

Educational Article

Designing numerical simulation *via* serious game in oral surgery: an observational study among third years dental students

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Abstract – Background: Serious games (SG) have emerged more than 40 years ago. Several studies have been conducted in the field of healthcare and remain scarce in oral surgery. **Objective:** A formative SG dedicated to oral surgery was designed and implemented within the cursus of dental students enrolled in the University Paris Cité. The objective of the study was to observe the students' use of the SG during their courses and to assess the judgment of students for this innovative e-learning modality. **Materials and methods:** Participants were recruited from the Faculty of Dentistry, University Paris Cité, during the 2021–2022 academic year. Two oral surgery teachers designed the SG. Third year dental school students ($n=200$) tested the oral surgery scenario. Working time required for the SG creation, the use of the SG and the judgement of students were analyzed in an observational study. **Results:** 165 students used the SG and 125 of them filled out the satisfaction questionnaire. Designing SG required more than 100 hours working time. SG was assessed as very useful (>90%) and interesting (81%). **Discussion:** SG appears to be a promising tool for technical skills learning, such as decision-making and procedural sequences (operating room checklist, surgical handwashing, imaging analysis). It also supports non-technical skills (patient history collection, risk management in oral surgery) by promoting active listening and communication with the patient.

Introduction

The COVID-19 pandemic has brought about significant changes in student learning conditions. The reduction in training sessions, such as tutorials, demonstrations and clinical practice has required educational adaptations. In addition to this major contextual element, the increase in the number of students per cohort in some faculties represented an additional challenge. Across educational settings, there has been a rise in e-learning, including conventional formats such as tutorials or lectures and interactive ones including serious game (SG). SG emerged over 40 years ago, defined as games with an educational purpose that is not primarily focused on amusement or attraction. They use gameplay modes such as role-playing games, board games, video games or new technologies to deliver a message in an engaging manner and combine a serious aspect, such as teaching, learning, or communication, with playful means like gaming [1]. According to the French National Authority for Health (HAS, 2012), health simulation corresponds to “the use of equipment (such

as mannequins or procedural simulators), virtual reality, or standardized patients to reproduce care situations or environments, teach diagnostic and therapeutic procedures, and allow healthcare professionals or teams to practice processes, clinical situations, or decision-making.” [2]. In this context, we became interested in serious games and wanted to know if they are a reliable solution to address the rise of e-learning.

Material and method

Creating and implementing SG in oral surgery is a part of the “*Seriodont*” project, which aimed at implementing SG into the educational environment of dental students at the University of Paris Cité (IDEX University Paris Cité Funding). The “*Seriodont*” project was approved by the Research Ethics Committee of the University of Paris Cité (00012021-59). The project also followed the ethical principles of the Helsinki declaration and Good Clinical Practices. In application of the French law of January 6, 1978, relative to information technology, the research has been reported to the national data protection agency (CNIL). The reporting of data followed the CONSORT guidelines.

