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Scientific articles

Aplicación educativa para fomentar el aprendizaje móvil

Educational application to promote mobile learning

Aplicativo educacional para promover aprendizagem móvel

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Resumen

El proceso de aprendizaje requiere la implementación de nuevas y novedosas estrategias educativas, así como el uso de tecnologías de la información y comunicación que promuevan el aprendizaje móvil con el fin de diversificar la educación. Por ende, el propósito de la investigación fue desarrollar una aplicación educativa y llevar a cabo una experiencia educativa basada en el aprendizaje móvil, sustentada en la teoría sociocultural y el aprendizaje colaborativo y en la tecnología móvil *smart-table*. Para ello, se emplearon las metodologías ADDIE y Scrum, que posibilitaron un desarrollo sistemático de la investigación. El estudio fue cualitativo y exploratorio, con un análisis longitudinal, que incluyó una encuesta aplicada a un grupo focal de 150 estudiantes de nivel superior. Los resultados revelaron que el 92 % de los estudiantes consideró que la aplicación móvil y la *smart-table* impulsaron el aprendizaje móvil

y colaborativo, así como la socialización. Respecto a la correspondencia entre el aprendizaje móvil y el presencial, el 100 % expresó que van de la mano. Finalmente, el 86.66 % indicó estar muy satisfecho con la experiencia educativa realizada. En conclusión, se evidenció que el aprendizaje móvil puede considerarse como una buena práctica cuando se combinan aplicaciones educativas innovadoras y tecnología como la *smart-table*, que fomentan la colaboración entre estudiantes. Por lo tanto, es indispensable implementar en el aula nuevas prácticas educativas respaldadas por la tecnología móvil, que favorezcan la inclusión de nuevas estrategias de aprendizaje en beneficio de los estudiantes.

Palabras clave: aprendizaje colaborativo, aprendizaje sociocultural, estrategias de aprendizaje, prácticas educativas, *smart-table*.

Abstract

The learning process requires the implementation of new and learning strategies, along with the use of information technologies that promote mobile learning to encourage educational diversification. Hence, the purpose of the research was to develop an educational application and carry out an educational experience based on the mobile learning approach going along with sociocultural theory and collaborative learning supported by mobile technology “Smart-table”. The ADDIE and Scrum methodology were used, which allowed the systematic development of the research. The research work was qualitative and exploratory with a longitudinal analysis which included a survey applied to a focus group of 150 higher education students. The results revealed that 92% of the students considered that the mobile application and the Smart-table promoted mobile and collaborative learning, as well as socialization. As for the correspondence between mobile learning and face-to-face learning, 100% expressed that it goes hand in hand with face-to-face learning. Finally, 86.66% stated that they were very satisfied with the educational experience carried out. To sum up, it has been shown that mobile learning can be considered a good practice, when innovative educational applications and technology such as the Smart-table go hand in hand, which encourages collaboration between students. Therefore, it is essential to bring new educational practices supported by mobile technology to the classroom so that students can benefit from the inclusion of new learning strategies.

Keywords: collaborative learning, sociocultural learning, learning strategies, educational practices, Smart-table.

Resumo

O processo de aprendizagem requer a implementação de estratégias educativas novas e inovadoras, bem como a utilização de tecnologias de informação e comunicação que promovam a aprendizagem móvel, a fim de diversificar a educação. Portanto, o objetivo da pesquisa foi desenvolver um aplicativo educacional e realizar uma experiência educacional baseada na aprendizagem móvel, apoiada na teoria sociocultural e na aprendizagem colaborativa e na tecnologia móvel smart-table. Para isso foram utilizadas as metodologias ADDIE e Scrum, o que possibilitou um desenvolvimento sistemático da pesquisa. O estudo foi qualitativo e exploratório, com análise longitudinal, que incluiu um inquérito aplicado a um grupo focal de 150 estudantes do ensino superior. Os resultados revelaram que 92% dos alunos sentiram que a aplicação móvel e a mesa inteligente impulsionaram a aprendizagem móvel e colaborativa, bem como a socialização. Quanto à correspondência entre aprendizagem móvel e presencial, 100% manifestaram que andam de mãos dadas. Por fim, 86,66% indicaram estar muito satisfeitos com a experiência educativa realizada. Concluindo, ficou evidente que a aprendizagem móvel pode ser considerada uma boa prática quando se combinam aplicações educacionais inovadoras e tecnologias como a mesa inteligente, que incentivam a colaboração entre os alunos. Portanto, é fundamental implementar em sala de aula novas práticas educativas apoiadas pela tecnologia móvel, que favoreçam a inclusão de novas estratégias de aprendizagem em benefício dos alunos.

