Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Impacto del m-learning en el proceso de aprendizaje: habilidades y conocimiento

The Impact Of m-learning On The Learning Process: Skills and Knowledge

Impacto do m-learning no processo de aprendizagem: habilidades e conhecimento

Jorge Rodríguez Arce
Facultad de Ingeniería, Universidad Autónoma del Estado de México, México
jrodrigueza@uaemex.mx

Juan Pablo Coba Juárez Pegueros
Facultad de Ingeniería, Universidad Autónoma del Estado de México, México
jjuarezp113@profesor.uaemex.mx

Resumen

El uso de dispositivos móviles y tabletas como herramientas de apoyo en el proceso de aprendizaje es conocido como m-learning. Una tarea de aprendizaje puede dividirse en dos partes: el conocimiento y las habilidades involucradas. El uso de los dispositivos móviles y tabletas como herramienta de aprendizaje en el aula de clases puede considerarse favorable, por lo que se realizó una revisión de la literatura existente centrándose en la pregunta ¿qué impacto tiene el uso del m-learning en el proceso de aprendizaje? Con base en los trabajos revisados, se puede concluir que no existe una tendencia clara respecto al uso del m-learning dentro y fuera del aula de clases, y en algunos casos los resultados son contradictorios entre distintos autores.

De los trabajos revisados se identificaron dos desventajas del uso del m-learning en el proceso de aprendizaje: la falta de desarrollo de habilidades cognitivas necesarias para la tarea de aprendizaje y la incorrecta incorporación de las modalidades de interacción disponibles en los dispositivos de m-learning para favorecer el proceso de enseñanza. De esta manera en este trabajo

se propone una metodología de diseño de aplicaciones de m-learning, la cual considera el estudio de las habilidades involucradas en la tarea de aprendizaje (dividiendo dicha tarea en habilidades primarias y secundarías) y así detectar las principales características o requisitos que se deben de considerar cuando se quiere enseñar o entrenar una tarea con la finalidad de identificar características muy específicas que deben ser desarrolladas de dichas habilidades. Después de identificar las habilidades se propone considerar su relación con los modos de interacción disponibles en los dispositivos móviles con la finalidad de realizar la integración de ambos en una estrategia de enseñanza que favorezca la adquisición de la tarea. Como trabajo futuro se propone considerar la metodología propuesta en distintas tareas de enseñanza para realizar la validación formal de dicha metodología y los resultados obtenidos aporten información para identificar el impacto que tiene el m-learning en el proceso de enseñanza.

Palabras clave: aprendizaje móvil, m-learning, tecnología educativa, innovación educativa.

Abstract

The use of mobile devices and tablets as support tools in the learning process is known as m-learning. In general, a learning task can be divided into two parts: the knowledge and skills involved. The use of mobile devices and tablets as a learning tool in the classroom can be considered favorable, however there is no conclusive formal study indicating the impact of its use on cognitive development and performance of the teaching process. The main goal of this study is to identify the advantages and disadvantages of the use of m-learning in the teaching process inside and outside the class classroom reported in the state of the art.

In this paper a review of the existing literature was made focusing on the question: what impact does the use of m-learning in the learning process have? And based on the results obtained, a methodology for the design of m-learning applications is proposed. In previous studies other authors have carried out several studies to demonstrate the advantages of using m-learning in the classroom, however the reported results are not conclusive and in some cases the results are contradictory among different authors. From the reviewed papers, two disadvantages of the use of m-learning in the learning process were identified: the lack of development of cognitive skills

involved in the learning task and the correct incorporation of the available interaction modalities in m-learning devices to improve the teaching process. As a result of this work, a methodology for the design of m-learning applications is proposed, through which the relationship among the modes of interaction available in m-learning devices, the task to be learned and the skills involved in the task is identified for the correct integration of the learning components in a m-learning application.

Key words: educational technology, mobile learning, educational innovation, m-learning.

Resumo

O uso de dispositivos móveis e tablets como ferramentas de suporte no processo de aprendizagem é conhecido como m-learning. Uma tarefa de aprendizagem pode ser dividida em duas partes: o conhecimento e as habilidades envolvidas. O uso de dispositivos móveis e tablets como uma ferramenta de aprendizado na sala de aula pode ser considerado favorável, então uma revisão da literatura existente foi feita enfocando a questão de qual impacto o uso do m-learning no processo de aprendendo? Com base nos trabalhos revisados, pode-se concluir que não há uma tendência clara quanto ao uso do m-learning dentro e fora da sala de aula e, em alguns casos, os resultados são contraditórios entre os diferentes autores.