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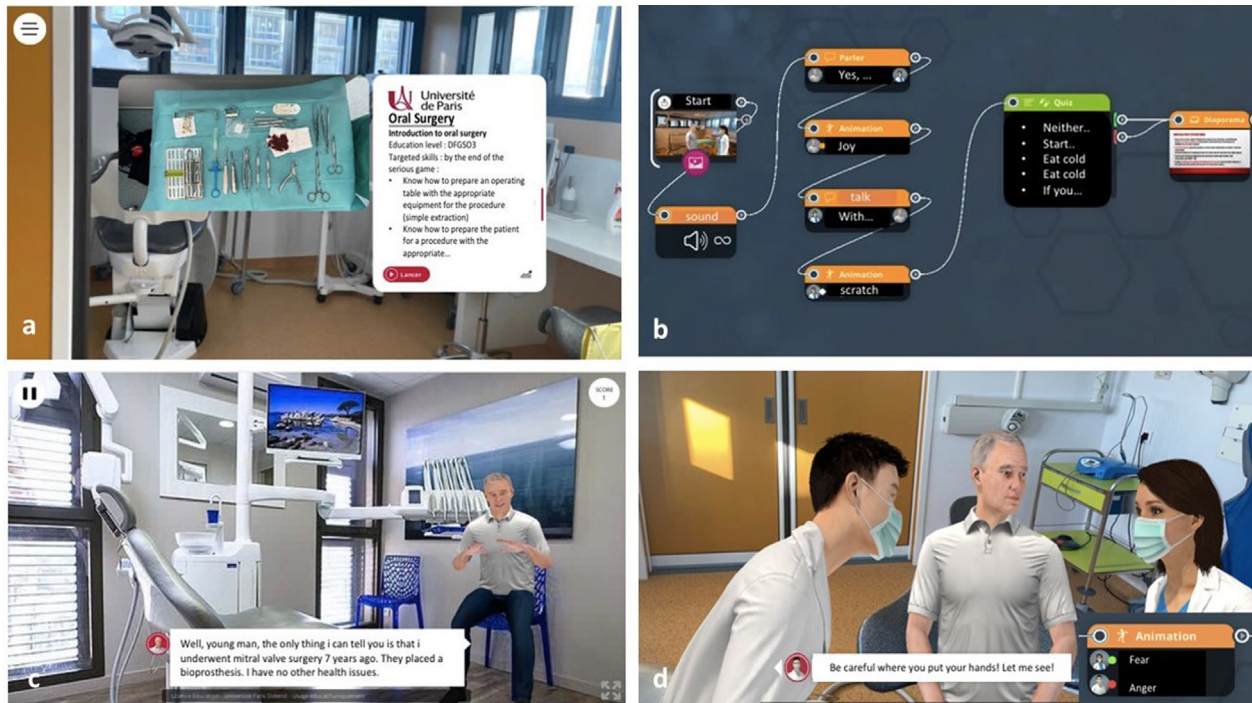


Fig. 1. Screenshots of the serious game. (a) Introduction to the serious game of oral surgery. (b) Scene development. (c) Example of characters and scenes.

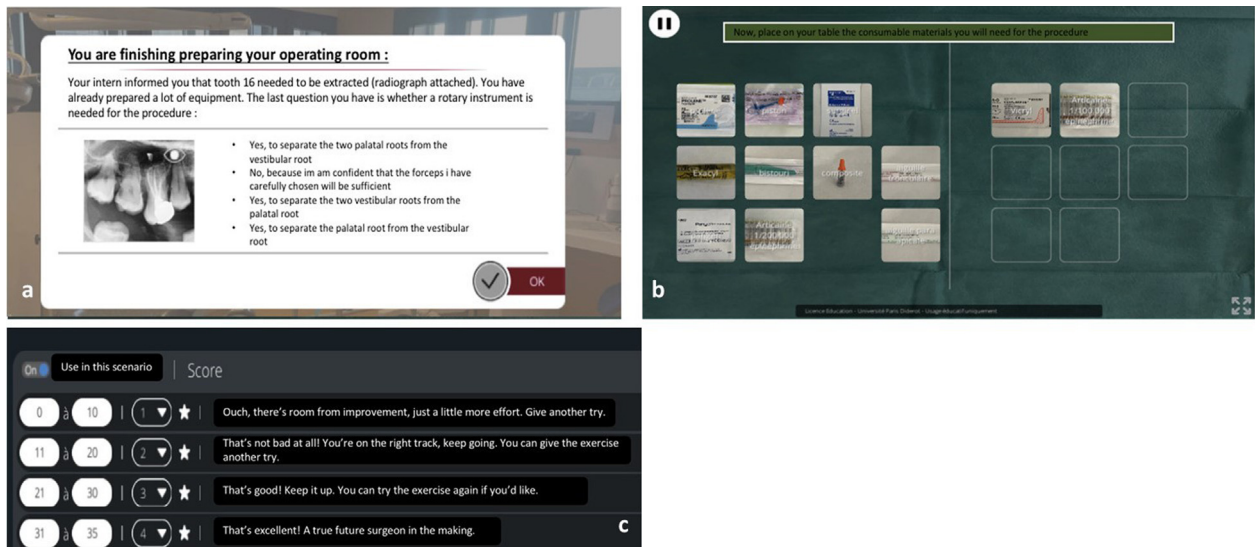


Fig. 2. Screenshots of interactions. (a) quiz; (b) drag and drop activity; (c) motivational message at the end of the game.

