Dental Materials and Their Selection – Virtual Patient (VP) Software from a Student Perspective

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Virtual-patient (VP) software is an innovative educational tool which provides a safe environment in which students and interns can acquire clinical skills before engaging in real patient cases. Virtual patients allow the study of different scenarios regardless of the teaching staff availability, student location or, more important in dentistry, accessibility to patient, dental materials and different technologies. Considering the high standards of nowadays dentistry and, unfortunately, the limited possibilities in university clinics, the young doctors might find themselves in front of an overwhelming dilemma concerning material selection, appropriate technique and technology. The aim was to assess the qualitative general impact of VPs on dentistry students and the qualitative impact of two virtual clinical cases in particular, focusing on the selection of dental materials and on the suitable technology. 73 students participated in this study. The study comprised 5 stages: answer to an initial questionnaire regarding the students' previous experience with VP software and their expectations related to the VP characteristics; incorporate the results of the initial questionnaire into building the two mentioned virtual cases; use built VPs in student training; answer to a final questionnaire recording the student feed-back to the VPs used; corroborate results from the two questionnaires to establish relevant qualitative features for VPs in dentistry. The results of the study are an important feed-back tool helping in developing and refining VPs with a high degree of acceptance, maximizing the educational efficiency of this learning method. Some of the most desired characteristics were: multimedia content, feed-back for good and bad decisions, low to medium degree of complexity, high coverage of course subjects. The use of VPs offers the chance of working with a broad range of dental materials (in a simulated mode) which is not normally possible in a real practice constrained by financial restrictions.

Keywords: dental materials, virtual patient, e-Learning, medical education

There is quite a while since computer technology made its way into medicine but it is only in the last decade that it went beyond medical imaging and started to support various medical activities that used to be an exclusive responsibility of the human medical professional. A clear sign of this progress is that its concepts are now popular and do not require further explanation. Along with CAD/CAM, terms as clinical simulation, 3D-modelling, virtual patient, e-Learning, simulated patients etc. are nowadays usual concepts that describe areas in which medicine interfaces with the new technologies.

One of the directions in which this collaboration has rapidly expanded is the medical education. This development is due to a series of particularities of this field like: rich terminology, use of large volumes of information in form of static images, video and audio material, complex clinical situations that require the combining information from several sources, use of human subjects in the training process, etc.

Dental material selection is the key process in the patient treatment plan. Considering the high standards of nowadays dentistry and, unfortunately, the limited possibilities in university clinics, the young doctors might find themselves in front of an overwhelming dilemma concerning material selection, appropriate technique and technology.

The traditional medical education is based on a combination of didactic information transfer in the classroom and hands-on learning in a clinical environment (the Socratic Method [1]). Therefore paradigms as Case-Based Learning (CBL) and Problem-Based Learning (PBL) are at the core of clinical training. The real challenge with this approach is to confront the trainee with a comprehensive array of clinical problems and situations that can appear in real-world scenarios. At the same time the environment in which these training activities take place must be attractive and complex enough in order to capture attention and to stimulate the learning process. Connected activities as cooperation on problem solving, documentation and decision making are strongly encouraged. Studies have shown that medical professionals that underwent a PBL training have increased abilities to solve clinical problems [2, 3]. The Computer Assisted Learning as part of the e-Learning domain is a learning method that makes use of specialized computer applications.

David Hadden, TheraSim founder, referring to the necessity and justness of simulation introduction in medical education [4], made a troubling comparison between the percentage of plane crash victims and that of the health care system, when the human factor was decisive. In similar flight situations, the difference between a happy ending and a catastrophe was determined by the type of training that the pilots received. In the first situation, the pilot was trained on simulator, in the other case he received only theoretical training. Among other security measures, the mandatory flight simulator training makes the plane the safest means of transportation, while the health care system continues to make many victims despite its mission. One of the major causes is the inadequate training of medical staff, as the article points out. Therefore, adopting simulation training in medical education seems the logical and necessary way to go.

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In the e-learning medical education, one field of particular interest is that of Virtual Patients. It emerged in the past 10 years as a novel technology supported medical training method and encompasses several approaches:

-simulated patients – patients recreated by other persons (actors) or computer generated characters with various level of details;

-real patients represented by their electronic medical file (e-Patient);

-computer simulated clinical cases – users must perform different activities and solve problems they encounter in the simulated setting.

