez
Facultad de Ingeniería y Arquitectura
Ingeniería de Sistemas
Universidad Autónoma del Perú
dayana.pizarro.ch@gmail.com

Luis Carrera Sicha
Facultad de Ingeniería y Arquitectura
Ingeniería de Sistemas
Universidad Autónoma del Perú
l.carrera1609@gmail.com

ABSTRACT
Nowadays people use mobile devices in different ways to make a profit. In this paper we present a literature review to know the use of the mobile devices as a learning tool, the factors that influence their use, and the advantages and disadvantages of the use of mobile applications that strengthen learning. Researchers seek to dispel doubts about the possibility of choosing mobile devices as tools for learning. As a result of this study it was found that the factors that influence the adoption of these tools are relevant, the advantages are really beneficial, and that students' academic performance can increase relatively.

CCS Concepts
•Applied computing→Education→E-learning

Keywords
M-learning; Learning; Digital education; Mobile device.

1. INTRODUCTION
Taking advantage of the information technologies and the opportunities they offer have led to the creation of new learning spaces. E-learning in the teaching/learning process has been introduced progressively at different levels of educational institutions over the years [1]. Students' use and acceptance of the new technologies have been made easier because mobile technology forms part of integrated into their daily lives [2]. E-learning provide a great support for students' independent knowledge acquisition [3]. However, in the education field its implementation is still complex since it requires a great deal of knowledge [4].

The introduction of mobile technology led to new ways of teaching, using devices called m-learning. M-learning emerged as an educational method that facilitated knowledge construction, problem solving and the development of several skills or abilities autonomously and ubiquituously, thanks to portable mobile devices [5].

There are four important steps to consider in order to support m-learning in traditional learning environments, and for students to assimilate these tools: be motivated to register for an e-course; participate and complete course; transfer and initiate change; sustain change, where the experience is generally positive for the students [6].

Activities that are considered motivating should include three elements: competence, autonomy and context [7]. Furthermore, a number of students may understand better through games, in which factors that influence learning are design and applications that are easy to use [8].

In this way, mobile devices can be used to reinforce or introduce students to learning a language [9]. M-learning, which allows teachers and students to present work in a timely manner, using technological devices such as tablets or smartphones, could be used to achieve this. These devices have changed the nature of higher education and are a significant part of the actual education process to create opportunities and challenges for students [10]. In digital learning systems, quality is a relevant factor to meet students' needs and requirements as well as to prevent failure in implementing them [11].

M-learning has great potential because it allows to tailor a study plan to the needs of each individual [12], that is students are more responsible for their learning [13]. In an education environment, mobile technologies still focus predominantly on the teacher in spite of their potential as learning tools to encourage critical thinking. Mobile applications for these mobile devices facilitate learning on the move and access to teaching materials, arouse interest in the younger generation because they recognise that information is available [14]. Moreover, innovation of these devices is constant [15]. It should be mentioned that data sharing applications can be supported in these devices [16] and are support tools for learning a language or a science subject where mnemonics is used to capture figures and symbols among others, making it an alternative to traditional learning [17].

In this study, a literature review was performed to analyze the use of mobile devices as a learning tool.

This article has been structured into five sections. Section 2 presents the background. Section 3 describes the methodology used. Section 4 presents the results. Finally, Section 5 provides a brief conclusion.

2. BACKGROUND
2.1 Learning
Learning can be classified as (1) learning as a product, when what is learnt can be valued, (2) learning as a process highlights incidents while gaining experience and, on completion, obtaining a product of what is learnt and (3) learning as a function, of which key aspects such as motivation, retention and transfer may result

ICICM '18, August 22–24, 2018, Edinburgh, United Kingdom

ACM ISBN 978-1-4503-6502-4/18/08…$15.00
https://doi.org/10.1145/3268891.3268910

in changes in behaviour towards learning [18]. In the education field, learning, which incorporates several concepts, can be defined as "Learning is a systematic, relatively permanent change in perception or behaviour that occurs through experience" [19]. Learning is not exclusive to teachers or other education professionals since, at some point in our lives, we learn from someone and then teach others [20]. Clear examples of this could be a new employee, someone filling a vacancy, asking for information or clarifying a doubt.