Foram identificadas duas desvantagens do uso do m-learning no processo de aprendizagem: a falta de desenvolvimento das habilidades cognitivas necessárias para a tarefa de aprendizagem e a incorporação incorreta das modalidades de interação disponíveis nos dispositivos m-learning para promover o processo de ensino. Desta forma, este trabalho propõe uma metodologia para o desenho de aplicações de m-learning, que considera o estudo das habilidades envolvidas na tarefa de aprendizagem (dividindo esta tarefa em habilidades primárias e secundárias) e, assim, detectar as principais características ou requisitos que devem ser considerados ao ensinar ou treinar uma tarefa para identificar características muito específicas que devem ser desenvolvidas a partir dessas habilidades. Depois de identificar as habilidades, propõe-se considerar sua relação com os modos de interação disponíveis em dispositivos móveis, a fim de integrar tanto em uma estratégia de ensino que favorece a aquisição da tarefa. Como trabalho futuro, propõe-se considerar a

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

metodologia proposta em diferentes tarefas de ensino para realizar a validação formal da referida metodologia e os resultados obtidos fornecem informações para identificar o impacto que m-learning tem no processo de ensino.

Palavras-chave: aprendizagem móvel, m-learning, tecnologia educacional, inovação educacional.

Fecha Recepción: Febrero 2017 **Fecha Aceptación:** Julio 2017

Introduction

Today it is common to observe the use of technology in the classroom: the classic computer lab, video projector, electronic whiteboards, internet connectivity and the use of mobile devices so that students can interact during classes.

With the advancement of technology and the expansion of the use of the internet, distance education has adapted to new technologies, giving rise to "e-learning", which is defined as the combination of learning forms that use technology or the internet as a means to teach at a distance (Georgiev, Georgieva, and Smrikarov, 2004).

In recent years, the development of wireless data networks has allowed the connection of devices such as electronic tablets and smartphones to the internet network with the ability to access educational content at any time and place without the need to be physically in a classroom; this phenomenon gives rise to a new mode of distance learning called "mobile learning" (known in English as m-learning). Elkheir and Mutalib (2015) define m-learning as a combination of e-learning and mobile computing that mixes mobile and wireless technology to provide learning experiences. Ally and Samaka (2016) add to the definition of m-learning that "... is considered as m-learning any type of learning that occurs when the student is not in a fixed and predetermined

location; or learning that occurs when the student takes advantage of the opportunity offered by learning through mobile technologies. "

At present, m-learning software developers have made available to the educators applications of various themes to be used as support in the learning process (inside or outside the classroom). However, there is little documentation (design guides, best practices or scientific studies) of how an m-learning application should be designed and how the proper integration of the different educational components (knowledge and skills) should be carried out, so that an application meets the established teaching objective; therefore, a combination of intuition, dexterity and luck has guided programmers or software designers to the development of a new application.

This study arises from the need to create educational applications of m-learning that are efficient and that impact the learning process. As a consequence, the question arises: what impact does the use of m-learning have on the learning process? From the educational point of view, although the use of mobile devices and tablets as a learning tool in the classroom can be considered beneficial, there is currently no conclusive formal study indicating the impact of its use in development cognitive and student performance.

State of the art

During the review of the literature, divergent results were found regarding the impact of technology on the learning process. Table 1 concentrates the studies carried out by different authors on the subject.

Table 1. Estudios realizados por diversos autores sobre el impacto de la tecnología en el aprendizaje.

Resultados negativos	
Autor	Resultado
Fried, C. B. (Fried, 2008).	Los estudiantes que usan tecnología en el aula tardan más tiempo en realizar tareas de aprendizaje.
Awwad, Ayesh, y Awwad (Awwad, Ayesh, y Awwad, 2013).	El uso de dispositivos móviles causa distracción durante el aprendizaje.
Lee, Lin y Robertson (Lee, Lin, y Robertson, 2012).	El uso de la tecnología interfiere con la adquisición de conocimiento.
Bowman et al. (Bowman, Levine, Waite, y Gendron, 2010)	Los estudiantes que usan tecnología durante el aprendizaje requieren más tiempo para realizar una tarea académica y se distraen con facilidad.
Wood et al. (Wood, y otros, 2012)	El uso de la tecnología no aumenta el rendimiento académico del estudiante.
Sana, Weston y Cepeda (Sana, Weston, y Cepeda, 2013)	La compresión se deteriora al realizar múltiples tareas durante al aprendizaje empleando tecnología.
Resultados positivos	
Autor	Resultado
Pitchford (Pitchford, 2015)	Se mejoró el desempeño de niños de primaria en un curso de matemáticas empleando tabletas electrónicas.
Bullock at al. (Bullock, Moyer-Packenham, Shumway, MacDonald, y Watts, 2015)	Las aplicaciones computacionales pueden facilitar el aprendizaje en niños.
He, Swenson y Lents. (He, Swenson, y Lents, 2012)	El uso de videos mejoró el desempeño de alumnos en un curso de química.
Chen y Yan (Chen y Yan, 2016)	La multitarea puede prevenirse e intervenirse con diferentes estrategias.