Virtual patients as computer simulated cases have gained in popularity due to some important characteristics:

-creates a simulated clinical setting and offers an increased level of interactivity compared to the traditional learning method;

-safe to use in all levels of expertise and all simulated problems, because no human patients are involved;

-flexibility in designing the clinical scenarios;

-use of multi-media content in describing the clinical case;

-possibility of reviewing the decision making process;

-use in learning and evaluation activities;

-accessibility from any location and at any time;

-low implementation and operation costs, etc.

At the international level, especially in the US [5-9], but also in Europe – Germany [10-12], Sweden [13], England [14-16], there is a high degree of acceptance among the prestigious universities for virtual patient programs, contributing to their academic excellence.

Virtual-patient (VP) software is an innovative educational tool which provides a safe environment in which students and interns can acquire clinical skills before engaging in real patient cases. Virtual patients allow the study of different scenarios regardless of the teaching staff availability, student location or, more important in dentistry, accessibility to patient, dental materials and different technologies.

The aim of the study was to assess the qualitative general impact of VPs on dentistry students and the qualitative impact of two virtual clinical cases in particular, focusing on the selection of dental materials and the suitable technology.

Experimental part

This research was targeted on a specific aspect of dental training of the 3rd year students at the Grigore T. Popa University of Medicine and Pharmacy in Iasi – improvement of student ability in selecting the appropriate dental materials in particular clinical cases. The material selection process and the restoration type are generally based on the following criteria: lesion type, extension of the lesion, the tooth/edentulism visibility, tooth volume, tooth vitality and social-economic status of the patient.

A group of 73 students participated in all stages of the study. Their participation took place at the end of the 3rd year of study, was anonymous and not constrained in any way.

In the first phase, using the Google Forms web application, two on-line questionnaires were set up: an initial one (Questionnaire A) to record student opinions related to previous use of VP platforms, type of VPs, software application, expected benefits from VP training. The opinions were collected prior to completing the VP session.

During the second phase, two virtual patients with dental lesions and edentulism were designed as simulated algorithms for diagnose, therapeutic solutions, including the dental material selection. In authoring these patients the results from Questionnaire A were taken into account for maximum student acceptance.

For authoring and playing the VPs, OpenLabyrinth was selected as the platform of choice [17]. This was motivated by a series of characteristics:

-use of the Linux operating system which offers a more secure computer platform;

-Open Source license which allows installation of software without any additional cost;

-a powerful set for editing and playing virtual patients;

-cross-platform compatibility;

-compatibility with MedBiquitous standards which allows VP exchange with other systems.

The web application was installed as part of the university eLearning platform and was made available to the participating students via a shared user account.

After the completion of the two VP cases, the students were asked to fill in Questionnaire B which collected opinions regarding the impact of VP training on the acquired clinical abilities in dental material selection. Some of the