2.2 M-learning

In the past few years, m-learning or Mobile learning has become very popular due to the increase in use of mobile devices. M-learning means facilitating students' learning by providing content through these devices [21]. M-learning occurs when the student uses technological devices such as tablets, smartphones or MP3 players, which can have an impact on learning [22].

M-learning is directly related to technology. This is why continuous advances in technology have allowed the development of this new way of learning and given a new direction to education. Mobile learning gives students the possibility to learning anytime and anywhere [23, 24]. This learning model is not only flexible, but also offers access to sources of information [25] and the material provided can be designed to develop thinking skills. The teacher is the facilitator who helps and guides learners in knowledge acquisition. [26] states that students' autonomy, committment and communication increase.

2.3 Mobile Device

The use of mobile devices has increased and is considered useful for teaching and learning [27]. Mobile devices are small hand-held devices that have the following characteristics: special computing powers, permanent or intermittent Internet connection, limited memory, main function-specific design and versatility for other functions. Its performance is associated with an individual's personal use, which can be tailored to that individual's preferences. Among other characteristics that differentiate these devices from computers are (1) portability: they can fit into the owner's pocket or a small handbag, (2) computing power (3) connectivity: permanent or intermittent Internet connection to a network, and (4) memory (RAM, MicroSD card, flash, etc.).

Of the characteristics mentioned, the main ones are mobility, reduced size, wireless communication and social interaction [28]. The significant contribution of mobile devices in education is recognised today because these gadgets in some way have succeeded in transforming traditional classes, making them more interactive and attractive [29] and a means to providing teaching materials.

Convenient, ubiquituous technology is the key factor of these types of devices, that is the possibility to learn from any place and at any time. The use of mobile devices can help to increase efficacy, efficiency and the pleasure of being able to learn anywhere and anytime [30]. Thus, educational institutions have begun to incorporate mobile devices to meet students' expectations and needs [31].

2.4 Mobile Application

The term mobile application was used to refer to software published at virtual shops. Mobile applications, also called apps, are computer programs that run on mobile devices such as cell phones or tablets. Some of these apps are free, while some are not. Learning and mobile applications are directly related. Currently, they facilitate outdoor educational activities, without any barrier to time and place. The apps, whose purpose is knowledge sharing, give students the opportunity to create and share information. They also allow teachers to use mobile technology to promote meaningful learning [12, 32].

Mobile applications can be developed as (1) local applications that have executable binary files that can be downloaded directly to the device and stored locally, (2) mobile web-based applications that are a promising trend as they have more tools that can be executed within the browser, and (3) the hybrid approach that combines local development with web technology. This approach rules out any offline availability since the content is not accessible when the device is not connected to Internet [33].

3. METHODOLOGY

For this review, articles published between 2010 and 2017 were consulted from ScienceDirect, Springer Link and IEEE Xplore databases. The search string the authors used were as follows: ("m-learning", "learning", "technology" or "mobile device") and ("students" or "digital education"). The above databases were chosen because of their huge impact and quality publications. The works that met the following criteria were reviewed: (1) complete text available, (2) related to learning and include mobile device, and (3) related to the goal of the research. A total of 16 articles were selected and analyzed.

4. RESULTS

The results of the literature reviewed are presented below. The articles focused on the use of mobile applications to foster learning and the versatility of the devices as a tool to facilitate educational content.

4.1 Factors that Influence the Adoption of M-learning

There are several factors that influence students' and teachers' adopting m-learning. Informal learning is one of the modalities students use to complement formal learning, that is they use m-learning to acquire knowledge. As [29] mentions, students can evaluate the quality of teaching better than with the traditional method.

Among the factors mentioned for adopting this modality are gender, age and employment status. Regarding age, in [34], it has been shown that younger students have used mobile devices to enhance learning, while the minimum age of people who had not was around 40. According to [35], the generation gap can be explained because older people view m-learning with scepticism. [36] mentions that age is an influential factor, although they go on to say that m-learning could be adapted to all ages.

In the case of individuals working full time, they chose to use their devices for learning. In terms of gender, [10] found that among those interviewed, women made greater use of these technological devices, while [36] did not find any significant difference among participants (teachers and students) who had a positive attitude towards m-learning.