Designing simulation scenario

The scenario focused on technical and non-technical skills developed for teeth removal. Defined objectives (intended competencies) were as follows:

- Conducting a preoperative clinical interview with the patient.
- Preparing the patient for an oral surgery.
- Preparing the appropriate equipment for a simple tooth extraction procedure.
- Performing hand washing.

- Recognizing and managing a syncopal episode.
- Recognizing and managing an accidental exposure to biological fluids.
- Recommending postoperative precautions.

The selection of objectives was based on the pedagogical level in oral surgery at the end of the third-year dental curriculum. The pedagogical scenario was based on the most common procedure in the field of oral surgery, *i.e.* tooth extraction. We found that this theme was suited for the creation

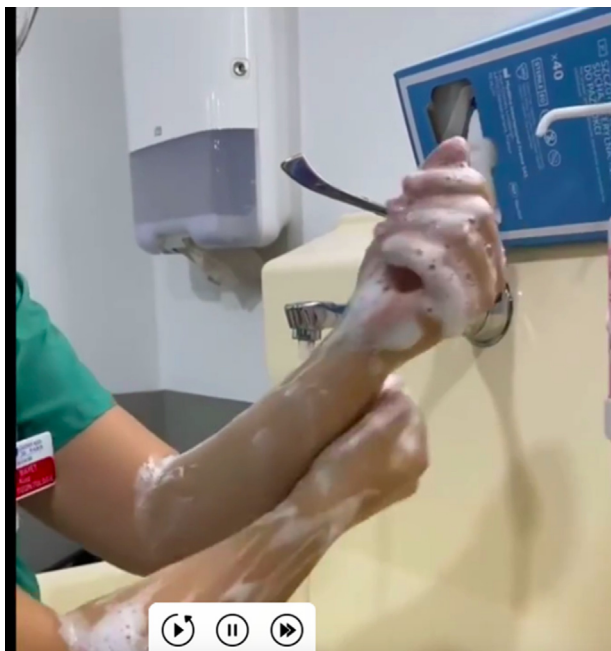


Fig. 3. Video-learning for surgical handwashing.

of an immersive scenario, which was designed based on the concept of a progressive clinical case file and included 11 scenes. SG was created using the software VTS Editor. The chronological appearance of events in each scene can be managed with a few clicks that connect the events to each other through curves (Fig. 1). The game included active (quiz, drag-and-drop exercise (Fig. 2), clickable areas and characters' animation management (Fig. 1) and passive learning formats such as slideshow and "video-learning" features (Fig. 3). Course reminders could be different depending on the response of the students (exact or inexact). Each interaction brings points when exact answer was provided by students (maximum score 35). SG was configured so that a score icon remained apparent in the top right corner (Fig. 1) throughout the course of the game and displays the points obtained in real time, which allowed students to track their progress during the game. The game ended with a motivational message based on the student's score (Fig. 3). Voices of the different characters were recorded by the teachers of the pedagogic team. Background and ambient sounds such as noise of rotating instruments, opening and closing doors, and background conversations with patients were recorded within a dental clinic (Henri Mondor Hospital, AP-HP). The software also provides stereotypical sound backgrounds or characters according to the implemented scenario.

