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The effect of a mobile application for learning about traumatic dental injuries during the COVID–19 pandemic

Ефекат мобилне апликације за учење о повредама зуба током пандемије *COVID*–19

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SUMMARY

Introduction/Objective University teachers have a challenging task in finding creative ways to display educational content. One of them is to create applications dedicated to educational purposes, which students can use on their mobile phones at any time. The aim of this study was to evaluate the impact of mobile learning of dentistry students during COVID–19 pandemic.

Methods The prospective study involved 56 students from two medical faculties in the Balkans, who continued to study online after the declaration of the COVID–19 pandemic. Online teaching was based on material in the form of PowerPoint presentations. In order to provide an additional educational tool, a step-by-step mobile application for managing traumatic dental injuries was developed. After one week of using that mobile application, all students completed a questionnaire in electronic form concerning teaching satisfaction.

Results Over 90% of the respondents stated that the application facilitated a learning process, improved their understanding of the teaching unit, and provided a great convenience in terms of access to information. Median value of the total score concerning clinical protocol by the use of application was 20 (16–20), which was significantly higher than the neutral value ($p < 0.001$). Median value of the total score concerning the use of conventional *PowerPoint* presentations did not differ significantly from the neutral value ($p = 0.284$).

Conclusion Mobile learning resulted in improved knowledge of dental traumatology diagnostics and treatment among undergraduate dentistry students during COVID–19 pandemic.

Keywords: COVID–19; mobile learning; dental traumatology

САЖЕТАК

Увод/Циљ Професори имају озбиљан задатак у проналаску креативних начина приказивања едука-тивног садржаја. Један од њих је и израда намен-ских апликација у образовне сврхе које студенти могу користити на свом мобилном телефону у сва-ком тренутку.

Циљ ове студије био да се процени утицај додатног мобилног учења апликацијом за денталну трауматологију за време онлине наставе узроковане пандемијом *COVID*-19.

Методе У проспективној студији учествовало је 56 студената са два медицинска факултета на Балка-ну, која су након проглашења пандемије *COVID*-19 наставиле рад онлајн наставом. Онлајн настава се засновала на материјалу у виду *PowerPoint* презен-тација. У циљу додатне едукације за потребе ове студије развијена је мобилна апликација корак по корак за учење денталне трауматологије. Након завршене онлајн рад-не недеље, сви студенти су попунили електронски упитник задовољства.

Резултати Преко 90% испитаника сматра да им је апликација помогла у учењу, олакшала разумевање, имала предност услед доступности у сваком моменту и да може бити од велике помоћи у учењу и у другим дисциплинама. Медијана укупног нумеричког скора питања везаних за савладавање терапијских поступака коришћењем апликације износила је и статистички значајно виша од медијане укупног скора за неутралан став ($p < 0,001$). Нема статистички значајне разлике између медијана укупног нумеричког скора питања везаних за боље савладавање терапијских поступака коришћењем конвенционалних *PowerPoint* презентација и меди-јане укупног скора неутралног става ($p = 0,284$).

Закључак Мобилно учење обезбедило је боље познавање дијагностике и терапије денталне трауматологије студената основних студија за време онлајн наставе узроковане пандемијом COVID-19.

Кључне речи: *COVID*-19; мобилно учење; дентална трауматологија

INTRODUCTION

Preventive measures instituted to limit a spread of the COVID-19 among population, such as social distancing and self-isolation, have initiated the closure of primary, secondary and higher educational institutions around the

world [1]. In their efforts to mitigate the immediate impact of school closures, many universities and faculties have replaced the traditional methods of teaching with distance teaching (and learning) [2]. As it was impossible to predict the duration of a self-isolation period, distance learning has been based primarily on electronic communication between students and teachers, i.e., on e-learning. E-learning can be defined as any use of computers and the Internet in education, where teaching content is sent in electronic form. With this technology, teachers can visually present educational content in a digital environment, trying to make the content inspiring and filled with interesting material, motivating students as much as possible. Students, on the other hand, can learn at the desired place [3].