With respect to the availability of devices, in their studies [32] found that all the participants had one. This means that mobile devices are tools that students and teachers use for learning. As [11] pointed out, the content of the applications is important and must satisfy the needs of users. Another factor is the user's

perception as what is considered quality will depend on each individual [12].

4.2 Use of Mobile Devices

People of all ages use mobile devices in their daily lives. According to [1], these devices can be used for education at all levels. Mobile devices have a positive impact on learning and are also students' favourite tools. However, the advantages and disadvantages of these technological tools should be studied if they are to be used formally for learning. The advantages and disadvantages that have been identified are presented in Table1.

Table 1. Advantages and disadvantages of the use of mobile devices

Advantages	Disadvantages
Usability of the device [4]	Reduced size [12]
Autonomy [7]	Small keypad [35]
Easy access to information [11]	Less formal texts [32]
Share, exchange information [34]	Difficulty in writing long texts [35]
Time reduction [4]	Little visual contact [32]
Flexibility of time and place [15]	Bad posture [32]
Connectivity [38]	Distraction [31]
Better resolution of problems [3]	Future blindness [31]

On the one hand, mobile devices offer advantages such as ease of use that make users use them every day. [4,7] state that the devices give users autonomy. Due to the evolution of technology, batteries last longer with each new version, which permits users to move around and have a mobile device that is still charged and available for any need.

Another advantage is the ease of getting information: there is quick access to sources of information, which justifies time reduction being considered an advantage [4, 11] in addition to efficient use of time [35]. Mobility and connectivity that mobile devices offer are the most significant features because they eliminate physical and geographical barriers [12,15]. Students who manage these devices have sharing and exchanging information options for their learning [34] and the speed that these devices offer in reviewing content as opposed to revising notes.

On the other hand, there are also disadvantages, for example users change devices frequently [28]; they have them for 12 – 24 months at most. The rings or tones as well as the vibration when receiving or sending a message may contribute to distracting the user [31,17]. Moreover, users feel frustrated with the small buttons on these devices [35]. Another disadvantage was the small screen size, which made users refuse to use their mobile devices to complement traditional classes [12].

4.3 Mobile Applications

Various studies, with positive results, on the use of mobile applications are oriented towards improving students' academic performance. Table 2 shows some of these mobile applications. As the Table 2 shows, twelve (12) of the sixteen (16) studies are dedicated to multidisciplinary higher education. The others are aimed at young primary and secondary level students, and only one study uses the EasyLexia application at all levels for dyslexic people. It should be noted that none of the studies reports negative results from the use of mobile applications for students.

Table 2. Characteristics of the studies on mobile applications

Author (s)	Year	Characteristics				
		Name of Application	Academic Level	N° of persons	Duration of teaching	Description
Rogers, Y., et al [39]	2010	LillyPad	Higher education	Not stated information available	12 months	Students did not suffer any adverse effects from sharing data using mobile applications; they used these correctly and did not find it difficult to record data in the app.
Tsoi, M. and Dekhane, S. [40]	2011	TsoiChem	Not stated	Not stated	Not stated	The application enhanced and complemented teaching. Clear explanation of the tasks to be performed allows students to carry them out without too much difficulty.
Erradi, A.; et al. [41]	2013	LingoSnack	Higher education	12	Not stated	Participants tried the application and showed great interest in using it to complement formal teaching and showed increased willingness to learn.
Schmitz, B.; et. al. [37]	2014	BauBoss/sms	Higher education	19	7 weeks	A post-test was given to the control and experimental groups. Participants showed a positive attitude towards the apps.
Skiada, R.; et. al. [42]	2014	EasyLexia	Children between 7-12 years old	Not stated	18 months	Students used the mobile application to record information and it reduced response or problem-solving time. Reading comprehension also improved.
Looi, C.; et al. [38]	2014	MyDesk	Primary	1196	4 years	Learning objectives proposed using the application doubled for 50% of the students. It motivated self-directed learning and students showed more interest in the topics.
Tam, V. and Luo, N. [43]	2014	iCExplorer	Higher education	10	4 months	The authors did not carry out an in-depth study into the quantitative data collected. Nevertheless, positive comments were given for iCExplorer used to complete successfully the evaluation plan.
Maha, H. [2]	2015	Say quran	Higher education	118	Not stated	A high level of satisfaction with the application developed for the study was obtained, exceeding the agreement score of 3.