Implementing SG to dental courses

The SG was finally transferred in a SCORM package format to the institutional Moodle platform dedicated to the third-year oral surgery courses. SG were proposed as mandatory to students, during the second semester, following lectures dedicated to tooth removal. They were available during a

4-weeks period, between April 22, 2022 and May 20, 2022. The presentation of SG within the platform was configured as repeatable as many times as desired by the student. In line with the recommendations of the French National Authority for Health (HAS) [3], the objectives of the activity were detailed to the students before beginning to play the game.

Study design

An observational study was conducted in order to assess how students used the SG and their subsequent experience. The recruitment of participants was conducted within the faculty of Dentistry at the University of Paris Cité during the 2021–2022 academic year. Testing the SG and participating to the study were proposed to third-year students ($n=200$). Inclusion criteria were: being enrolled in third-year dental course at the University Paris Cité for the 2021–2022 academic year and consenting to participate to the study. The secondary objective was based on a 14-questions satisfaction questionnaire (Tab. I) that was proposed to students who had completed the SG during the test period. This questionnaire primarily focused on the overall appreciation of the proposed educational module. Some of those questions were used to assess, for example, the time-consuming nature of this task, the technical difficulties, or even to estimate the clinical impact for the students who completed it by asking them if it would have an impact on how they will treat their patients in the future. The feedback, which could be likened to a simplified debriefing, was evaluated through an open-ended question at the end of the questionnaire that asked students what they thought of this approach overall. The scores of zero on the serious game were excluded as they were considered to be due to software usage issues or as a withdrawal by the student.

Data analysis was performed using the Excel software. A descriptive analysis of the data related to the satisfaction and reporting experience questionnaire was carried out (means and standard deviation, distribution and frequency).

Results

Out of the 200 students who received the information, 191 signed the consent form and 165 students completed the SG. Finally, 125 students filled out the questionnaire after testing the SG. The population included 67% women ($n=84$) with a mean age of 20.3 ± 3.4 years; ranging from 19 to 45 years). It was acknowledged that the 125 participating students were representative, in terms of gender distribution, age, and school year repetition rate, of third-year students in a French dental school.

The mean score of the serious game for the 165 students who completed it was 24.5 ± 7.3 (ranging from 3 to 34). This diagram (Fig. 4) was created by excluding grades of 0. Indeed, students who obtained a score of zero out of 35 always made one or two additional attempts afterward. Their additional attempts were taken into account for this diagram. In total, 34 over 165 students made 2 attempts, 13 students made 3 attempts, and only 3 students went up to 4 attempts.

Table I. Satisfaction questionnaire.

	Yes	Rather Yes	Rather No	No
<i>Did the interview with a virtual patient interest you ?</i>	81%	19%	0	0
<i>Was the activity presented in a clear and pedagogical manner ?</i>	66%	29%	5%	0
<i>Do you believe that serious games provide additional knowledge or help develop skills beyond traditional lessons ?</i>	70%	24%	6%	0
<i>In your opinion, are serious games suitable for your training ?</i>	69%	26%	5%	0
	Very satisfied	satisfied	unsatisfied	very unsatisfied
<i>What is your overall appreciation of the teaching ?</i>	43%	54%	3%	0
<i>How would you rate the serious game overall ?</i>	55%	43%	2%	1%
	very usefull	usefull	not very usefull	
<i>How would you describe the impact of teaching through serious games in clinical practice ?</i>	45%	51%	4%	
	Less than 30 minutes	Between 30 minutes and one hour	Between 1 and two hours	More than 2 hours
<i>How many time did you spend on the serious game ?</i>	17%	41%	35%	7%
	This is not going to change the way I approach an oral surgery patient.	I am less comfortable treating a patient in oral surgery	I am more comfortable treating an oral surgery patient	
<i>Do you think serious games have an impact on how you will treat a patient in the clinic?</i>	16%	2%	83%	