Source: elaboración propia con base en la revisión del estado del arte.

Based on the results shown in Table 1, it can be concluded that there is no generalized tendency regarding the impact of the use of technology in the learning process, also it can be observed that there are studies with results in favor of its application in the classrooms, while others warn about the negative consequences of their use.

An example of the contrast of results shown in Table 1 is the study by He, Swenson and Lents (2012) where a group of university students improved their performance in a chemistry course through the use of videos. Based on the topics that were most difficult for students, the videos focused on improving critical thinking, problem analysis and its solution; These videos were consulted by students through an m-learning platform. On the other hand, the work of Chen and Yan (2016) found that there are several components that can affect learning, when you have a mobile device in the classroom. One result shows that mobile devices are a source of distraction, particularly in smartphones, where there is a significant relationship between a person's low performance and the distraction of instant messages and social networks. Chen and Yan (2016) also observed that, if the task is to read and use instant messengers, the time taken to complete the task is between 22% and 59% higher than their control group.

Al Hamdani (2013) reports that mobile devices are used in education as mediators in the teaching and learning process, because these devices can be used to consult various educational materials, this would mean that their use should promote the development of skills involved in the task of learning. In the study conducted by Al Hamdani participants reported that the devices helped them to promote their thinking skills and to cooperate with their peers; Similarly, Fried (2008) points out that mobile devices can increase the motivation of students in the classroom.

Elkheir and Mutalib (2015) mention that the use of mobile phones and tablets could encourage students to be interested in some subject and therefore to spend more time studying. Issa and Isaias (2016) and Baron (2016) identify some positive and negative factors in the use of internet-connected mobile devices in generations in the age range between 20 and 30 years. Among the positive factors in the use of mobile devices, it is concluded that it is possible to promote communication and collaboration between individuals, no matter where they are. Another advantage of using the technology is that you can search for information and get results quickly, however, you have the disadvantage that in some cases due to the speed with which the search is done, the user does not remember the result obtained (which can create weak memory mental connections).

On the other hand, Baron (2016) found that students using mobile applications are more likely to remember the search pattern (procedural ability) than the result itself (cognitive ability), ie, the brain adapts to use of technology. As a consequence memory divides the task into responsibilities, this memory is referred to as transactional memory and delegates to technology the "effort" to remember. In addition, this fact can create in the student a false sense of knowledge about subjects that have investigated due to searches made by Internet. This behavior is defined by Issa and Isaias (2016) as superficial thinking.

In conclusion, the use of mobile devices and the Internet according to the studies of Issa and Isaias (2016) and Baron (2016) show a negative impact on the development of basic cognitive abilities such as memory because the brain adapts to the environment that stimulating, forming unwanted mental connections and delegating to technology tasks that require recalling important data; so the user is able to remember how to look for information (procedural ability), but not the result (cognitive ability), that is, does not remember the information sought.

Fried (2008) and Awwad, Ayesh and Awwad (2013) report that the use of mobile devices in classes is negative for students learning because they produce distraction, so their use should be limited and established appropriate ways of integrating this type of device during the learning process in a way that minimizes its negative effects.

Conversely, Huffman and Hahn (2015) point out that with the rapid growth of mobile applications it is important to identify applications that help the development of long-term information retention. In their study they focused on identifying learning processes that will help to retain vocabulary in users (cognitive skills) and detected learning strategies that helped to memorize the vocabulary and integrated them into an application, thus establishing the importance to select the learning strategy and its subsequent integration with technology.

Based on the studies presented in this section, it can be concluded that there is no previous study or methodology that can be conclusive regarding the advantages of using m-learning in the teaching process, and even more the advantages that it has in the academic performance of

students. However, what can be emphasized is that several authors mention that one of the disadvantages in the use of technology in the learning process is the lack of development of skills necessary for the learning task. In addition, none of the papers reviewed shows how the integration of the various elements that integrate an m-learning application should be carried out and that they consider the development of the skills involved in the learning task.

How to design an m-learning application?

Developing learning skills

In the educational field, learning can be defined as the reorganization of cognitive structures in the individual (Bond, 2012), due to the appropriation of skills acquired through interaction with the environment, which to facilitate their understanding is usually divided into two components . The first is the "information" that represents the knowledge and data acquired, through experience or study associated with the theoretical understanding (laws, rules, procedures, etc.) of a task. The second component is the "ability" that, unlike information, is learned through practice and its interaction with the environment, in other words, a skill is acquired and / or developed through practice (Rodríguez, 2011).

