ADVANCING THROUGH INNOVATION

ADEA | THE VOICE OF DENTAL EDUCATION | WILEY

Augmented reality as e-learning tool for intraoral examination and dental charting during COVID-19 era

Rasa Mladenovic DDS, PhD[1] ⬤ | **Vladimir Matvijenko DDS, PhD[2]** |
Ljiljana Subaric DDS, PhD[2] | **Kristina Mladenovic MD[3]**

[1] Department of Dentistry, Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia

[2] Department for Dentistry, Faculty of Medicine, University of Pristina, Kosovka Mitrovica, Serbia

[3] Center for Rehabilitation Medicine, University Clinical Center Kragujevac, Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia

Correspondence
Rasa Mladenovic, DDS, PhD, Department of Dentistry, Faculty of Medical Sciences, University of Kragujevac, 34000 Kragujevac, Serbia.
Email: rasa.mladenovic@med.pr.ac.rs

1 | PROBLEM

After declaring the COVID-19 outbreak a global pandemic, traditional learning methods became a critical issue for final year dentistry students. Even after the restrictive measures were relaxed during 2021, the number of patients who are an integral part of clinical training remained limited—the reason being the prevention of transmission by asymptomatic carriers, either students or patients. To bridge the gap between preclinical and clinical training, it is necessary to integrate e-learning technologies into learning processes. One of the more sophisticated learning methods is based on augmented reality (AR) technology, which is being increasingly used in dental training. In AR technology, the existing environment is enhanced by adding virtual elements, rather than replaced with a completely new environment.[1]

2 | SOLUTION

To properly prepare students for clinical practice, we used an AR-based mobile system for virtual dental examination (Immersify Dental, Manchester, UK) (Figure 1). Chartistry mode brings the experience of examining a virtual patient—students use a virtual dental mirror to identify teeth issues and record the data in a digital dental chart (Figure 2). After the Zoom tutorial on how to use the application and 10 days of using the application at home, a learning evaluation was conducted (13 students were included in the pilot study).

FIGURE 1 Using augmented reality (AR) simulator at home

3 | RESULTS

All descriptive data were presented as n (%) or median (Q1–Q3) values calculated by the Wilcoxon test for one sample. A total of 76.9% of respondents agreed partially or completely that the application was easy to use and that they had no difficulties using it; 92.4% considered oral examination realistic, while all respondents (100%) stated that the application helped them learn how to properly fill in the dental chart and that this type of simulation could be very helpful if applied in other dental disciplines (Figure 3). The median of the total numerical score for positive responses was 19 (17–20) and was statistically significantly higher than the median of the total score for the neutral attitude ($p < 0.001$).
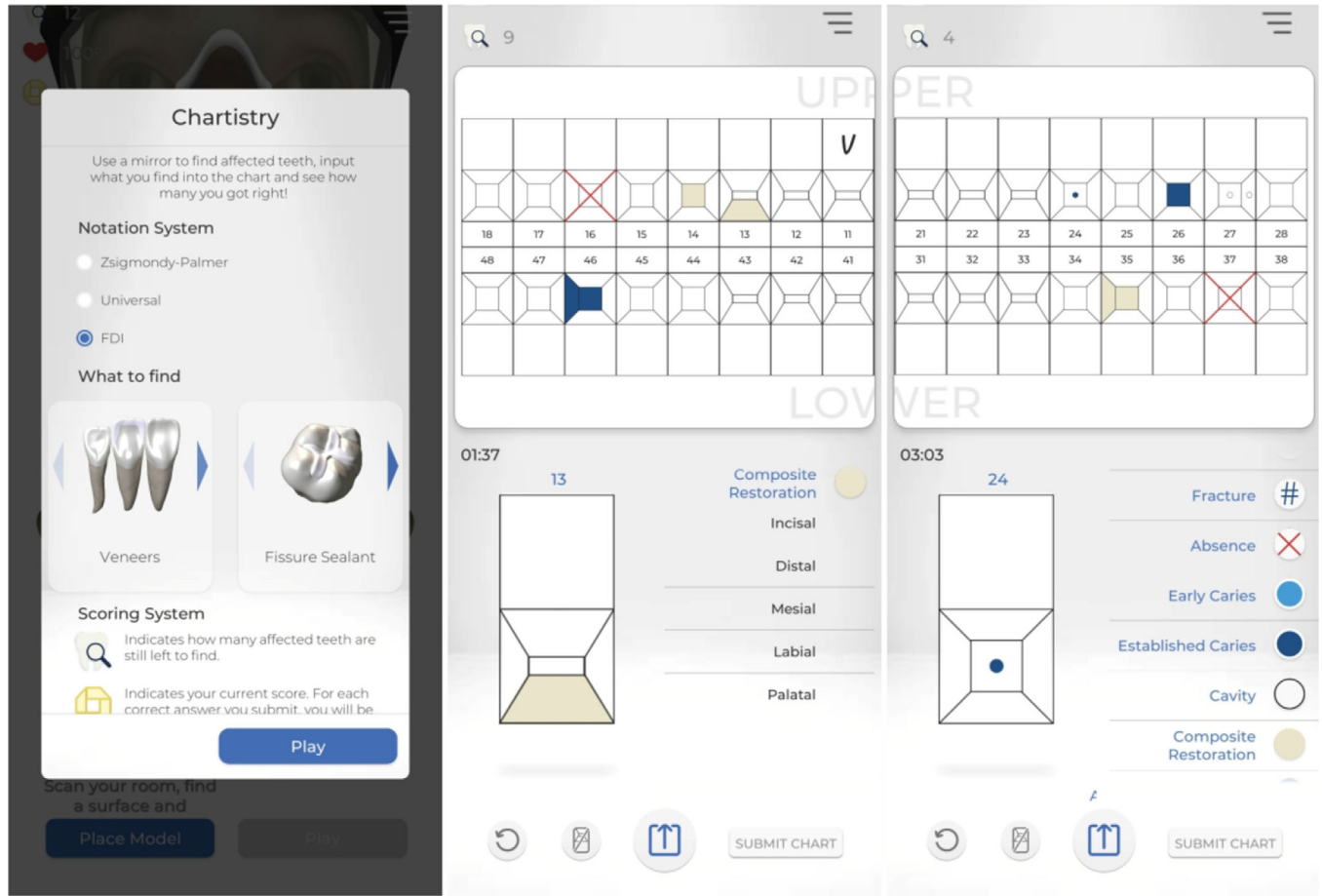
FIGURE 2 Screenshots—Filling in the digital dental chart (Notation systems available—Zsigmondy-Palmer, Universal and FDI)
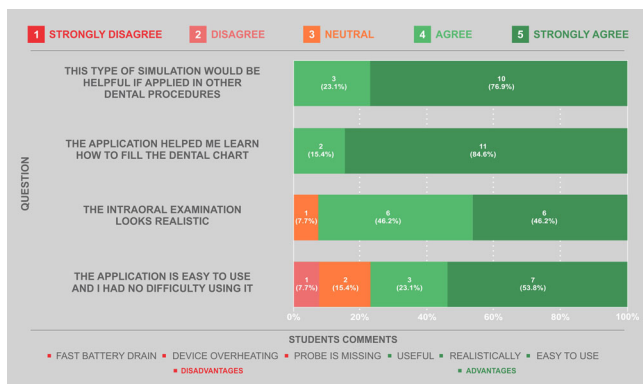