Palavras-chave: aprendizagem colaborativa, aprendizagem sociocultural, estratégias de aprendizagem, práticas educativas, mesa inteligente.

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Introduction

UNESCO's Education Agenda 2030 (2016) highlights the importance of students acquiring learning skills, which requires the implementation of innovative methods, strategies and content. With the support of information and communication technologies (ICT), we seek to improve and facilitate the teaching-learning process, which is why we agree with UNESCO (2016) that it is pertinent and necessary to integrate these technologies in the classroom. to contribute to educational quality. This approach, therefore, leads us to consider best educational practices that include the use of smart devices both inside and outside the classroom with the aim of promoting mobile learning (West and Vosloo , 2013).

Currently, the use of these tools has provided students with study alternatives and the opportunity to carry out self-learning (Vidal *et al .*, 2015). Therefore, mobile learning has

become an innovative educational strategy to implement good practices in the teaching process (Lagunes *et al.* , 2017) and to promote the relationship between socialization and learning (Soncco, 2022).

In this context, the success story of the mSchools and App Education programs stands out , proposed by Albert Forn (Unesco, 2019), which focus on training teachers to develop educational applications based on problems, so that students collaborate to find solutions. This approach promotes digitalization in the educational field without neglecting the pedagogical dimension, which must always accompany the integration of technology in education to generate value in the students' learning process.

In the specific case of Mexico, since 2008 the Tecnológico de Monterrey has been innovating with mobile learning (Aguilar *et al.* , 2010) with the aim of diversifying teaching methods thanks to the development of multimedia educational resources —such as smartphones, tablets and interactive whiteboards—which can be used to promote collaborative learning (Martínez and Torres, 2017). This approach promotes social interaction and cooperation between students (Alcívar *et al.* , 2021; Koole , 2009), important aspects that facilitate the acquisition of new knowledge.

For example, the research by Ballesteros *et al.* (2020) shows how the use of interactive educational resources and mobile devices encourages learning of complex mathematics topics, such as the concept of limits. Another impact that has been observed, according to Romero (2021), has to do with the possibility that these types of devices offer to facilitate understanding when consulting content, even though students do not have specific educational applications installed. In other words, the use of mobile devices in education can be considered a good practice that teachers could gradually implement, inside and outside the classroom, to improve student performance (Rodríguez *et al.* , 2019).

To do this, however, the design of the applications used must be taken into account, which requires the participation of a multidisciplinary team of specialists, that is, pedagogues, proofreaders, designers, developers, authors (teachers), as well as *webmaster* . If you do not have this equipment, it is essential to seek advice and follow guidelines for the production of resources, such as those provided by the Directorate of Virtual Education (DEV, 2023) of the National Polytechnic Institute.

Indeed, in the design of educational resources, the pedagogue plays a fundamental role by collaborating with the author to define the educational model that will be implemented in the design of the resource, which allows the construction of knowledge (Martínez, 2017). In addition, the pedagogue must consider the learning style, learning theory, educational model and purposes. In this regard, it is important to highlight that educational resources must be

designed with the objective of promoting sociocultural learning (Scott and Palincsar , 2013) and collaborative learning (Vygotsky and Cole , 1978). In this way, students are encouraged to support each other, which facilitates communication and feedback and, therefore, improves the acquisition of knowledge (Escobar *et al.* , 2021).

One of the mobile devices that facilitates the implementation of new and innovative educational experiences with this approach are interactive or tactile tables (*smart -table*), which allow the participation of up to eight students interacting with the educational resource. As mentioned by De Caso (2012), “ the table allows stimulating collaboration, debate and consensus and a meeting point to explore digital lessons, participate in educational games and interactive learning activities” (p. 192).

Having explained the above, this research work focused on two stages of study: the first consisted of the development of an educational application to be used on the *smart -table mobile device* with the objective of promoting mobile, collaborative and sociocultural learning. In the second stage, the educational experience was carried out using this educational application mediated by *smart - table* technology. The main purpose of this work was to visualize how mobile learning is integrated with the design of interactive (game-based) educational resources to foster collaborative learning and diversify educational strategies.

In summary, this article describes the materials, resources and methodology used, as well as the design and development process of the educational application called *Learning feedback through competence-based gaming* . In addition, the results obtained from the evaluation of the implementation of the mobile learning educational experience with the support of the educational application are presented, and a discussion is offered in which the results are analyzed in comparison with existing research. Finally, conclusions are presented and future work is recommended.

Materials and methods

Kind of investigation

This research work was qualitative and exploratory, for which a focus group was chosen. In addition, a longitudinal analysis was carried out.