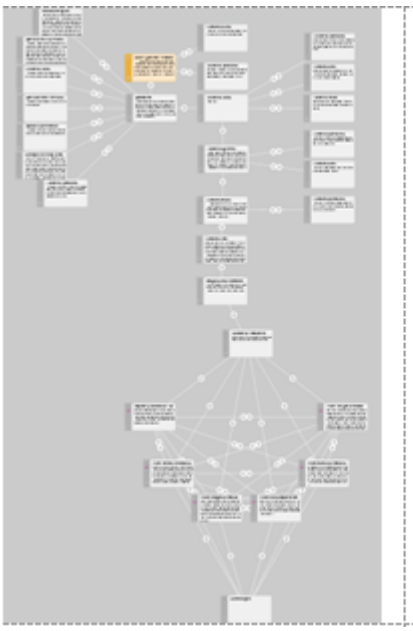

Fig. 1. OpenLabyrinth graph structure of the VP

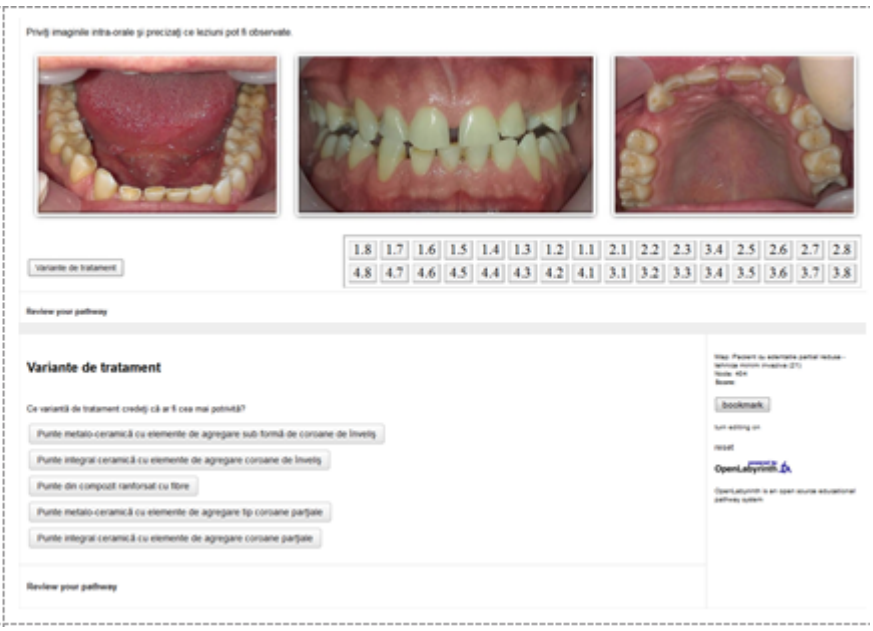

Fig. 2. Virtual patient player

most representative issues approached in this questionnaire were:

-how realistic is the simulation of a clinical case by comparison with a real-life situation;

-does the virtual patient engage the trainee in all clinical phases (e.g. history taking, physical examination, intra-oral examination, paraclinical investigations, diagnosis and treatment planning);

-has the trainee reconsidered his/her opinion related to the diagnosis and the adequate treatment plan as a result of feedback received from the simulation;

-has the ability of clinical reasoning improved as a consequence of training with VPs;

-what were the main reasons that contributed to the improvement of the clinical reasoning;

-is the VP training considered as a useful as an enhancement of traditional learning methods.

In the final phase of the study, the results of the two questionnaires were evaluated in order to establish if the student expectations were met by the VP simulations and what characteristics should these systems incorporate in order to reach a high level of acceptance among students.

Results and discussions

The acceptance of VP systems by the trainees in educational activities is an important factor contributing to a series of positive effects: increased communication abilities between the medical professional and the patient, increased capacity to deal with a wide spectrum of clinical scenarios, retention of the acquired abilities for a longer period etc.

The Questionnaire A results point out some important aspects. From the entire group of students, 21.7% did not use any virtual patients in their training or did not have any knowledge about VPs at the time of our study (fig. 3).

The overwhelming majority of the students considers that VPs are useful in the educational process (fig. 4). The z-test for proportions reveals a z-score of 7.60 which is considerably higher than the reference value $z_{0.05}$ = 1.96. This shows the strong relevance of the VP contribution in the educational process. The most important benefit as perceived by the students is that VPs are an enhancement of the classical learning methods (fig. 5).

Questionnaire B offers feedback after completing two VP training sessions. Some of the results show that 44 students out of 73 consider the simulations having a high degree of credibility which reflects a good level of immersion and realism (fig. 6). The z-test for proportions reveals a z-score of 7.67 which is much higher than the reference value $z_{0.05}$ = 1.96, proving a high and moderate credibility of clinical cases simulations.

When questioned about the reasons that contribute to the improvement of clinical reasoning (fig. 7), most students mentioned the variety of clinical scenarios which is ranked even before the multimedia content. This shows that the coverage of various subjects and possible situations that can appear in real-life medical activities is an important factor in the expected effect of VP training.