Rodríguez (2011) states that human skills in general can be classified into: primary and secondary. Primary skills are those that allow us to relate to our environment. Examples of primary skills are: perceptual abilities (they help to recognize sensory information, produced by different stimuli from outside), motor skills (control muscles for coordinated and precise movements), verbal skills cognitive skills (they allow the processing of sensory information and eventually learn to evaluate, analyze, remember, make comparisons and understand cause and effect), procedural skills (support the knowledge of the procedure of a specific task), among other.

The secondary skills are developed based on the combination and integration of the primary skills, allowing to create more complex competences for the execution of some task entrusted. Some examples of secondary skills are: writing, reading, performing numerical operations, among others, which in themselves reflect the development of primary skills and can establish a

relationship between the two types of skills. Each secondary skill comprises numerous primary skills, and each primary skill may be a part of various secondary skills.

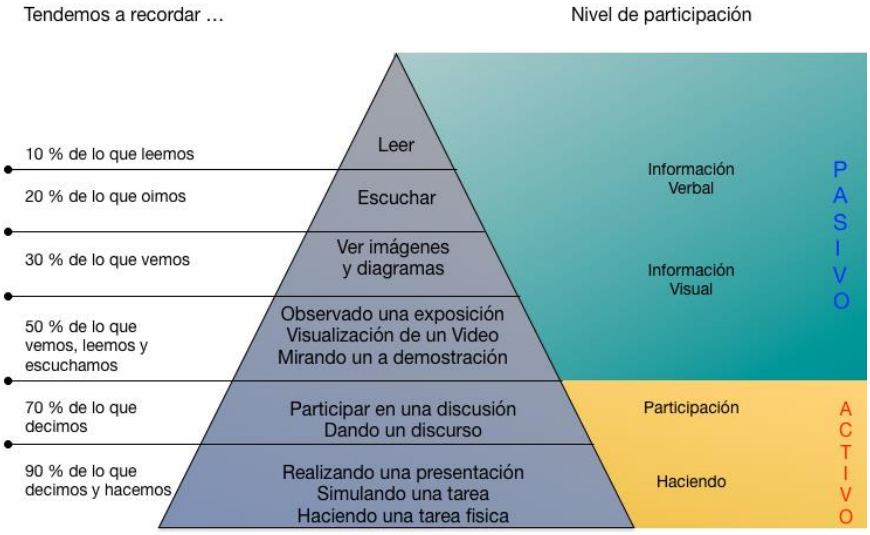
In the previous section, a presentation was made of works by other authors related to the use of technology in learning tasks, showing that there is no general trend towards the impact of the use of technology in the learning process. Moreover, studies that show a negative impact on the development of cognitive skills necessary in the learning process such as memory (Baron, 2016, Issa and Isaias, 2016, Lee, Lin, and Robertson, 2012) and critical thinking (Wolf and Barzillai, 2009). These results open a window of opportunity to study how the educational applications of m-learning should be designed in such a way as to promote the development of the skills involved in the task to be learned and that have an effect on learning equal to or greater than results obtained by traditional methods in the classroom.

Interaction in the learning process

Having reference frames for the development of m-learning applications helps to justify how the educational content should be displayed within the application, as well as the type of activity that favors the learning of the individual. In 1954, Edgar Dale (1946) proposed the cone of experience (or also known as the learning cone) as a frame of reference for the learning process (figure 1). This framework helps to understand how individuals learn and remember based in their level of participation or interaction that they experience during the learning process.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Figure 1. Cono de la experiencia.



Source: elaboración propia adaptada de Dale (1946).

According to Dale's (1946) learning cone shown in figure 1, the learner's level of participation can be classified during a learning task in:

a) *Passive learning:* it is distinguished in that the student is not actively involved in the process, that is, he only pays attention to the information presented to him through text, images, audio or the combination of the previous ones that are foreign to his daily life, which limits their ability to learn.

b) *Active learning:* this promotes the generation of experiences that are closer to reality, so that it is possible to relate personal experiences with previous / current knowledge, because the student learns doing, which helps him / her to recover information with greater ease.

Traditional classroom teaching methods such as exposition by the teacher (explanation and visualization of presentations) and reading are considered as passive activities according to the Dale cone, which limit the learning ability of the student. The more dynamic tasks in which the student participates, turns learning into an active task, which according to the Dale cone favors the acquisition of knowledge. However, the fact of carrying out activities in which the student

learns by doing is sometimes limited by factors such as the teaching methodology used by the teacher or the available time that the teacher has in front of the group .