Author (s)	Year	Characteristics				
		Name of Application	Academic Level	N° of persons	Duration of teaching	Description
Perry, B. [7]	2015	Xplorez	Not stated	6	1h 40 min.	The results from students who used this application were positive and encouraging.
Simonova, I. and Poulova, P. [1]	2015	Blackboard Mobile Learn	Higher education	203	2 years	Users of the app concluded that the experience was motiving and pleasant and the app was easy to use. These are important factors for students and teachers who support these tools.
Muhammed, A. [4]	2016	Not stated	Higher education	130	Not stated	Students said the application used was innovative and allowed to gain knowledge in a simple way. Teachers looked favourably on it as well. They mentioned that it contributed positively to the organizational process.
Han, I. and Shin, W. [31]	2016	LMS	Higher education	1604	10 sessions	The study system used influenced positively the results of the volunteers.
Huang Y., et al. [14]	2016	TEDQuiz	Higher education	49	1 week	Ease of use and the installation of the application were characteristics that influenced the participants who, as a whole, responded positively to TEDQuiz.
Heflin, H.; et. al. [32]	2017	HeadsUp	Higher education	159	3 months	Students related to HeadsUp, making it a positive experience.
Oyelere, S.; et. al. [44]	2017	MobileEdu	Higher education	142	11 weeks	MobileEdu application has a potential to improve students' learning achievements.
Pechenkina, E.; et. al. [45]	2017	No define	Higher education	1205	1 year	The students who used the application had higher scores. There was a difference of 7.03% between those who did and those who did not use the app.

The abovementioned studies showed that students' academic performance and their interest in discussion topics increased, and the use of mobile applications were positively accepted by volunteers. Nevertheless, it should be kept in mind that as [16] state, the design features of the mobile applications should be realistic and meet the real needs of teachers and students to achieve their educational goals.

The factors that were identified for the use of mobile devices, for instance gender, age, employment status or student ownership of the devices have been pointed out in other technological research. These findings concur with those of the authors [46] who consider gender to be the most significant. Likewise, the advantages and disadvantages that the authors of this article identified concur with [47] who, in the light of m-learning, the new e-learning education methodology, identified positive and negative aspects of mobile devices that could be adopted as learning tools. Finally, academic performance is high among students or individuals who use mobile applications through their mobile devices [48].

5. CONCLUSIONS

The conclusions the authors reached can be useful for teachers who wish to adopt m-learning to enhance learning, bearing in mind that in the review one factor the different authors all mentioned was student ownership of mobile devices. Of the different mobile applications that the authors used to gather student data, it was found that students on the whole assimilate positively content, thus achieving greater performance. What is more, they found similar factors that, to some extent, affected whether or not students use their mobile device for learning rather than for social interaction. These factors as well as the advantages should also be considered. The researchers recommend future studies to develop strategies that identify which features students adopt to make them users of educational applications, since more information from reliable sources was not found.

6. REFERENCES

[1] Simonova, I. and Poulová, P. 2015, Social networks and mobile devices in higher education: pilot project. *In Proceedings of the IEEE 39th Annual International Computers, Software & Applications Conference*, pp. 851 – 856.

[2] Maha, M. 2015. "Mobile Applications' Impact on Student Performance and Satisfaction". *Turkish Online Journal of Educational Technology*, 14, 102-112.

[3] Yanuschik, O., Pakhomova, E. and Batbold, K. 2015. E-learning as a Way to Improve the Quality of Educational for International Students, In *Procedia - Social and Behavioral Sciences*, 215, 147-155.

[4] Abildinova, G., et al., "Developing a Mobile Application "Educational Process Remote Management System" on the Android Operating System", In International Journal of Environmental & Science Education, Vol. 11, pp. 5128-5145, 2016.

[5] Brazuelo, F. and Gallego, G. 2011. *Mobile Learning. Los dispositivos móviles como recurso educativo*. Sevilla: Editorial MAD, S.L.