Concerning the dental material selection ability, 64% of the students considered that the use of VPs is highly

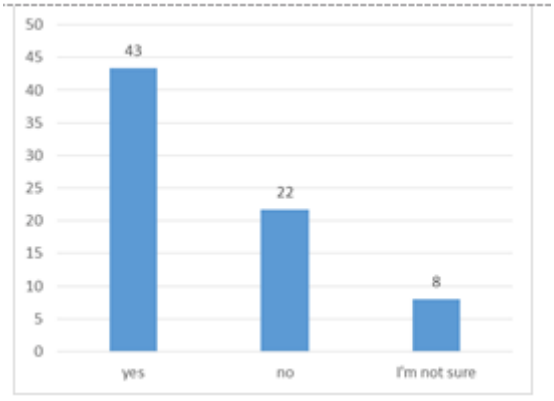

Fig. 3. Previous experience with virtual patients

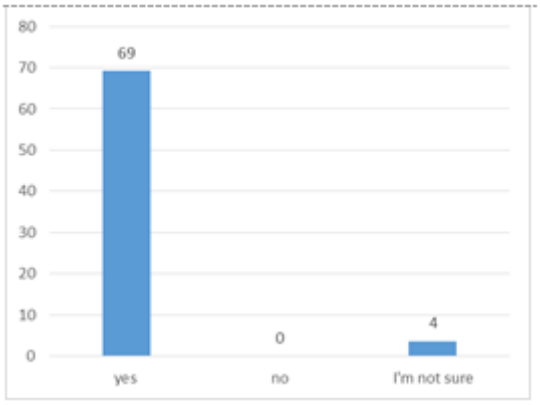

Fig. 4. Are VPs regarded as useful in the educational process?

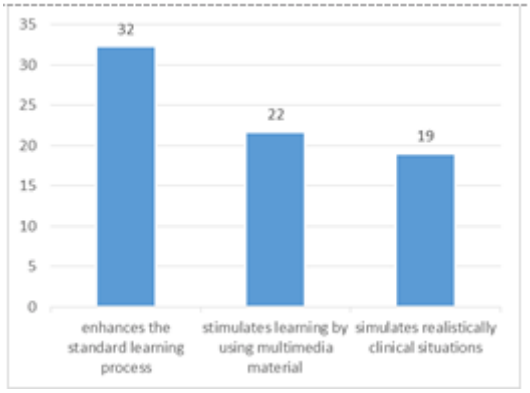

Fig. 5. Benefits of using VPs in training

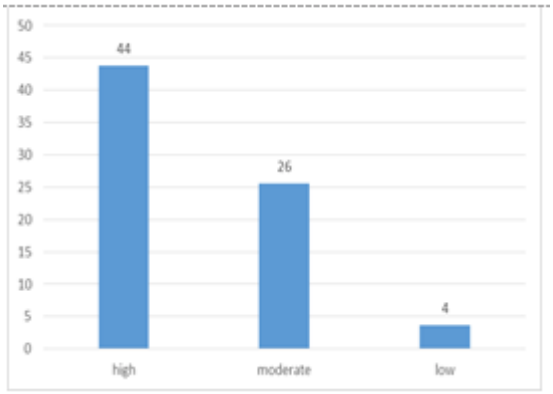

Fig. 6. Credibility of the clinical cases simulation

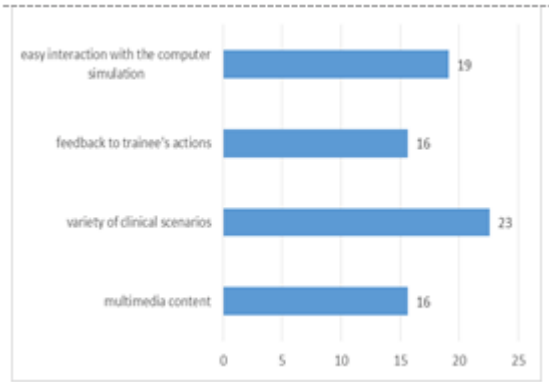

Fig. 7. Improvement of clinical reasoning due to the variety of clinical scenarious

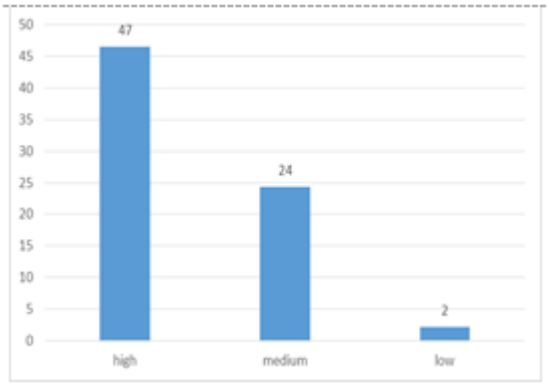

Fig. 8. Relevance of material selection training with VPs from a student perspective