Regarding the secondary objective, students declared that the educational module was useful or very useful (>90%), interesting (81%), and presented in a clear and apparently tailored manner to their expectations based on their level of education. Sixteen students (12%) stated that this exercise would not change their approach to their oral surgery patients in any way. However, the majority of students judged that the tool is suitable for acquiring additional skills beyond what is taught in traditional lectures. We asked students about the time spent on the serious game; 41% of students declared that they completed the exercise within a maximum of 1 hour while 18% took less than 30 minutes for the activity. Only 8 out of the 125 students (6%) reported spending more than 2 hours on the exercise. We also assessed the perceived coherence between formal lectures and the serious game. Some students

felt that the scenario included new concepts that were somewhat distant from the theoretical teaching they had received so far. The debriefing phase should be more thorough, but it was logistically difficult to bring together all the students from the different groups to enhance its impact. Nevertheless, the open-ended question at the end of the satisfaction survey seems to be a good representation of this debriefing phase.

Discussion

The development of the SG strictly adhered to the recommendations established by the French National Authority for Health (HAS) [3] regarding simulation in the healthcare

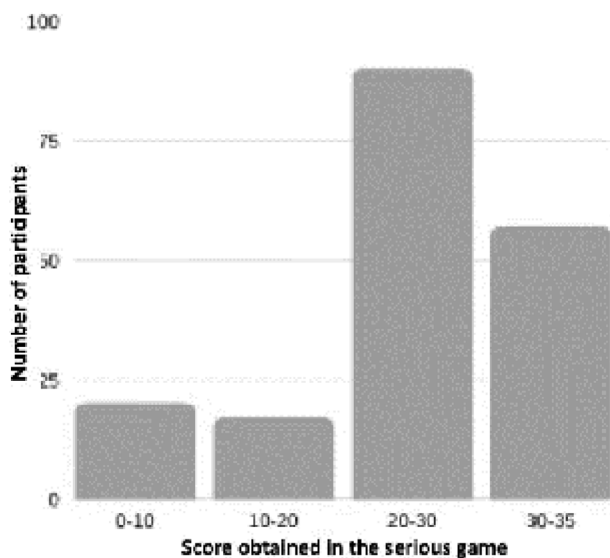


Fig. 4. Distribution of scores.

field. Creating SG seemed very time-consuming and the potential complexity of using medical simulation software be perceived as challenging for teachers. However, SG may be reused by the pedagogical team later in the course. The pedagogical format also allows *ad lib* use by students, whenever they want, and as many times as they want. The majority of students only played one time, but almost one third of students made several attempts, and may obtain higher scores. This may explain why the majority of students received a “good” or an “excellent” rating at the end of their last play. We reasonably considered the attempt with a score of zero as a result of a student’s mistake, regardless of the reason (misunderstanding, lack of time to do the test after starting it, computer issues...). These results do not have a comparative or statistical value, but they likely allow us to assess the difficulty level of our game and the overall level of theoretical and clinical knowledge of the students according to the pedagogical objectives. Additionally, thanks to the motivational message and score tracking during the game, students had the ability to get a self-assessment. Comparing the grades across different attempts is not very meaningful here, given the high proportion of 0 out of 35 for the first attempt and sometimes even for the last attempt. Moreover, when the grades were not initially zero, they varied very little due to the absence of immediate feedback and correction provided at the end of the exercise.

SG also received high levels of satisfaction, which has previously been described [4]. When focusing on a pedagogical model using a serious game for completely edentulous patients at the University of Paris Cité, time spent to play game seemed to be a common limitation mentioned during the debriefing phase with students [4]. This limitation was often raised when the time spent playing SG exceeded one hour.

Present results are consistent with previous studies conducted [5–7] in other medical specialties, indicating that SG may improve clinical skills of students and get high

satisfaction levels. And some of them found the same results when regarding the diagnosis and treatment of oral lesions [8]. They hold significance by entering a field where too few studies have been conducted in oral surgery. However, there are biases, primarily the issue of attrition. Among the consenting students, 75 of them did not complete all the steps and the level of scientific evidence for this type of exercise is low. Statistical power may be gained by increasing the sample size. The level of evidence may also be improved by reducing selection biases, such as by creating a control group. However, the creation of a control group would raise ethical concerns: would there be a loss of opportunity for the group of students receiving only conventional teaching, or vice versa for those receiving simulation-based teaching? But it could be attractive to compare the stress and satisfaction between those two groups. It could also be interesting to assess the satisfaction of the teachers with a similar questionnaire that we made for the students. In further studies, we will also evaluate the influence of the SG on student stress induced by the clinical confrontation with a real patient.