Materials

- Educational experience classroom equipped with a *smart -table* (interactive table with privacy skirt), property of the educational institution.
- Educational application *Learning feedback through competency-based gaming* .



Participants of the focus group

150 students participating in the Good Software Practices learning unit, corresponding to the second semester of the academic program of the degree in Computer Science of the Interdisciplinary Professional Unit of Engineering and Social and Administrative Sciences (UPIICSA) of the National Polytechnic Institute (IPN).).

Design of the educational experience

The Good Software Practices course is taught in person two days a week with two hours each day. Therefore, for the educational experience the following was considered:

- It took place in the month of May 2023.
- It was done during class hours.
- Mobile learning was used using the educational experience room.
- The educational application was installed on the *smart table*.
- Teams of 10 members were formed.
- The teams presented themselves in the educational experiences classroom.
- *smart-table* technology and the educational application, with free time to complete it.
- The members of each team answered the experience evaluation survey.
- With the survey, the information analysis was carried out and the results were collected.

Methodologies for the development of the educational application

The ADDIE instructional design (Morales *et al.* , 2014)—which consists of the stages of analysis, design, development, implementation and evaluation—allowed the creation of the educational application through a didactic orientation that considered the models and types of learning. This instructional approach favored the design of the educational application with a personalized and collaborative approach to learning. The instruction managed to create a dynamic, interactive and attractive environment with the objective of benefiting the students.

The methodology used to develop the educational application was Scrum (Sutherland, 2016). This supported the management and monitoring of development by assigning specific roles, defining tasks, establishing development and delivery times. A distinctive feature of Scrum is the holding of sessions called *Sprints* during which the production of the application and its functionalities were reviewed. This allowed us to verify with the author/expert (teacher) that the established requirements were met. If deviations or misunderstandings were found in the requirements, corrections were made to ensure that the application complied with the requested graphic, instructional design, and navigation and interaction interface.

Development of the educational application

A) Analysis

Table 1 shows the actions of the ADDIE methodology. In column 1 is the methodology stage and in column 2 are the activities developed.

Table 1 . Activities of the ADDIE methodology

ADDIE Stage	Methodology activities
Analysis	Determines objectives, learning models and styles, content, training action, the elements of interface design and instructional design.
Design	The layout of the educational application is carried out considering the specifications of the analysis stage.
Development	<i>software</i> development methodology .
Implementation	Tests of the educational application were carried out to make adjustments to incidents in operation. With the application completed and free of incidents, it was put into production, that is, the application was installed on the interactive table, the final tests were carried out and it was released to be used by the students.
Assessment	After the application was put into production and used by students, evaluation was conducted to determine its impact and relevance. Based on the results, adjustments were made, which should be done periodically for continuous improvement.

Source: self made

b) Design and development of the educational application “Learning feedback through competency-based gaming”

The application was designed to be implemented on the *smart -table mobile device* with Android operating system. Following the requirements established in the instructional analysis stage, its development was proceeded. Figure 1 shows the first two interfaces of the application, which present its purpose, as well as the instructions for use.

Figure 1. First two interfaces of the educational application



Source: self made

Figure 2 shows the interface where students can select the topic in which they wish to participate. Available topics include *software requirements fundamentals*, *information systems or software development processes* . Once the topic is selected, students register, which allows monitoring of the participants, response time and the score obtained at the end of the game.

Figure 2 . Interface for accessing games and player registration



Source: self made

c) Implementation of the educational application

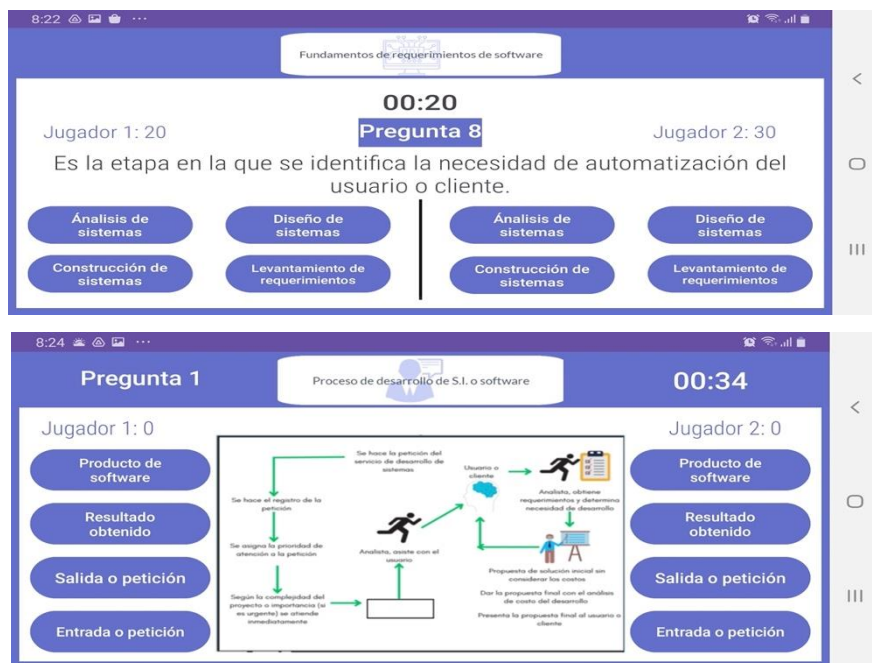
The educational application was installed on the *smart-table* , and the implementation plan was carried out with the following actions:



