Use of Virtual Patients in Dental Education: A Survey of U.S. and Canadian Dental Schools


Abstract: The use of virtual patients in dental education is gaining acceptance as an adjunctive method to live patient interactions for training dental students. The objective of this study was to determine the extent to which virtual patients are being utilized in dental education by conducting a survey that was sent to sixty-seven dental schools in the United States and Canada. A total of thirty dental schools responded to the web-based survey. Sixty-three percent of the responding dental schools use virtual patients for preclinical or clinical exercises. Of this group, 31.3 percent have used virtual patients in their curricula for more than ten years, and approximately one-third of those who do use virtual patients expose their students to more than ten virtual patient experiences over the entirety of their programs. Of the schools that responded, 90.5 percent rated the use of virtual patients in dental education as important or very important. An additional question addressed the utilization of interactive elements for the virtual patient. Use of virtual patients can provide an excellent method for learning and honing patient interviewing skills, medical history taking, recordkeeping, and patient treatment planning. Through the use of virtual patient interactive audio/video elements, the student can experience interaction with his or her virtual patients during a more realistic simulation encounter.

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Simulation as a pedagogy in dental schools has undergone a significant revolution over the past thirty years. Although the use of virtual patients (VPs) is a relatively new strategy in dental education, the use of a simulated patient record in combination with laboratory exercises in diagnosis and treatment planning was utilized as early as 1990.1 Preclinical benchtop exercises are being replaced with simulation “operatories,” and computer-aided and/or virtual reality-based simulations are becoming more popular.2,3 Coupling VPs with simulation can provide the student learner with experiences that more closely resemble encounters with a live patient. A VP can be as simple as a list of demographics and health data on paper or as complex as a computer-generated avatar with whom a student interacts in a program like Second Life.4 VPs can also provide a self-paced method with immediate feedback for students to progress, such as in medical/dental history-taking or development of clinical skills.5

Learning skills in interviewing, patient communication, and clinical procedures using simulated patients offer dental students the opportunity to develop overall decision making skills that will ultimately increase confidence and consistency. One study investigating the use of VPs in dental education (specifically targeting patients with special needs) found the use of VPs did increase the comfort level of the student when working with this population.6 Additionally, dental students demonstrated improved skills, especially in the area of communication, and the use of VPs in the learning process helped graduates become more effective and efficient when caring for patients with special needs.6

Technology in support of VPs is trending toward development of simulation experiences that allow students to learn and practice in an environment as close to live patient encounters as possible. One study found that utilizing interactive VPs improved the capability of dental students to take a relevant oral health history.7 That report further speculated that the use of VPs in dental education may increase the cost-to-benefit ratio, i.e., the quality of the learning may improve at a much lower cost. Technology also
makes it possible to create a stronger link between VP simulations and the reality of the clinical experience. By establishing a connection between the learner and the VP, it may be possible to enhance the sense of realism and to introduce the idea that actions have consequences. For example, faculty members could post and direct VP social media accounts that would allow students to follow the virtual patient’s life. The aim would be to have the student so immersed in the simulated experience that he or she may not realize that this is not a real encounter. Establishing personalities and back stories for the VPs may make it possible for the student to suspend disbelief. Utilization of this type of social media combined with decision tree technology could provide a more robust simulation experience, which in turn should enhance problem-solving, critical thinking, and reflective learning.

Creating VPs with this type of extensive scripted background could also allow for an easier introduction of other behavioral and ethical scenarios into the scripts for virtual patients. The impact on students’ learning of social issues related to patient behavior, patient management, and communication and ethics would be enhanced. Recently, Japanese engineers appear to have combined the best of simulation, using computer-generated VP technology, and the latest robotics technology to create the first dental-training robot. The patient robot answers questions, responds to commands, and even simulates gagging and coughing. This could be the future of the VP experience.

Medical education is also beginning to embrace the use of VPs for student training. A driving force has been the decision to include VPs as part of the United States Medical Licensing Exam. VP simulations in medical education can be either static or dynamic. Static VP interactions allow medical students to ask relevant questions in response to a patient’s medical condition. However, the simulated patient’s condition does not change and does not afford the student as much of an opportunity to develop critical thinking skills. Dynamic interactions present the student with a VP whose conditions progress over time and press the student to make decisions “on the fly.” How do medical schools define VPs? A VP can be defined as a computer-based simulated patient who can be distinguished from a standardized patient, an actor trained to interact with the trainee. VPs are commonly used to teach medical history taking, patient interviewing skills, ethics, and clinical decision making.