[6] Noesgaard, S. 2016. "Can e-learning change work practices?", In *International Conference e-Learning*, 61-68.

[7] Perry, B. 2015. Gamifying French Language Learning: A Case Study Examining a Quest-based, Augmented Reality Mobile Learning-tool, In Procedia - Social and Behavioral Sciences, Vol. 174, pp. 2308-2315, 2015.

[8] Silva, R., Rebelo, F. and Gamboa, F. 2015. Defining Personas of University Students for the Development of a Digital Educational Game to Learn Portuguese as a Foreign Language, In *Procedia Manufacturing*, 3, 6214-6222.

[9] Muhammed, A. 2014. The Impact of Mobiles on Language Learning on the Part of English Foreign Language (EFL) University Students. In *Procedia - Social and Behavioral Sciences*, 136, 104-108.

[10] Al-Emran, M., Elsherif, H. and Shaalan, K. 2016. Investigating attitudes towards the use of mobile learning in higher education. C*omputers in Human Behavior*, 56, 93-102.

[11] Masita, M. and Mustafa, M. 2016. Empirical investigation to explore factors that achieve high quality of mobile learning

system based on students' perspectives. *Engineering Science and Technology, an International Journal*, 19 (3) 1314-1320.

[12] Cheng, Y. 2015. Towards an understanding of the factors affecting m-learning acceptance: Roles of technological characteristics and compatibility". *Asia Pacific Management Review*, 20, 109-119.

[13] Pei-hao, S., Yow-Bang, W., Tien-han, Y. and Lin-shan, L. 2013. A dialogue game Framework with personalized training using reinforcement learning for computer-assisted language learning. In *International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 8213-8217.

[14] Huang, Y., Yang, T., Chen, M., Chen, C, and Sun, Y. 2016. Design of an Online Multimedia Learning System for Improving Students' Perceptions of English Language Learning. In *Proceedings of the 6th International Conference on Advanced Learning Technologies*, 327-331.

[15] Shuib, L., Shamshirband, S. and Ismail, M. 2015. A review of mobile pervasive learning: Applications and issues. *Computers in Human Behavior*, 46, 239-244, 2015.

[16] Mannheimer, J. and Warner, Z. 2016. Mobile apps for science learning: Review of research. *Computers & Education*, 94, 1-17.

[17] Zheng, Q. 2016. Does multitasking with mobile phones affect learning? A review. *Computers in Human Behavior*, 54, 34-42.

[18] Knowles, M., Holton, F. and Swanson, R. 2001. Andrología: el aprendizaje de los adultos.

[19] Alonso, C., Gallego, D. and Honey, P. 1995. *Los Estilos de Aprendizaje: Procedimientos de diagnóstico y mejora*. Editorial Ediciones Mensajero, 6ta Edición, España.

[20] Gallego, D. and Ongallo, C. 2004. *Conocimiento y Gestión*. Editorial Prentice Hall, Madrid.

[21] Bollen, L., Eimler, S. and Hoppe, H. 2004. SMS-based Discussions – Technology Enhanced Collaboration for a Literature Course". In *Proceedings of the 2nd IEEE Workshop on Wireless and Mobile Technologies in Education*, 209-210.

[22] Dudeney, G. and Hockly, N. 2007. How to teach English with Technology. *Educational Technology & Society*, 320-324.

[23] Jokela, T., Koivuma, J., Pirkola, J., Salminen, P. and Kantola, N. 2006. Methods for quantitative usability requirements: A case study on the development of the user interface of a mobile phone. *Personal and Ubiquitous Computing*, 345-355.

[24] Chen, C. and Huang, T. 2012. Learning in a u-Museum: developing a context aware ubiquitous learning environment. *Computers and Education* 873-883.

[25] Hamm S., Saltsman, G., Jones, B., Baldridge, S: and Perkins, S. 2013. A mobile pedagogy approach for transforming learners and faculty. In Zane Berge & Lin Muilenburg, pp. 176-186.

[26] Dunn, P., Richardson, A., Oprescu, F. and McDonald, C. 2013. Mobile-phone-based classroom response systems: Students' perceptions of engagement and learning in a large undergraduate course. *International Journal of Mathematical Education*, 1160-1174.

