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SHORT ARTICLE

A mobile application for teaching elementary lesions in the oral cavity

Aplicación móvil para la enseñanza de lesiones elementales en cavidad bucal

Eilien Tovio-Martínez[1]* orcid.org/0000-0003-3702-2791
Martha Carmona-Lordouy[1] orcid.org/0000-0003-3066-2219
Jonathan Harris[1] orcid.org/0000-0002-4662-0729
Eliana Guzmán[1] orcid.org/0000-0002-8475-6301

1. Dentistry Program, University of Cartagena. Cartagena, Colombia

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Resumen

Introducción: El desarrollo de las Tecnologías de la Información y la Comunicación (TIC) y su fácil acceso, hacen de ésta una alternativa educativa que contribuye a incrementar la calidad de la educación, facilitando el proceso de enseñanza-aprendizaje con medios virtuales. Las lesiones elementales son alteraciones del tejido bucal y su conocimiento es importante para realizar un adecuado diagnóstico y manejo terapéutico. **Objetivo:** Diseñar, implementar y evaluar una aplicación móvil para la enseñanza de lesiones elementales en cavidad bucal. **Materiales y métodos:** Estudio de intervención, experimental, que evaluó una herramienta educativa sobre lesiones elementales bucales, utilizando una pre-prueba, una intervención y una prueba posterior, para el grupo control se evaluó el aprendizaje a través de la lectura de un artículo. Se compararon los resultados obtenidos mediante prueba de Chi^2 con un $p \leq 0{,}05$. **Resultados:** Ambos grupos lograron un incremento en el nivel de conocimiento sobre lesiones elementales; sin embargo, quien utilizó la aplicación móvil obtuvo resultados significativamente mejores de aprendizaje (Chi^2 $p=0{,}014$). **Conclusiones:** Las TIC constituyen una estrategia útil para afianzar nuevos conocimientos, se comprobó que los estudiantes que emplearon la herramienta educativa incrementaron significativamente el aprendizaje en lesiones elementales de una forma agradable y amena.

Palabras clave: Boca; educación en salud; tecnología de la información; patología bucal; aprendizaje; efectividad. (Fuente: DeCS, Bireme).

Abstract

Introduction: The development and widespread access to Information and Communication Technologies (ICTs) have reinforced the view of them as didactic alternatives to improve the quality of education. These technological advances have facilitated the teaching-learning process through the use of virtual media. Knowing elementary lesions in the oral cavity tissue is important for their appropriate diagnosis and therapeutic management. **Objective:** To design, implement and assess the use of a mobile application in the teaching of elementary lesions of the oral cavity. **Materials and methods:** An intervention and experimental study that evaluated a didactic tool about oral elementary lesions, applying intervention, pre and post testing. The control group learning skills were assessed through the reading of an article. We finally compared the results via Chi^2 test, with $p \leq 0.05$. **Results:** Although both groups showed an improvement in learning levels, the group that used the mobile application achieved significantly better results in reference to learning about elementary lesions (Chi^2 $p=0.014$). **Conclusions:** ICTs have become useful strategies to strengthen new knowledge. In this study, we show that students who used the educational tool improved the learning of elementary lesions, in a significant and enjoyable way.

Key words: Mouth; health education; information technology; oral pathology; learning; effectiveness. (Source: DeCS, Bireme).

***Corresponding author at:**
Eilien G. Tovío Martínez
e-mail: etoviom@unicartagena.edu.co

Introduction

The information and communication technologies (ICTs) include all the media platforms developed by the computing sciences that facilitate communication and interaction for educational purposes, which can take place synchronously or asynchronously and from geographically distant places[1]. There is a link between education and ICTs that is getting stronger as the time passes. Currently, basic, medium, and higher education levels benefit from this connection in order to improve coverage and facilitate pedagogical processes[2]. Despite the benefits of ICTs, they can be used inappropriately to disseminate misleading information that can interfere with learning activities and professional performance. For this reason, it is important that people learn how to use these new technologies so they do not become an undervalued resource[3].

Currently, the utility and interactions that exist between technological advances and education are evident, allowing students and instructors to define new roles and use these means as didactical strategies to improve academic performance. Electronic devices such as tablets, cell phones, and iPads have become a working tool that can be used to transform already established knowledge and give it other uses, allowing students to acquire greater autonomy and responsibility in the learning process and forcing educators to rely less on their traditional roles as exclusive sources of knowledge. This leads to a creative restructuring of academic institutions[4,5].

The increase in the implementation of ICTs in classrooms helps students to learn, fulfilling the roles of transmission of knowledge and development of abilities and skills in technologies already created. Thus, academic institutions face the great challenge that demands that educators establish strategies based on the appropriation of technological processes, applying them in either professional or technological fields; leaning on different elements required for research and innovation of processes, products, and services emerging from technological areas[6].