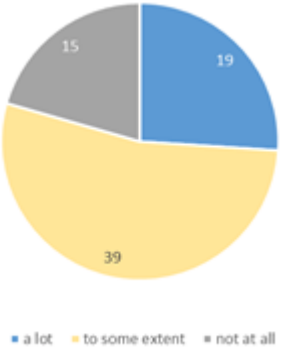

Fig. 9. Opinion about improvement of clinical reasoning regarding dental material selection before VP training

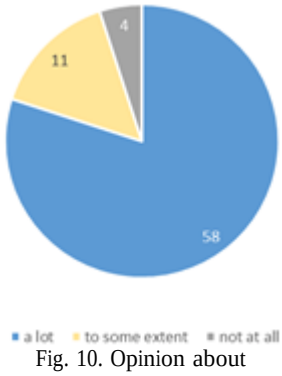

Fig. 10. Opinion about improvement of clinical reasoning regarding dental material selection after VP training

beneficial, while 33% evaluated them as moderately beneficial for this field (fig. 8). The z-score is 2.47 which compared with the reference value ($z_{0.05}$ = 1.96) demonstrates a high relevance of material selection training with VPs from the student perspective.

Figure 9 and 10 show the student perception about improvement of clinical reasoning in dental material selection, before and after completing the VP training. This indicates a very positive response of the trainees as a result of this type of training. Percentages of students considering VPs having a high impact on clinical reasoning improvement have risen from 26% (19 students) to 80% (58 students). The z-test for comparing the two proportions, outputs z-value = 6.5 and p-value < 0.0001 which demonstrates the statistically significant increase in trainee confidence after the VP-sessions. This is a very encouraging result and confirms the general impression that from the point of view of student acceptance, virtual patient systems are an important tool in teaching clinical skills in general and for dental material selection in particular.

Critical opinions expressed towards the usage of VPs in the training process mention: insufficient variety of clinical scenarios to cover all subjects, the interaction with the VP has still a lot of limitations compared to the real-life situations, VPs concentrate mostly on only one pathology whereas in reality several conditions might occur at the same time.

Recent studies [18] have shown that VPs as computer simulated clinical scenarios are effective in teaching clinical reasoning, clinical data gathering and interpretation and to some extent in acquiring communication skills and ethical reasoning. The degree of acceptance among the students is very high [19], especially with the students in the first years where the detailed information offered by a VP is not otherwise available.

Studies regarding the use of virtual patients in dental medicine [20] reveal that this is a relatively new approach in dental training. Common use of virtual patients targets the improvement of student skills in taking relevant oral health history. Most simulations concentrate on improving the psychomotor abilities of the trainees related to teeth drilling or attempt to create a virtual patient through 3D reconstruction from photographs, CT scans, X-Ray images, etc. [21-22].

When looking at the advances in nowadays dental medicine on one hand and at the limited possibilities in some university clinics [23], on the other hand, young doctors might find themselves in a difficult situation as to which dental material should be selected, which technique or technology should be employed. This is where virtual patient platforms can fill the gaps. They can simulate various scenarios with a certain degree of realism, which prepares the future dentist for situations that he/she might encounter.

Conclusions

The simulation of clinical scenarios through virtual patients has a high degree of acceptance among students in dental medicine and in particular in the field of dental material selection. The results indicate that VP training can be an efficient tool for improving knowledge assimilation and clinical abilities that can be later used in real clinical situations. Especially in educational environments where access to various dental materials is constrained by financial restrictions or when the limited number of patients does not provide a sufficient number of cases for training purposes, the use of VP platforms can complete or, where necessary, replace the traditional methods.

It has been determined by this study that a lot of room for improvement exists, mainly in two directions: increasing the level of realism that VPs can deliver and increasing the number of simulated scenarios for a better coverage of possible situations that can be encountered in real-life. The former can be achieved by using advanced technologies in 3D visualization, virtual reality and animation which are currently used in the gaming industry. The latter requires a more consistent effort from VP authors which must receive the support of their organizations to achieve a better coverage of the topics.

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