[27] Khaddage, F., Muller, W. and Flintoff, K. 2016. Advancing mobile learning in formal and informal settings via mobile app technology: Where to from here and how? *Educational Technology & Society*, 16-26.

[28] Hsiao, M. and Chen, L. 2015. Smart phone demand: An empirical study on the relationships between phone handset, Internet access and mobile service. *Telematics and Informatics*, 32, 158-168.

[29] Khorsandi, M., Kobra, A., Ghobadzadeh, M., Kalantari, M. and Seifei M. 2012. Online vs. Traditional Teaching Evaluation: A Cross-Sectional Study. In *Procedia - Social and Behavioral Sciences*, 46, 481-483.

[30] Evans, C. 2008. The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers and Education*, 491-498.

[31] Han, I. and Shin, W. 2016. The use of a mobile learning management system and academic achievement of online students. *Computers & Education*, 102, 79-89.

[32] Heflin, H., Shewmaker, J. and Nguyen, J. 2017. Impact of mobile technology on student attitudes, engagement, and learning. *Computers & Education*, 107, 91-99.

[33] Hasan, M., Haque, M. 2010. *Mobile Application Development Approaches: Recommendation for E-commerce Enterprises.* In Laurea University of Applied Sciences, 6-36.

[34] Al Hamdani, D. 2013. Mobile Learning: A Good Practice. In *Procedia - Social and Behavioral Sciences*, 103, 665-674.

[35] Gikas, J., Grant, M. 2013. Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education*, 19, 18-26.

[36] Taleb, Z., Sohrabi, A. 2012. Learning on the Move: The use of Mobile Technology to Support Learning for University Students. In *Procedia - Social and Behavioral Sciences*, 69, 1102-1109.

[37] Schmitz, B., Klemke, R., Specht, M. 2014. The impact of coupled games on the learning experience of learners at-risk: An empirical study. *Pervasive and Mobile Computing*, 14, 57-65.

[38] Looi, C., et. al. 2014. Implementing mobile learning curricula in a grade level: Empirical study of learning effectiveness at scale. *Computers & Education*, 77, 101-115.

[39] Rogers, Y., Connelly, K., Hazlewood, W. and Tedesco, L. 2010. Enhancing learning: a study of how mobile devices can facilitate sensemaking. *Personal and Ubiquitous Computing*, 14, 111-124.

[40] Tsoi, M., Dekhane, S. 2011. TsoiChem: A Mobile Application To Facilitate Student Learning in Organic Chemistry. In *Proceedings of the11th IEEE International Conference on Advanced Learning Technologies*, 543-547.

[41] Erradi, A., Almerekhi, H. and Nahia, S. 2013. Game-based micro-learning approach for language vocabulary acquisition using LingoSnacks. In *Proceedings of the International Conference on Advanced Learning Technologies (ICALT)*, 235-237.

[42] Skiada, R., Soroniati, E., Gardeli A. and Zissis D. 2014. EasyLexia: A Mobile Application for Children with Learning Difficulties. *Procedia Computer Science*, 27, 218-228.

[43] Tam, V. and Luo, N. 2014. An Intelligent Mobile Application to Facilitate the Exploratory and Personalized Learning of Chinese on Smartphone. In *Proceedings of the*

IEEE 14th International Conference on Advanced Learning Technologies, 411-412.

[44] Oyelere, S., Suhonen, J., Wajiga, G., Sutinen, E. 2017. Design, development, and evaluation of a mobile learning application for computing education. *Education and Information Technologies*, 1-29.

[45] Pechenkina, E., Laurence, D., Oates, G., Eldridge D., and Hunter D. 2017. Using a gamified mobile app to increase student engagement, retention and academic achievement. *International Journal of Educational Technology in Higher Education*, 1-12.

[46] Lopez, F., Silva, M. 2016. Factors of Mobile Learning Acceptance in Higher Education. *Estudios sobre Educación*, 30, 175-195.

[47] Monge, D. 2013. *Mobile devices in education*. In Universidad de Valladolid, 3-44.

[48] Ibrahim, A., Yusoff, N. and Kamarudin, M. 2016. Mobile Learning Quality of Education and Increase in Student Discipline. *Creative Education*, 7, 555-560.