- The students were transferred to the UPIICSA innovative educational experiences classroom.
- Teams of six members were formed (three teams participated in each session).
- In the classroom, students were given freedom to use the educational application on the *smart-table*. They were informed that use of the application was optional and that upon completion they would be given a survey to evaluate their experience and satisfaction with mobile learning.
- The students carried out the activity.

Figure 3 shows two of the exercises they carried out. In both there is a space for two players, the general time to respond and the time of each player are marked. Likewise, a question is presented and each player can answer; The player who answers correctly gets a point, while if he doesn't get it right, the turn passes to the other player. Both players have a time limit to answer. The interaction between the application and the players varies in each exercise. For example, in the game *IS or Software Development Process*, players must drag the concept to the corresponding image. At the end, the result and the time used are displayed.

Figure 3. Interface of two application games



Source: self made

d) Evaluation of the application and educational experience

To evaluate the educational application and the learning experience, a questionnaire was administered to the students, which collected information on the following aspects: didactic design and interface design of the educational application, perception of mobile learning, and level of satisfaction with the educational experience.

Results

Regarding the didactic design of the educational application, the aspects of the instructional design were evaluated based on the following questions:

- 1.- Does the content allow the educational activity to be carried out?
- 2.- Does it allow us to see the results of the learning?
- 3.- Is it necessary to have instruction to carry out the activity?
- 4.- Is more instruction required to carry out the activity?
- 5.- Does it contain the instructions to carry out the activity?

The results for these questions show that 93.33% of the participants consider that they have the instruction to guide the activity (figure 4).

Figure 4. Results of the evaluation of the didactic design of the educational application



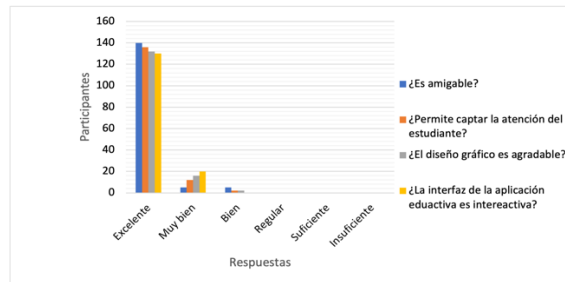
Source: self made

Regarding the design of the interface of the educational application, the following questions were raised:

- 1.- Is it friendly?
- 2.- Does it allow you to capture the student's attention?
- 3.- Is the graphic design pleasant?
- 4.- Is the educational application interface interactive?

As seen in Figure 5, 93.33% believe that the educational application is friendly and interactive.

Figure 5. Results of the evaluation of the interface design of the educational application



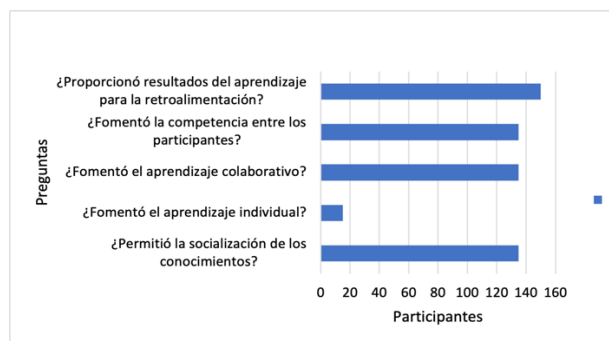
Source: self made

The results regarding the relevance of learning are identified through the following questions:

- 1.- Did you provide learning outcomes for feedback?
- 2.- Did you encourage competition among the participants?
- 3.- Did it promote individual learning?
- 4.- Did it allow the socialization of knowledge?