FIGURE 3 Satisfaction survey responses

In addition to our results, Mahrous et al. and Zafar et al. reported on the ease of use of AR in education.[2,3] The main advantage of digital simulations is reflected in the acquisition of the necessary skills, which are achieved through repeated digital exercise. This type of simulation provides standardized feedback, which is important for targeted student guidance and ensuring the quality of training.[4] The

Chartistry mode of the application belongs to the field of serious games in medical education, which are designed to complement education-based content with gameplay, providing users with the capability to apply specific learning outcomes to the real world. In game-based learning, a player engages in the game's activity and loses the sense of effort and repetition, and gains knowledge and satisfaction from solving the game's challenges. Motivation and engagement are fundamental elements to framing learning from gaming experience.[5]

3.1 | Advantages and disadvantages

The biggest advantage of this AR simulation is that it is delivered through a mobile device (iOS or Android). E-learning methods provide continuous learning, and they allow students to explore the content at their own pace and dive deeper into what is most interesting to them. The application may be a helpful training tool mainly for dental charting, but not for proper dental examination per se. To make the oral examination even more realistic, it is

necessary to include a dental probe as a simulation tool (with haptic feedback). Also, it would be extremely important to create a virtual patient with primary and mixed dentition. In this way, students would be able to identify the type of dentition and understand the differences between primary and permanent teeth. Students' comments indicate that running the application caused intensive power usage as well as heating up the mobile device. These problems are of technical nature and are likely to be solved with the development in smartphone industry.

4 | CONCLUSION

The AR technology in dentistry is not only a temporary solution during the pandemic era but also an integrative e-learning tool for further educational concepts. For successful integration of any technological educational tools (including AR technology) there must be a well-defined link to a clear educational objective that support their use, to ensure optimised learning and justify the investment in resources.

CONFLICT OF INTEREST
The authors report no conflict of interest.

ORCID
Rasa Mladenovic DDS, PhD https://orcid.org/0000-0003-0767-8423

REFERENCES
1. Mladenovic R, Mladenovic K, Milanovic P, Selakovic D. Augmented reality technology as a method of distance learning for local anesthesia training. *J Dent Educ.* 2021;86(Suppl. 1):2038-2040. https://doi.org/10.1002/jdd.12581.
2. Mahrous A, Elgreatly A, Qian F, Schneider GB. A comparison of pre-clinical instructional technologies: natural teeth, 3D models, 3D printing, and augmented reality. *J Dent Educ.* 2021;85(11):1795-1801. https://doi.org/10.1002/jdd.12736.
3. Zafar S, Zachar J. Evaluation of HoloHuman augmented reality application as a novel educational tool in dentistry. *Eur J Dent Educ.* 2020;24:259-265. https://doi.org/10.1111/eje.12492.
4. Zhang B, Li S, Gao S, et al. Virtual versus jaw simulation in oral implant education: a randomized controlled trial. *BMC Med Educ.* 2020;20:272. https://doi.org/10.1186/s12909-020-02152-y.
5. Zaror C, Mariño R, Atala-Acevedo C. Current state of serious games in dentistry: a scoping review. *Games Health J.* 2021;10(2):95-108. https://doi.org/10.1089/g4h.2020.0042.