The use of technology in the classroom could encourage active learning (for example, exercises and / or simulations in which the student is actively involved), and even more the student can continue with the learning task in an attractive and sometimes entertaining way outside the classroom. In the case of m-learning, the student can interact with tablets or mobile devices through different modalities, which can be through text, images, sounds and tactile gestures to perform a specific activity (the term "modality" refers to the channels of input and output interaction that humans can do). An advantage of these devices is that in an educational application two or more modes of interaction can be used at the same time for the student to experience a more active level of participation, for example: the student may be looking at an object and at the same time a Audible message gives you indications of dragging that object to a specific position. This combination of modalities is known as multimodal interaction.

Touch screens on tablets and mobile devices have modified the way interaction in learning applications, while the visual and auditory channels prevail, the tactile has been used to perform different tasks during the learning process. Because it is easy to use this type of tactile interaction, users sometimes perform several tasks at the same time. Junco and Cotten (2012) define the process of performing more than one task at the same time as multitasking and describe it as the process of divided and non-sequential attention. Their definition is based on the decomposition performed by Chun, Golomb and Turk-Browne (2011), where they observed two processes that are carried out and concluded that attention is divided and commuted depending on the tasks performed by the individual. According to Chen and Yan (2016), a disadvantage of m-learning is the multi-tasking process favoring m-learning devices, which is a distractor in the learning process and its effect can sometimes be negative depending on the learning task.

Posner (1982) states that people have limits when processing information when performing tasks simultaneously (multitasking), since people can not process more than one stimulus so their attention is divided and it switches rapidly between different tasks; Put another way, humans can

only process one stimulus at a time by rapidly changing stimulus. Posner comments that because of the technology we can now handle multiple screens or use technology to do other things (for example, texting), however, the problem is that a student who has the confidence to be able to perform multiple tasks at the same time, obtains worse results than those who do not.

It is common for preteens and teens to believe that multitasking does not affect the quality and outcome of learning. Baron (2016) from the cognitive point of view mentions that multitasking is a practice that should not be performed. This agrees with Lee, Lin, and Robertson (2012) because a student retains less information when performing more than one task at a time, ie, does not develop their cognitive ability efficiently. Similarly, studies by Sana, Weston and Cepeda (2013), Terry, Mishra and Roseth (2016) and Chen and Yan (2016) agree that these devices in the classroom cause distraction and consequently their use during the process should be regulated.

Therefore, before developing an application of m-learning, it is important to study and understand the modes of interaction with tablets and mobile devices that allow and favor the development of the skills involved in the learning task to be integrated from the better shape and favor the learning process. In addition, the cognitive burdens associated with different modes of interaction must be considered in order to limit the multitasking that impedes the development of the ability. This in order to find evidence of improvement in the academic performance of the student through the use of m-learning (Baars y Gage, 2012).

Methodology for designing an m-learning application

As previously mentioned, the use of mobile devices today is very common in many aspects of our lives. This adoption has also permeated the educational environment, developers have made available to educators applications of various topics to be used as support in the learning process inside and outside the classroom. However, there is a need to establish the best way to design educational applications, because it is currently unknown what impact these applications have on the student's final performance. It is therefore important that the creators or designers of these

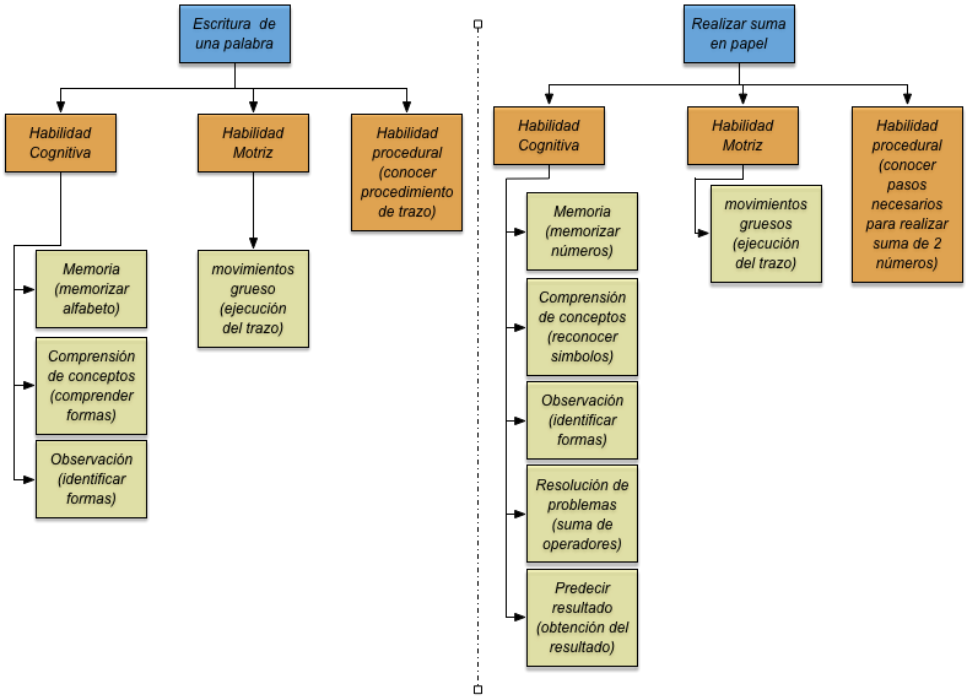
types of applications consider how the human being learns and which strategies favor the process of acquiring new knowledge. According to the state of the art, digitizing an activity seems to be insufficient for an individual to acquire a specific skill. Understanding by "digitizing an activity" to the process of executing a task or activity through the use of an electronic device, for example, if the activity is the resolution of sums through the use of pencil and paper, the digitization of this activity involves representing and resolve said activity using some electronic device. Finally, the challenge for application developers is to identify what elements should be considered for a correct use of technology in the development of learning, considering the skills involved and the interaction between devices and students.