Elemental injuries are clinical indicators or signs that manifest in oral mucosa and are characterized by changes in shape, size, texture, consistency, color, and appearance. The alterations that appear in healthy mucosa are called primitive or primary lesions, whereas those derived from existing primary lesions are known as secondary elemental lesions. The recognition of these lesions is important for early diagnosis and treatment of patients[7].

The oral mucosa has a limited number of pathological responses that are known as elemental lesions and characterize mucocutaneous diseases. They are generated by either a damage caused by external agents or by systemic diseases. Common causes of these lesions are trauma caused by prosthetics, hygiene, inflammation, allergic reactions to the prosthetic material, dietary factors, infections caused by microorganisms, and systemic factors[8]. These clinical signs represent the principles over which the dermatological and stomatological language and thought are supported, being similar to the alphabet on which the communication system is built. In the stomatological practice, knowing and interpreting the meaning of each of the elemental lesions is important, allowing a correct association between lesions and their respective images. The identification of the disease images and the data collected during anamnesis facilitates timely diagnosis and effective treatments for each oral pathology[9].

Dentists should be able to identify the large number of oral mucosa lesions in order to achieve a precise diagnosis and a proper treatment. An inadequate procedure of oral mucosa scanning can lead to an incorrect differential diagnosis of lesions, which can overlook important lesions and lead to erroneous treatments[10]. The purpose of this article is to design, implement and assess a mobile application for the identification and teaching of elemental lesions in the oral cavity for students from the Dentistry Program of the University of Cartagena (Colombia), allowing the use of ICTs as a learning strategy.

Materials and methods

An educational intervention study of experimental nature was conducted, which included a pretest, an intervention, a post-intervention test, and a control group. The sample included 74 students (37 in each intervention and experimental groups) belonging to the Dentistry Program of the University of Cartagena. The students were taking classes during the first period of 2017 and belonged to VIII, IX, and X academic cycles. They fulfilled academic standards, participated voluntarily in the study, and had mobile devices with Android system.

Phase 1: Design of the mobile application
A mobile application to be used as an educational tool was designed and created. This tool was installed and used as a guide to diagnose oral pathologies from elemental lesions, which became a fundamental instrument for the comprehensive training of dentistry students. The application designing team included a systems engineer, who was trained during four months to conduct thorough bibliographic reviews, selection of images of each elemental lesion together with its pathology, and the making of videos for the explanation of the topics related to diagnosis of oral pathologies.

Phase 2: Random assignment
The students were randomly distributed in the two groups (G1: intervention group and G2: control group) before they had any knowledge of the application. The G1 group was informed of the mobile application, while the G2 group received printed information about the study. The Epidat Software version 4.1 was used for the random assignment of these students.

Phase 3 and 4: Implementation and assessment of the application (techniques and instruments for information gathering)
The implementation step involved the installation of the application on the devices of the students belonging to the intervention group. A 10-item questionnaire was used for a one-hour initial assessment (pre-test), which included multiple-choice questions to identify each lesion, establish differences between lesions, and associate each lesion with its respective pathology. The final quantitative score was based on a scale of one to five. Then, the application was installed on the cell phones of all G1 students, whereas the G2 students only received printed copies containing information about the same subject. Both learning strategies (mobile application vs. traditional methods) were implemented for an eight-day period. After this initial intervention stage, a second assessment instrument was used to compare the efficiency of these two strategies and evaluate the user perception level of the application. In addition, a survey was applied to the G1 group, which assessed the effectiveness and satisfaction level of this educational tool. Finally, the tests results were quantified and the obtained data was stored and analyzed with Excel software. Each participating student has his/her own confidential code.

Phase 5: Data analysis and interpretation
Frequency measurements, proportions, and 95% confidence intervals were used for the analysis of quantitative variables. Average and standard deviations were reported if the data fit a normal distribution, otherwise median and interquartile range were used.

When the data showed a normal distribution, an unpaired Student's t-test was applied to compare levels of knowledge between the two groups. On the contrary, non-parametric statistics, such as Chi^2 with a statistical significance level of $p<0.05$, were used. The construction of the database was achieved through the Stata 11.0 software.

Ethical considerations
The study was classified as a risk-free research based on both the 8430 Resolution of the Colombian Ministry of Health and Social Protection of 1993 and the Helsinki Declaration. It was also approved by the Research Ethics Committee of the Dentistry Program of the University of Cartagena. Finally, each participating student signed the informed consent form.

Results

The majority of participants were women (59.46%) and their average age was 23.72 ± 3.49 years old. The students belonged to the ninth (37.84%), tenth (33.78%), and eighth (28.38%) academic cycles (Table 1).