With growing utilization of smartphone technology, both for personal and professional purposes [4], mobile learning (m-learning) has developed as a new research branch of e-learning, in which mobile devices are used during the learning process [5]. With numerous entertainment-oriented applications available online, teachers have a challenging task in finding creative ways to display educational content. One of them is creating educational tools that students can use on their mobile phone at any time. Numerous mobile applications are constantly being developed that allow mobile learners to have access to a wide variety of learning resources [6,7].

These are particularly valuable for topics that do not ordinary happen in everyday dental practice, such as managing dental trauma (Traumatic Dental Injuries - TDI) [8]. As the prognosis of traumatized teeth depends on immediate and appropriate treatment, the dentist must be conscious of the best clinical protocol at all times. However, several reports have been published showing students having insufficient knowledge on how to manage a TDI, and indicating the need for more effective educational programs [9-12].

The aim of this study was to evaluate the impact of mobile learning during COVID-19 pandemic, using an application for managing TDIs.

MATERIALS AND METHODS

Participants

This prospective study involved 56 fifth year students in five-year schooling (average age 23 years) at the Department of Dentistry from Faculty of Medicine University of Pristina (Kosovska Mitrovica) and Faculty of Medicine University of East Sarajevo (Foca), who continued to operate online after the declaration of the COVID-19 pandemic (12 of 68 students refused to participate) (Fig. 1). Online teaching was based on material in the form of PowerPoint presentations (the presentations were of the same content for both faculties), distributed to students

via e-mail or the *Moodle* e-learning platform. All participants in the study went through all stages of the educational process and signed the consent form electronically.

Additional mobile learning

In light of the COVID-19 pandemic and transfer to online teaching methods, a curriculum-aligned mobile application dedicated to dental injuries teaching (Dent.IN JURY) was developed by the corresponding author (based on recommendations of the International Association of Dental Traumatology and faculties curriculum) [13]. All students downloaded the Dent.IN JURY application from the Google Play Store, available in Serbian and English (Fig. 2).

Satisfaction Questionnaire

After completing the online working week according to the curriculum, all students filled out an electronic satisfaction questionnaire (Google Forms). Twelve items were quantified with a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) [14]. The questionnaire contained three sections that referred to: a) student experience and satisfaction with mobile learning environment (Questions 1-4); b) student satisfaction with learning process using the mobile application Dent.IN JURY (Questions 5, 7, 9, 11); and c) student satisfaction with learning process using conventional online teaching tools (*PowerPoint*) (Questions 6, 8, 10, 12). To ensure confidentiality, participants signed a separate consent form.

Statistical Analysis

Data are presented as n (%) or median (Q1-Q3). To test whether the median of the sample was equal to a known standard value, we used the Wilcoxon one-sample test. Statistical hypotheses were tested at the level of statistical significance of 0.05. All data were processed in the R programming environment (R Core Team, 2019).

RESULTS

Over 90% of the respondents believed that the Mobile phone application facilitated the learning process, improved their understanding of the teaching unit, and provided great convenience in terms of access to information (Fig. 3).

Over 85% of respondents believed that they have mastered treatment following dental injury, mostly concerning injuries of permanent teeth with completed growth (Fig. 4).

The data show that the respondents chose neutral option for items 6 and 8 of the questionnaires (33.9%), whereas they completely disagree with statements 10 and 12 (26.8% and 30.4%). Only 1/3 of the respondents indicated agreement with these statements (Fig. 5).

The median score for statements related to satisfaction with the learning application was 20 (18.5-20) and significantly higher than the neutral value ($p<0.001$). The median score for statements related to mastering of clinical protocol using the application was 20 (16-20) and significantly higher than the neutral value ($p<0.001$). The median score for statements related to mastering of clinical protocol using conventional *PowerPoint* presentations was 12 (7-15) and did not differ significantly from the neutral value ($p=0.284$).

DISCUSSION

In the last decade, there has been a rapid expansion of educational resources available for medical students. As well as traditional resources, students are increasingly accessing mobile technology and online tools for learning [15]. As it provides learning flexibility and autonomy, the concept of mobile learning (m-learning) attracts the interest of both students and researchers [16]. Smartphones are becoming a more suitable tool for advancing education in developing countries [17-19].