In this section the authors propose a methodology for the design and implementation of an application of m-learning in which the development of the skills involved in the learning task and the interaction between the devices and the students are considered. As a starting point we consider the classification of primary and secondary skills proposed by Rodríguez (2011), in this way each learning task must be divided into their primary and secondary skills. Thus it is possible to detect the main characteristics or requirements that must be considered when teaching or training this task in order to identify very specific characteristics of the skills involved.

An example of the decomposition of tasks in skills and sub-skills is shown in figure 2 where in general the tasks of making a paper sum and writing a word can be decomposed into secondary skills and in turn can be decomposed into sub- skills or abilities.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Figure 2. Descomposición de tareas (en color azul la tarea, en color naranja la habilidad secundaria y en color amarillo la habilidad primaria).



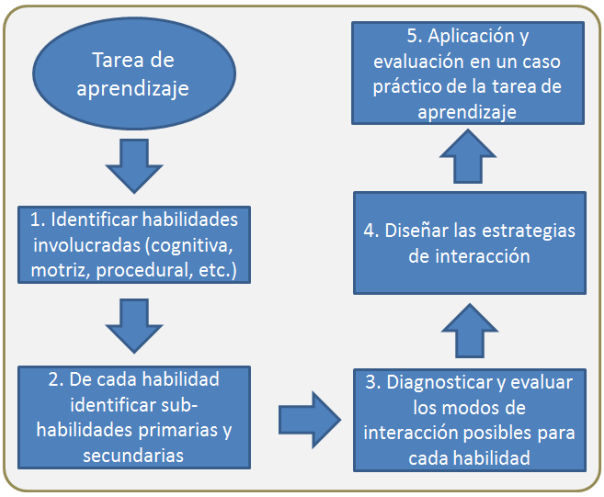
Source: elaboración propia.

Figure 2 shows that a sub-skill can be occupied in more than one task. For example, in the two tasks shown in figure 2 it can be visualized that the memory (primary ability) is a necessary skill to carry out both tasks successfully.

In the proposed methodology it is also suggested to consider Dale's learning cone, which fits with the development of skills because it states that if an individual participates actively in an activity learns by doing, in other words, the fact that an apprentice is actively interacting with an application suggests that it better develops the skill for which it was created. In this way, after identifying the primary and secondary skills of a learning task, the Dale cone will be used to evaluate the possible modes of interaction for each skill and thus to select for each one the interaction mode that provides the best student performance in the learning process. Figure 3 summarizes the complete process of the proposed methodology for the design of an m-learning application.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Figure 3. Metodología propuesta para el diseño de aplicaciones de m-learning.



Source: elaboración propia.

As can be seen in figure 3, before applying the proposed methodology, it is necessary to have the learning task defined, for example, to learn to write letters or to learn to add two numbers. Steps 1 and 2 refer to the identification and division of primary and secondary skills of the learning task (similar to the example shown in Figure 2). While steps 3 and 4 focus on diagnosing and evaluating the modes of interaction available on mobile devices and tablets in the development of each of the skills involved in the task to choose those that favor individual development in each of the skills identified in the previous steps. Finally, in step 5 the evaluation of a practical case selected based on the learning task is performed, in this step the integration of the interaction modes selected for each of the identified skills is performed. Figure 4 shows in greater detail the application of the proposed methodology to evaluate the modes of interaction in the case of a specific skill.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Figure 4. Metodología propuesta para la evaluación de los modos de interacción y una habilidad específica.

Source: elaboración propia.