Furthermore, the association with virtual reality (VR), whose effectiveness (in various forms) on clinical and pedagogical impact has already been proven in previous studies [9–11], will be evaluated in our department using the Oculus Go headset that we already have.

Conclusion

Present experience demonstrated that clinical situations can be simulated with a numerical immersive environment that closely resembles the reality of the hospital setting. Additionally, this method of distance learning is appealing for adapting to situations that prevent the teaching staff from delivering in-person classes (such as COVID-19), and it would also effectively address an increase in student numbers and a decrease in their presence in hospital services.

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Conflicts of interest

All authors state that they have no conflict of interest.

Data availability statement

All data analyzed are included in this article.

Ethics approval

This study received ethical approval from the Ethic committee of Université de Paris (CER U-Paris) 2020–2021.

Informed consent

All the students who participated provided informed electronic consent.

References

1. Alvarez J, Djaouti D. Une taxinomie des serious games dédiés au secteur de la santé, *Revue de l'Électricité et de l'Électronique, Société de l'Électricité, de l'Électronique et des Technologies de l'Information et de la Communication (SEE)* 2008;11:91–102.
2. America's Authentic Government Information. H.R. 855 To amend the Public Health Service Act to authorize medical simulation enhancement programs, and for other purposes. 11th Congress GPO; 2009 – translation proposed in the "simulation report HAS" (January 2012).
3. HAS, Guide de bonnes pratiques en matière de simulation en santé (2012)
4. Tuil N, Lescaille G, Jordan L, Berteretche M-V, Braud A. Game-based learning of technical and non-technical skills in oral rehabilitation: a single-blinded, randomized controlled trial, Université de Paris (2021)
5. Gorbanev L, *et al.* A systematic review of serious games in medical education: quality of evidence and pedagogical strategy. *Med Educ Online* 2018;23:1438718.
6. Kapralos B, Fisher S, Clarkson J, Van Oostveen R. A course on serious game design and development using an online problem-based learning approach. *Interactive Technol Smart Educ.* 2015;12:116–136.
7. Gentry SV, Gauthier A, L'Estrade Ehrstrom B, Wortley D, Lilienthal A, Tudor Car L, Dauwels-Okutsu S, Nikolaou CK, Zary N, Campbell J, Car J. Serious gaming and gamification education in health professions: systematic review. *J Med Internet Res* 2019;21:e12994.
8. Buajeeb W, Chokpipatkun J, Achalanan J, Kriwattanawong N, Sipiyaruk K. The development of an online serious game for oral diagnosis and treatment planning: evaluation of knowledge acquisition and retention. *BMC Med Educ* 2023;23:830.
9. Ulbrich M, Van den Bosch FV, Bönsch A, Gruber LJ, Ooms M, Melchior C, Motmaen I, Wilpert C, Rashad A, Kuhlen TW, Hölzle F, Puladi B. Advantages of a training course for surgical planning in virtual reality for oral and maxillofacial surgery: crossover study. *JMIR Serious Games* 2023 11:e40541.
10. Grall P, Ferri J, Nicot R. Surgical Training 2.0: A systematic approach reviewing the literature focusing on oral maxillofacial surgery – Part II. *J Stomatol Oral Maxillofac Surg* 2021;122:423–433.
11. Akaltan KF, Önder C, Vural Ç, Orhan K, Akdoğan N, Atakan C. The effect of game-based learning on basic life support skills training for undergraduate dental students. *J Dent Educ* 2023;87:1458–1468.

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