Given that in normal conditions the average person spends up to 5.5 hours a day on their phone [20], we can assume that in quarantine conditions, during a state of emergency due to the COVID-19 pandemic, this number increased greatly. According to the available data, no mobile application for managing TDIs is available in Serbian. In order to animate students during the pandemic and provide them with a better insight into dental traumatology, we developed a mobile application (Dent.IN JURY) for the purposes of this study. Creating educational applications is a unique opportunity for developers, but it also comes with numerous obstacles and challenges. The biggest problem for the developers is to understand the educators' requirements for the application to be relevant to the end user. In our case, this was not a problem because the corresponding author of this article developed the application [13]. Over 90% of respondents believed that the application facilitated the learning process and improved their understanding of the teaching topic. It seems to have precedence over the classic *PowerPoint* presentation as it enables better accessibility to information and ease of use. Respondents agreed that it can possibly be of great help in learning process in other areas as well. The results of our study confirm the fact

that additional mobile learning methods are important for students, and can reduce educational difficulties in remote areas or during emergencies [21].

The opportunity for dentistry students to encounter a traumatic injury during undergraduate education depends on a variety of factors, whereas incidents are managed by specialists or post-graduate students, leaving the dentistry students with very little opportunity to be directly involved in the treatment process, and to acquire sufficient clinical competency prior to graduation [22]. The step-by-step concept used in the mobile application in this research helped students to improve their understanding on management of injuries of both deciduous and permanent teeth. Students found the interactive approach to learning more efficient compared to the less inspiring *PowerPoint* presentations. The positive effects of mobile learning were also reported by Machado et al, who noticed that dentistry students showed greater affinity to a mobile application for managing TDIs compared to printed material [9].

Having knowledge of proper diagnosing and treating a dental injury is also important for medical practitioners, and especially for those who work in rural areas, where dental practice is not well supported. Medical students receive little or no formal dental trauma assessment and management during medical study, and in order to educate this target group, numerous educational models for learning were recommended [23]. Positive results of our study support the fact that the teaching application can be easily adapted to the needs of medical practitioners and applied in everyday practice, making it easier for them to provide first aid. Conventional teaching, despite serious and thorough research, seems uninspiring for students. In order to improve the transfer of knowledge, it is necessary to incorporate new technologies into learning process. It is very important that educators keep up with the times and provide students with the latest methods of learning and working as much as they can, thus bringing them closer to their interests [24].

One of the limitations of this application is that it is Android exclusive, so it is necessary to adapt it to other platforms in order to be available to all users (iOS, Windows Phone).

CONCLUSION

Supplementary mobile learning has improved the knowledge in diagnostics and therapy of dental trauma in undergraduate students in quarantine conditions caused by the COVID-19 pandemic. The development of dedicated applications is extremely important for providing better access to information and facilitating learning process for dentistry students.

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Availability of data and materials

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Written informed consent was obtained from all study participants – electronically Google Forms.

Conflict of interest: None declared.

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Table 1. Satisfaction questionnaire

No.	Question	Section
1.	Mobile phone application helped me master the dental injury teaching unit	a
2.	Mobile phone facilitated my understanding of clinical protocol following dental injuries	a
3.	The advantage of the Mobile phone application is its accessibility at any time using a smartphone and ease of use	a
4.	This type of additional learning can be very helpful in learning in other disciplines as well	a
5.	I have mastered dental injuries through Mobile phone application	b
6.	*PowerPoint* presentations were more beneficial in mastering dental injuries compared to Mobile phone application	c
7.	I have mastered the treatment following injuries to primary teeth by learning through Mobile phone application	b
8.	*PowerPoint* presentations were more beneficial in mastering the treatment following injuries to primary teeth compared to Mobile phone application	c
9.	I have mastered the treatment following injuries to permanent teeth with incomplete root growth by learning through Mobile phone application	b
10.	*PowerPoint* presentations were more beneficial in mastering the treatment following injuries to permanent teeth with incomplete root growth compared to Mobile phone application	c
11.	I have mastered the treatment following injuries to permanent teeth by learning through Mobile phone application	b
12.	*PowerPoint* presentations were more beneficial in mastering the treatment following injuries to permanent teeth compared to Mobile phone application	c

a – student experience and satisfaction with mobile learning environment; b – student satisfaction with learning process using the mobile application Dent.IN JURY; c – student satisfaction with learning process using conventional online teaching tools