Figure 4 shows the steps that should be followed to identify the modes of interaction that provide the best academic performance in the development of a specific skill. The proposed methodology is divided into two stages: analysis and design of the strategy and evaluation of a case study. In the first stage, step 1 proposes to start with a study related to the variables involved in the development of the skill. Step 2 consists of making a diagnosis and evaluation of the different modes of interaction available in the m-learning devices in order to know the impact that each one has on the development of said ability, in this way identify which modes of interaction interact positively in the learning process. The results obtained will be the basis of the design of new modes of interaction (teaching strategy) to present the content of the learning task, which would be step 3 and end of the first stage.

Subsequently, step 4 of the second stage proposes to apply the teaching strategy in a practical case related to the learning task, for example, if the task is to learn a new language the practical case could be to memorize words in that language. Step 5 consists of the evaluation and validation of results; in this step it is suggested to contrast the results obtained with the teaching strategy designed in the previous steps in comparison with the results obtained with a traditional method (for example: a presentation by the teacher or to make a reading). Finally, the objective

of analyzing the results in stage 6 is to establish the relationship between the type of interactions and the development of the skill in the learning process.

As can be seen, the proposed methodology (see Figures 3 and 4) contemplates that during the process of designing an m-learning application the study of the skills involved in the learning task together with the modes of interaction of the devices employees. In this way, it is possible to solve the disadvantages identified in the state of the art and to respond in a more objective way to the question: what impact has the use of m-learning in the learning process?

Conclusions and future work

As for the question, what impact does the use of m-learning have on the learning process ?, the review of the state of the art suggests that to date there is no study demonstrating the widespread use of mobile applications (m learning) in the learning process. Based on the results shown in Table 1, it can be concluded that there is no clear trend towards the use of m-learning in and out of the classroom. In addition, among the results of some authors, the conclusions are contradictory, such as Fried (2008), Huffman and Hahn (2015), Lee, Lin and Robertson (2012) and Chen and Yan (2016). observe that there are studies with results in favor of the use of m-learning during the learning process, while others warn about the negative consequences regarding their use. From the review of the state of the art it can be emphasized that some studies mention that one of the disadvantages of the use of m-learning in the learning process is the lack of development of cognitive skills necessary for the learning task (Baron, 2016; and Isaias, 2016, Lee, Lin, and Robertson, 2012). In addition, none of the papers reviewed explains or suggests how the integration of the various elements that integrate a m-learning application should be carried out and that the development of the skills involved in the learning task should be considered in order to the teaching process in or out of the classroom.

Based on the above, the authors suggest that designers and / or programmers when designing mobile applications for education should consider how the human being learns, the skills involved in the learning task and what strategies favor the acquisition process of new knowledge;

because digitizing an activity appears to be insufficient for an individual to acquire a specific skill.

On the other hand, due to the lack of guidelines and design guides for mobile application programmers in this document, the authors propose a methodology for designing m-learning applications that considers the study of the skills involved in the learning task and its relationship with the modes of interaction available in devices with the purpose of integrating these into a teaching strategy that favors the acquisition of the task.

As future work it is proposed to consider the proposed methodology in different teaching tasks involving different skills, having as initial proposal the study of tasks that involve cognitive skills and to carry out the formal validation of said methodology so that the obtained results contribute information in identifying the impact which has m-learning in the teaching process.

Bibliography

Al Hamdani, D. S. (2013). Mobile Learning: A Good Practice. *Procedia - Social and Behavioral Sciences, 103*, 665-674. doi:10.1016/j.sbspro.2013.10.386

Ally, M., & Samaka, M. (2016). Guidelines for Design and Implementation of Mobile Learning. In B. H. Khan (Ed.), *Revolutionizing Modern Education through Meaningful E-Learning Implementation* (p. 443). USA: McWeadon Education.

Awwad, F., Ayesh, A., & Awwad, S. (2013). Are Laptops Distracting Educational Tools in Classrooms. *Procedia - Social and Behavioral Sciences, 103*, 154-160. doi:http://dx.doi.org/10.1016/j.sbspro.2013.10.320

Baars, B., & Gage, N. M. (2012). *Fundamentals of cognitive neuroscience: a beginner's guide.* USA: Academic Press.

Baron, N. S. (2016). Only Connect: What the Internet Might Be Doing to Us. *The American Journal of Psychology, 129*, 337-343. Retrieved from http://www.jstor.org/stable/10.5406/amerjpsyc.129.3.0337

Bond, T. G. (2012). Piaget's Learning Theory. In N. M. Seel (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 2634-2636). Boston, M: Springer. doi:10.1007/978-1-4419-1428-6_39

Bowman, L. L., Levine, L. E., Waite, B. M., & Gendron, M. (2010). Can students really multitask? An experimental study of instant messaging while reading. *Computers & Education, 54*, 927-931.