The initial assessment (pre-test) showed that 33.8% (25) of the students had a high level of knowledge, whereas 63.5% (47) and 2.7% (2) had medium and low levels, respectively. After the interventions, the results of the second evaluation were 64.9% (48), 32.4% (24), and 2.7% (2) for high, medium and low level of knowledge, respectively. The data were further processed, tabulated, and analyzed. The Chi^2 statistical value, with a significance level of $p<0.05$, demonstrated statistically significant differences ($p=0.016$).

A comparison between the two educational interventions (traditional vs. mobile application) was carried out. The 37 students assigned to the mobile application group were subjected to the initial assessment (pre-test), which showed that 42.1% (16) of them had a high level of knowledge. 52.6% (19) of

participants had a medium level and 5.3% (2) exhibited a low level. After the intervention, an increase in the percentage of students with a high level of knowledge (26; 71.1%) is worth highlighting. There were reductions in both medium and low levels, with 26.3% (10) and 2.6% (1), respectively. However, the *Chi²* test indicates that these differences were not statistically significant ($p>0.05$).

The same analysis was applied to the students (37) belonging to the traditional method group. The pre-test that assessed their knowledge about elemental lesions indicated that 25% (9) of participants had a high level, whereas 75% (28) displayed a medium level. The assessment performed after the traditional intervention showed that 58.3% of students reached a high level. 38.9% (14) and 2.8% (1) of students displayed medium and low levels after the intervention, respectively. These differences were statistically significant as demonstrated by the *Chi²* statistical test (p=0.014) (Table 2). From the total of participating students (74), only those that used the mobile application (50%) answered the survey about their satisfaction with the application (only one student did not participate in the survey). Here, 27% (20) of the students agreed with the effectiveness of the application, followed by 14.8% (10) who expressed to be in total agreement with its effectiveness. Total disagreement with the effectiveness of the mobile application was expressed by 4.1% of participants, whereas 2.7% (2) and 1.4% (1) of the students disagreed and were uncertain about the effectiveness of the intervention, respectively (Table 3).

Table 1. Sociodemographic characteristics of the study population

	General		Application		Paper copies		*p* value
	N=74	%	n (37)	%	n (37)	%	
Gender							
Male	30	40.5	13	36.8	17	44.4	0.506 ¥
Female	44	59.5	24	63.2	20	55.6	
Academic cycle							
VIII	21	28.4	12	31.6	10	25.0	
IX	28	37.8	12	31.6	15	41.7	0.757 ¥
X	25	33.8	13	36.8	12	33.3	
Age	**Average**	**SD**	**Average**	**SD**	**Average**	**SD**	***p* value**
	23.7	3.5	23.50	2.43	23.94	4.36	0.588 §

¥: *Chi²*. §: *Student's t*

Table 2. Level of knowledge about elemental lesions before and after the interventions

Level of knowledge	General				*p* value	Application				*p* value	Paper copies				*p* value
	Pre-test		Post-test			Pre-test		Post-test			Pre-test		Post-test		
	n(74)	%	n(74)	%		n(37)	%	n(37)	%		n(37)	%	n(37)	%	
High	25	33.8	48	64.9	0.016 ¥	16	42.1	26	71.1	0.133 ¥	9	25	22	58.3	0.014 ¥
Medium	47	63.5	24	32.4		19	52.6	10	26.3		28	75	14	38.9	
Low	2	2.7	2	2.7		2	5.3	1	2.6				1	2.8	

¥: *Chi²*

Table 3. Level of satisfaction about elemental lesions after the intervention of the mobile application

	Strongly disagree n (%)	Disagree n (%)	Undecided n (%)	Agree n (%)	Totally agree n (%)
Effectiveness	3 (4.1)	2(2.7)	1 (1.4)	20(27)	10(14.8)
Efficiency	2(2.7)	-	-	17(23.5)	17(23.5)
Satisfaction	5 (6.8)	25(35.1)	6(8.1)	-	-
Ease of learning	2 (2.7)	16 (21.6)	18(25.7)	-	-
Memorability	2 (2.7)		1(1.4)	20(27)	13(18.6)
Mistakes	4 (5.4)	20(27)	6(8.1)	3(4.1)	3(4.1)
Content	2 (2.7)	1(1.4)	33(45.9)	-	-
Accessibility	2 (2.7)	5 (6.8)	29(40.5)	-	-
Safety	12(16.2)	17(24.3)	1 (1.4)	2(2.7)	4(5.4)

Discussion

There is a very important link between science, education, and technology, which demonstrates the impact that ICTs have on learning processes of students. They affect school communities, especially instructors who are continuously learning about new technologies, transforming them into valuable alternatives to face-to-face classes. ICTs simplify information access, communication, and discussion, among others[11].