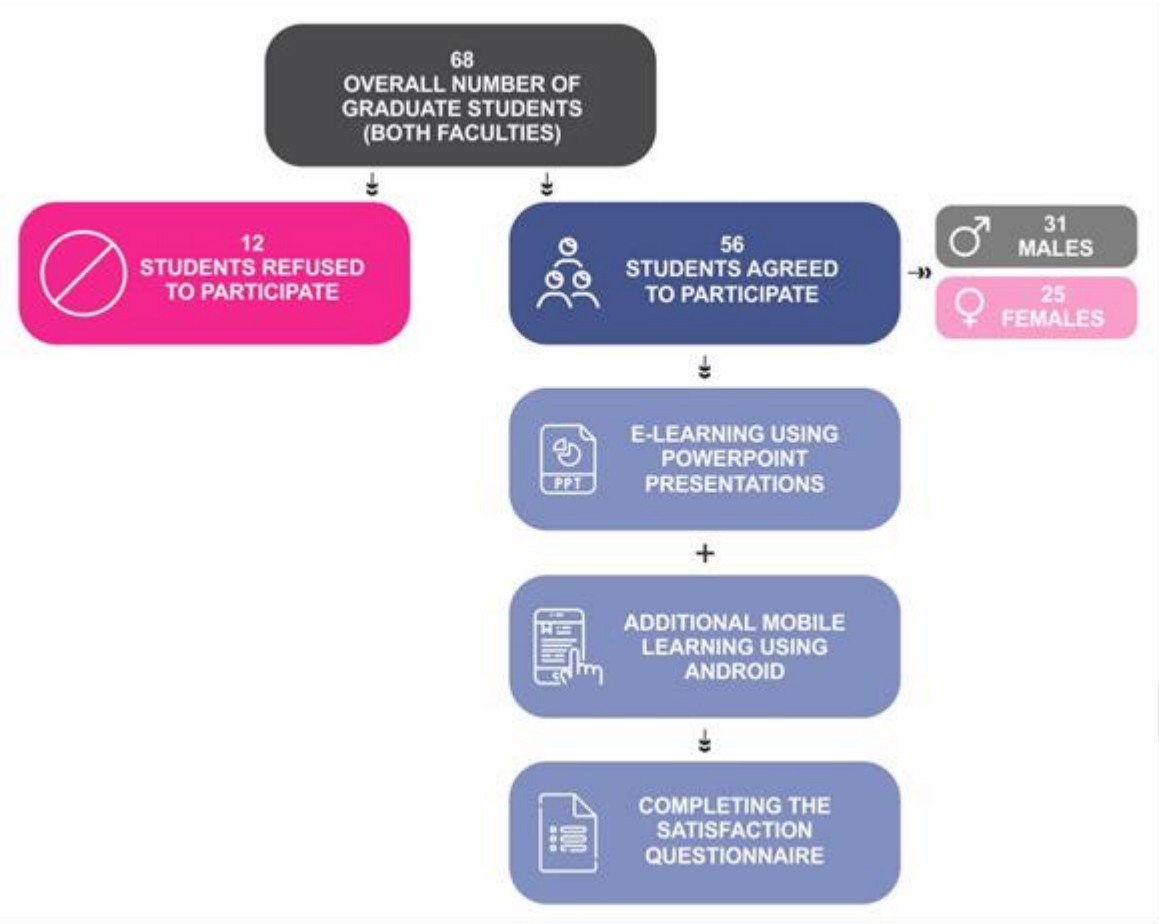

Figure 1. Research protocol

Figure 2. Mobile phone application (Dent.IN JURY) screenshots

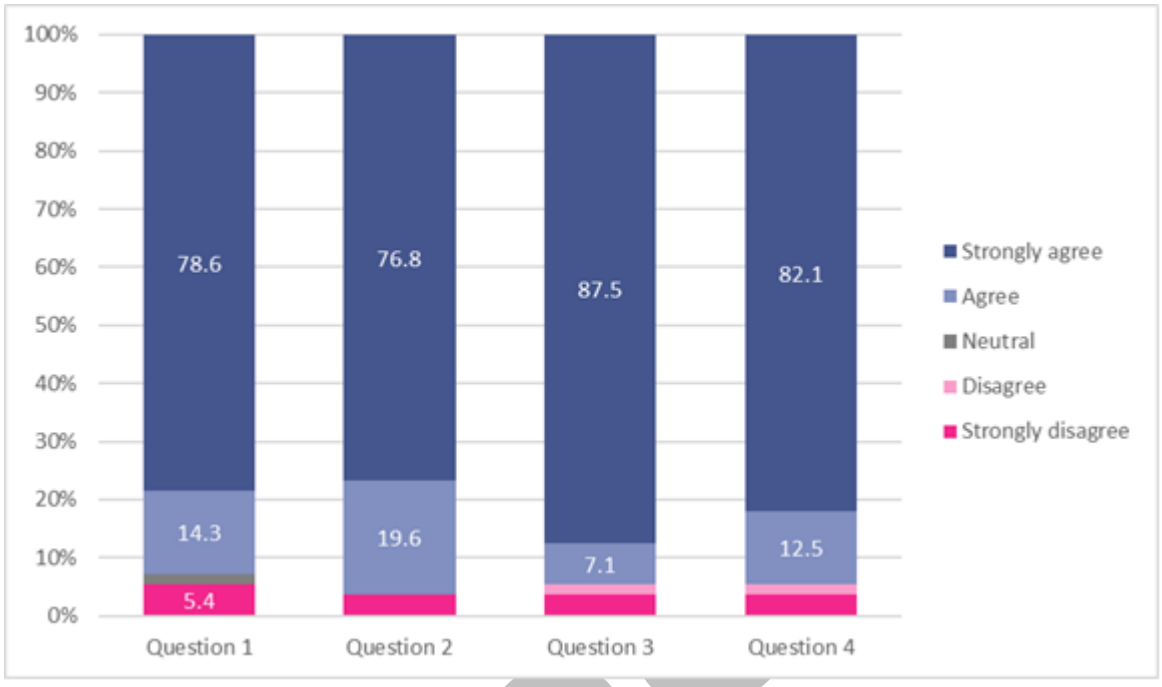