Bullock, E. P., Moyer-Packenham, P., Shumway, J. F., MacDonald, B., & Watts, C. (2015). Effective Teaching with Technology: Managing Affordances in IPad Apps to Promote Young Children's Mathematics Learning. *Society for Information Technology and Teacher Education International Conference.* Las Vegas: AACE.

Chen, Q., & Yan, Z. (2016). Does multitasking with mobile phones affect learning? A review. *Computers in Human Behavior, 54*, 34-42. doi:http://dx.doi.org/10.1016/j.chb.2015.07.047

Chun, M. M., Golomb, J. D., & Turk-Browne, N. B. (2011). A taxonomy of external and internal attention. *Annual review of psychology, 62*, 73-101.

Dale, E. (1946). The "Cone of Experience". In E. Dale, *Audio-visual methods in teaching* (pp. 37-52). NY: Dryden Press.

Elkheir, Z., & Mutalib, A. A. (2015). Mobile Learning Applications Designing Concepts and Challenges: Survey. *Research Journal of Applied Sciences, Engineering and Technology, 10*, 438-442. doi:10.19026/rjaset.10.2509

Fried, C. B. (2008). In-class laptop use and its effects on student learning. *Computers and Education, 50*, 906-914. doi:10.1016/j.compedu.2006.09.006

Georgiev, T., Georgieva, E., & Smrikarov, A. (2004). m-learning: a new stage of e-learning. *Proceedings of the 5th international conference on Computer systems and technologies.* Association for Computing Machinery (ACM). doi:10.1145/1050330.1050437

He, Y., Swenson, S., & Lents, N. (2012). Online video tutorials increase learning of difficult concepts in an undergraduate analytical chemistry course. *Journal of Chemical Education, 89*, 1128-1132.

Huffman, W. B., & Hahn, S. (2015). Cognitive Principles in Mobile Learning Applications. *Psychology*, 456-463.

Issa, T., & Isaias, P. (2016). Internet factors influencing generations Y and Z in Australia and Portugal: A practical study. *Information Processing & Management, 52*, 592-617.

Junco, R., & Cotten, S. R. (2012). No A 4 U: The relationship between multitasking and academic performance. *Computers and Education, 59*, 505-514.

Lee, J., Lin, L., & Robertson, T. (2012). The impact of media multitasking on learning. *Learning, Media and Technology, 37*, 94-104. doi:10.1080/17439884.2010.537664

Pitchford, N. J. (2015). Development of early mathematical skills with a tablet intervention: a randomized control trial in Malawi. *Frontiers in psychology*.

Posner, M. (1982). Cumulative development of attentional theory. *American Psychologist, 37*, 168-179.

Rodriguez, J. (2011). *Study Of The Transfer Of Procedural And Motor Skills Using Virtual Reality For Training Industrial Maintenance And Assembly Operations.* Ph.D. dissertation, Universidad de Navarra.

Sana, F., Weston, T., & Cepeda, N. J. (2013). Laptop multitasking hinders classroom learning for both users and nearby peers. *Computers and Education, 62*, 24-31. doi:10.1016/j.compedu.2012.10.003

Terry, C. A., Mishra, P., & Roseth, C. J. (2016). Preference for multitasking, technological dependency, student metacognition, and pervasive technology use: An experimental intervention. *Computers in Human Behavior, 65*, 241-251. doi:10.1016/j.chb.2016.08.009

Wolf, M., & Barzillai, M. (2009). The importance of deep reading. *Educational Leadership, 66*, 32-37.

Wood, E., Zivcakova, L., Gentile, P., Archer, K., De Pasquale, D., & Nosko, A. (2012). Examining the impact of off-task multi-tasking with technology on real-time classroom learning. *Computers and Education, 58*, 365-374.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Rol de Contribución	Definición (solo poner nombre del autor)
Conceptualización	**JORGE RODRIGUEZ ARCE**
Metodología	**JORGE RODRIGUEZ ARCE**
Software	**NO APLICA**
Validación	**NO APLICA**
Análisis Formal	**NO APLICA**
Investigación	**IGUAL JORGE RODRIGUEZ ARCE / JUAN PABLO COBA JUAREZ**
Recursos	**NO APLICA**
Curación de datos	**NO APLICA**
Escritura - Preparación del borrador original	**JUAN PABLO COBA JUAREZ**
Escritura - Revisión y edición	**JUAN PABLO COBA JUAREZ**
Visualización	**JORGE RODRIGUEZA ARCE**
Supervisión	**JORGE RODRIGUEZA ARCE**
Administración de Proyectos	**JORGE RODRIGUEZA ARCE**
Adquisición de fondos	**JORGE RODRIGUEZA ARCE**