Epidemiological studies on the use of ICTs have demonstrated that these technological tools have facilitated the achievement of knowledge, science and competencies in a didactic way, thus becoming a captivating method to acquire knowledge[12]. In 2018, Arriaga *et al.* carried out a study with 27 students from the Communication Technologies and Information Management (CTIM) program of the Autonomous University of Nayarit (AUN). The authors compared the students' awareness in reference to different analyzed issues, observing an increase of 9.83% between pre-test (62.02%) and post-test (71.85%). In agreement with our results, Arriaga *et al.* also reported an improvement in achieving competencies through the use of Web 2.0 applications for the assessment of significant learning[13].

In a study by Escobar *et al.* in 2015, an object and a Chemistry virtual laboratory were designed in order to teach the Law of Conservation of Mass. 17 tenth grade students from a High School of Pasto (Colombia) participated in this study. 1.76% of the students answered properly to pre-test questions, a figure that increased to 82.35% during the post-test[14]. In reference to the performance of students, these results are similar to those presented in this article as a higher level of learning was obtained after the intervention and the grades in the post-test were significantly better.

In 2015, Salgado *et al*. stated that although participants accepted new technologies, they were not comfortable with the platform and available resources since internet access is required to search study materials. Also, some participants experienced difficulties handling the technological tools, concluding that those tools may not be important for the students. On the contrary, they thought that books are always available to the reader, are easy to carry and use, have high credibility, last for a long time, and play an important role in the learning process of students and professors, making them valuable teaching tools[15]. Arévalo *el al*., in 2017, suggested that students may find books unappealing, not interactive, and not completely useful to resolve doubts. On the other hand, technological tools evolve continuously and are present in all scenarios[3]. However, it is important to mention that, in this study, the group that used the traditional method (hard copies) also achieved an increase in learning.

Currently, access to technological resources allows students to reach a higher level of internet connectivity through electronic devices, which can be used at home, school or any other place with available network connection. Nevertheless, these resources could represent an obstacle to integrating ICTs to education systems due to the lack of computers, virtual educational programs or a stable internet connection. This situation also restricts professors' access to technology, which makes it difficult to implement more flexible teaching-learning models. Education evolves and adapts to the demands of the new generations. It went from an analog culture of paper, pencil, book, and chalkboard to digital environments with networks, work platforms, digital books, as well languages containing texts, numbers, icons and visual and sound components[16].

Díaz *et al*., suggest learning through technological tools and recommend that independent study skills must be evaluated according to specific functions such as goal assessment, monitoring, and note taking[10]. This view is in agreement with the present study as the mobile application only represents a tool to facilitate students' understanding of the topics. The applications must be improved to be compatible with different software systems since 8.1% of the participating students used mobile phones with non-android operating systems, which made it difficult to use the application. This improvement will provide better adaptability, quick access, and easy handling of the application by the student, regardless of the wireless network provider.

Academic institutions that train health professionals will benefit from these types of studies. Teaching aids improve learning and assessment of students, so that institutions can make better decisions regarding the selection of better teaching methodologies[17]. The results presented in this study supported the

hypothesis in reference to the usefulness of ICTs, particularly mobile applications, for the teaching/learning processes of professors and students carried out both inside and outside the classroom. Thus, the implementation of an educational video improved the level of understanding of elemental lesions in Dentistry students belonging to the VIII, IX, and X academic cycles from the University of Cartagena. In this context, Córdoba *et al.,* indicate that the use of technologies as supportive didactic tools has a positive impact on the teaching and learning processes[18]. This idea corroborates that ICTs facilitate the development of competences in students according to the present dynamics. The results obtained in this study show that the learning of students improved after the use of the application.

Conclusions

The level of understanding about elemental lesions in Dentistry students of VIII, IX, and X academic cycles from the University of Cartagena before the educational implementation was not appropriate. However, the students reached a predominantly high level after the intervention. In the context of the educational strategies applied in this study, statistically significant differences were observed between control and intervention groups. Even though both strategies (application and hard copies) were useful for the acquisition of a better understanding of elemental lesions, the intervention through the mobile application showed a better outcome. Therefore, in addition to reaching better learning levels, the application can also be used for the students to reach proper clinical diagnoses.

A better understanding of elemental lesions is important since it facilitates a timely diagnosis of pathologies affecting the oral cavity, which could improve the quality of life of patients.

Recommendations

Given the fact that modern student communities are more technologically savvy, it is necessary that education systems attract them more in order to improve their learning in all areas of knowledge. Therefore, it is important to apply new technologies in order achieve an accurate and timely diagnosis of the different types of lesions that affect the oral cavity, which ultimately will improve the quality of life of patients that request oral health consultations.

Finally, there is the need to carry out new studies in order to determine the level of satisfaction of students in reference to the implementation of ICTs in education.

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Conflict of interests

None to be declared by the authors.

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