93.33% of the participants considered that collaborative learning, the socialization of knowledge and competition were promoted. Likewise, 100% of the participants indicated that the educational application allowed them to verify the result of their learning. Finally, 10% carried out the activity individually (figure 6).

Figure 6. Results of the evaluation of the relevance of learning



Source: self made

In another aspect, students' perception of mobile learning was evaluated. In this sense, it was observed that 92% believe that it facilitates learning, 100% affirm that it provides access to content at any time, and 100% agree that it complements face-to-face learning. Furthermore, 100% mention that it is not equivalent to learning in the face-to-face classroom (figure 7).

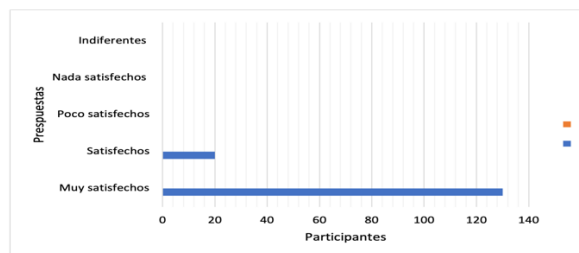
Figure 7. Mobile learning perception results



Source: self made

The last aspect evaluated focused on the satisfaction of the educational experience, as shown in Figure 8. The opinions reflected that 86.66% were very satisfied and 13.33% were satisfied with the experience.

Figure 8. Experience satisfaction results



Source: self made

Performing the analysis of the results obtained, it is observed that the didactic design of the educational application achieved its purpose, since it encouraged students to participate in collaborative learning and social interaction. Furthermore, it was evident that learning through competitive games motivates them to interact socially.

On the other hand, it was perceived that it is an effective teaching strategy for the application to show the score or learning results, which allows the student to receive feedback through the participation of their classmates.

Regarding the mobile learning experience, it was detected that the use of the *smart-table* and the resource incorporated into it created a different learning environment that contributed to students feeling more comfortable and with greater freedom, which favored their learning. Finally, the students' satisfaction is evident when carrying out a new learning experience with the use of mobile technology.

Discussion

Based on the results achieved, it can be stated that, to successfully promote mobile learning, it is necessary to devise and develop educational resources whose instructional design incorporates didactic and pedagogical elements for the construction of collaborative knowledge, in line with what was reported by Martínez (2017). Likewise, the findings obtained demonstrate that the use of technologies such as the *smart-table* with interactive educational applications and a competency-based orientation encourages the active and collaborative participation of students in the acquisition of knowledge, which coincides with what was pointed out by Scott and Palincsar (2013) and Vygotsky and Cole (1978).

On the other hand, the evidence collected on the didactic orientation and design of the application promoted, for example, kinesthetic, visual and contextual learning, which improves the academic performance of students, which is in line with what was stated by Rodríguez *et al* . (2019) and Escobar- Rynel *et al* . (2021).

Furthermore, it was observed that mobile learning, the educational application and the collaborative and social learning approach, together, constitute an innovative educational strategy to diversify the media used in the learning process and promote improvement.

It should also be noted that, according to the observation of the participating teachers, more work should be done on this type of learning experiences to achieve better results. At certain moments of the activity, the students had some problems relating to and using the application and the *smart-table* .

Finally, it can be stated that it was necessary to direct attention towards *smart-table technology* as a means to carry out mobile learning, which allowed the educational experience to be carried out. In short, the results are considered satisfactory, since, as Romero (2021) expresses, when using this type of technology the teaching processes are regulated and, consequently, they constitute a good option that is in line with good practices. educational initiatives in favor of educational improvement and quality, as recommended by UNESCO (2016).

Conclusions

smart-table technology and the educational application allow us to conclude that mobile learning mediated by technology and educational applications designed with an appropriate didactic orientation are an excellent option for students to work active, entertaining and collaborative way. Therefore, academic institutions must encourage the use of mobile

technology, such as the *smart-table*, and the design of educational experiences enriched with interactive content to diversify learning methods with the aim of improving educational quality.

In addition to this, it is important to highlight that the educational application can be used on any mobile device with Android operating system, since it is designed to work on this platform and its design is adaptable. Additionally, if you are not working as a team, it can also be used individually.

In conclusion, it is considered that the results are encouraging and that this experience, as a first foray into the classroom, provides a starting point so that both teachers and students can benefit from its use in the future.

Future lines of research

Work must be done on the development of educational applications to promote mobile learning and diversify teaching strategies, for which various topics must be addressed that enrich new experiences, especially at the higher level. These initiatives will be in line with the use of mobile devices such as the *smart-table* and will incorporate the use of smartphones, which will allow teaching strategies to be adjusted to a more personalized learning approach.

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