Figure 3. Student experience and satisfaction with mobile learning

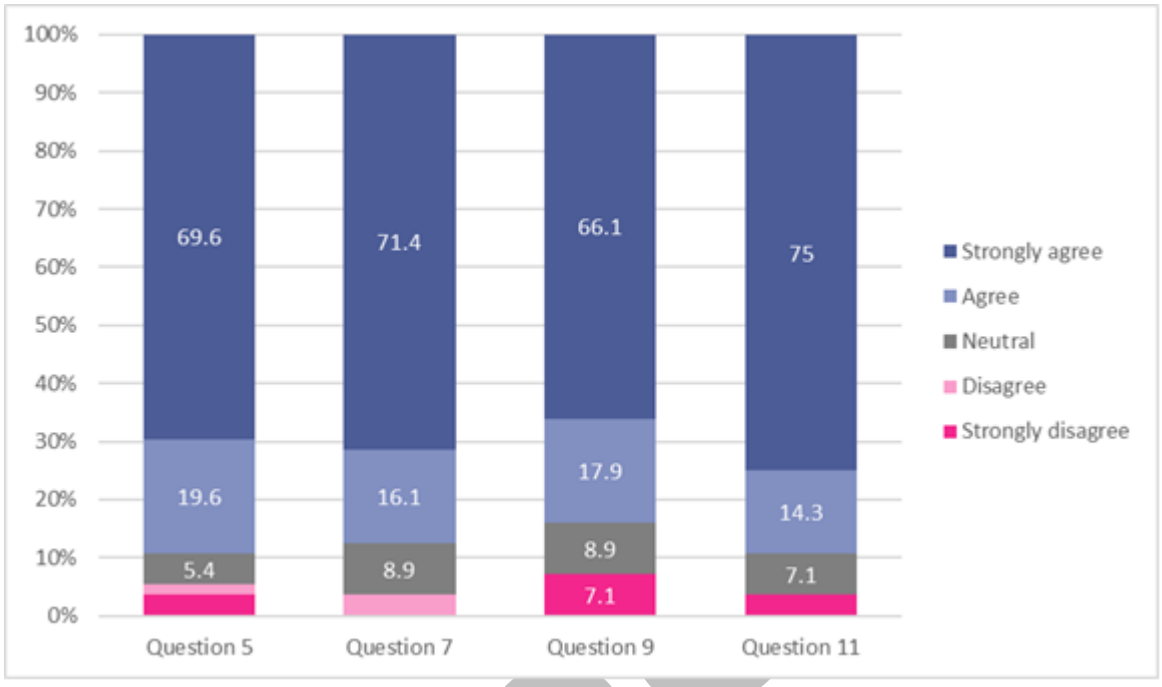

Figure 4. Student satisfaction with learning process using Dent.IN JURY mobile application

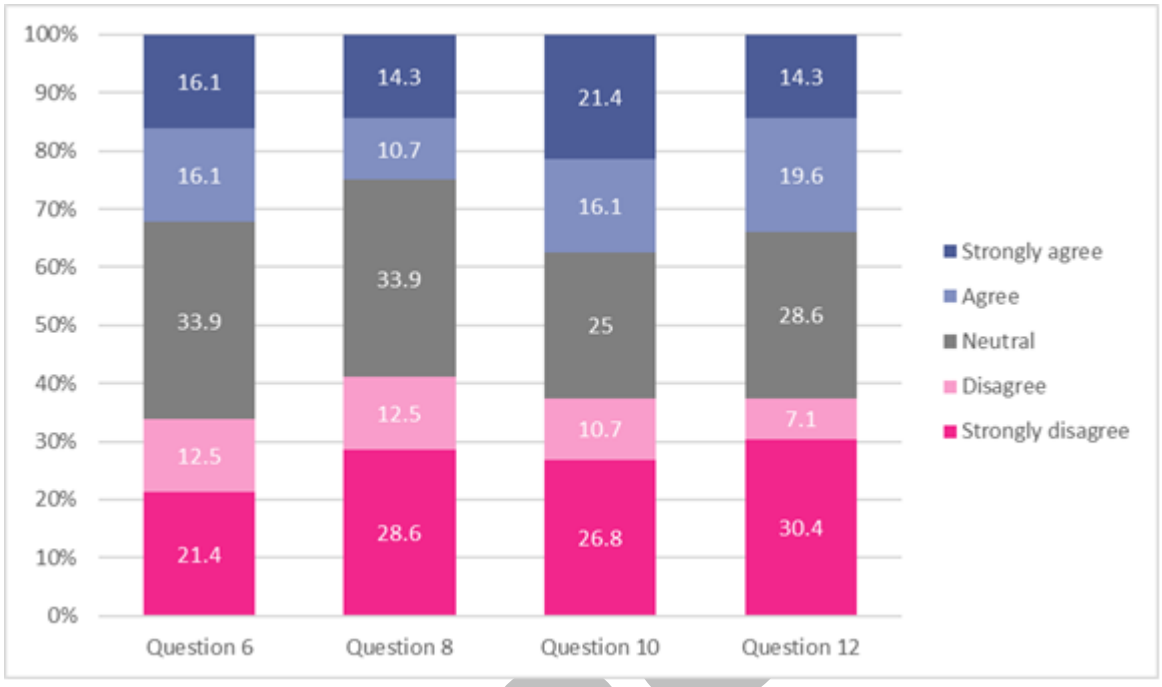

Figure 5. Student satisfaction with learning process using PowerPoint presentations