VPs provide many advantages in medical education, including efficiency, efficacy, standardization of experiences, interactivity, exposure to rare but critical cases, immediate feedback, and, most importantly, improvement of clinical skills in a non-threatening environment. Disadvantages are cost, difficulty in integrating VPs into curricula, difficulty in editing, technology limitations, and the level of resources required. A survey similar to the one used in our study was sent to 142 U.S. and Canadian medical schools in 2005. Of the 108 schools that responded, twenty-six (24 percent) had developed VP case scenarios. This investigation suggested that the expansion of VPs for medical student training may be problematic until broader access and cooperative development of VP resources exist among medical schools.

For dental student training, the development of critical thinking skills related to treatment planning has perennially been a difficult concept to teach. Dynamic interactions developed for VPs in dentistry, as in medical education, should allow the student to develop the skills necessary to successfully navigate through medical and dental history taking, patient interviewing, medical management, ethical dilemmas, and, ultimately, treatment planning. The objective of our study was to determine the extent to which VPs are being utilized in dental education by conducting a survey of dental schools in the United States and Canada.

### Methods

This study was approved by the Institutional Review Board of the University of Texas School of Dentistry at Houston (HSC-DB-11-0220). The instrument was developed using the online software SurveyMonkey to survey U.S. and Canadian dental schools concerning the use of VPs in dental education. (For a copy of the survey, contact the corresponding author.) The seventeen-question survey included both multiple-choice and open-ended questions. In May 2011, an e-mail was sent to all U.S. and Canadian dental schools via a listserv for academic deans, inviting the recipients to respond to the survey or refer the e-mail to the appropriate person at their institution. Access to the listserv was facilitated through the American Dental Education Association.

The survey was designed to capture data concerning VP usage, but also included questions
to discover the extent to which schools are utilizing interactive components in the development of VP scenarios. An introductory paragraph explained the purpose and nature of the survey and its anonymous nature and provided a way for respondents to receive results if desired. The first four questions asked respondents for their interpretation of a definition of VPs, preclinical and clinical use of VPs, how long VPs have been used at their school, and parameters or descriptors used with VPs. Questions 5 through 7 asked about numbers of VPs used, where they were used in the curriculum, and whether or not an interactive component was utilized. Questions 8 through 10 allowed for free text responses to describe the interactive components used, associated tools or software utilized, and the time committed to developing and maintaining interactive components. Questions 11, 15, 16, and 17 asked about the current use and/or future use of VPs, perception of student experiences with VPs, advantages to the use of VPs, and a rating of the importance of VP use. Questions 12, 13, and 14 asked respondents to describe how the VP experience is assessed and graded, as well as a success and horror story/disaster when using VPs.

The deadline for completion of the survey was set for approximately three weeks following the date of the first e-mail announcement to schools. A second e-mail reminder was sent out approximately two weeks after the first e-mailing. Data were collected from SurveyMonkey and imported into an Excel spreadsheet. Descriptive statistics, such as percentages, means, and standard deviations, were used to analyze the findings.

Results

The survey was divided into two distinct categories: data relevance and data collection. Table 1 summarizes the findings from the data-relevant questions, and Table 2 shows the data-collection questions (including open-ended responses). Of the sixty-seven U.S. and Canadian dental schools contacted, a total of thirty (45 percent) responded to the survey.

Overwhelmingly, 86.2 percent of the respondents felt that VPs could be defined as a combination of physical and digital elements simulating a real patient (Table 2). When asked if VPs are being used or have ever been used for preclinical or clinical exercises, nineteen (63.3 percent) answered yes. Since total respondents to the majority of the questions ranged from fifteen to seventeen, approximately 12 percent chose not to answer other questions in the survey; alternatively, the 12 percent may have been schools that used VPs in the past but do so no longer. The average time of usage of VPs in respondents’ curricula was one to four years (37.5 percent), and 31.3 percent indicated that they have used VPs for more than ten years. The use of digital radiographs with VPs was noted by all respondents (100 percent) as important, followed by medical/dental history and medications (Table 3). The results for the numbers of VP encounters, where they were used in curricula, consideration for use, student impressions, advantages, and a rating of the importance of VPs are summarized in Table 1. Almost two-thirds (62.5 percent) of the respondents said they utilized between one and six VPs during preclinical and/or clinical training curriculum, with the majority (68.8 percent) confining the use of VPs to the preclinical years.

Another key question of interest was the use of interactive elements in VP design. Of the seventeen respondents to this question, twelve (70.6 percent) indicated that they did not use interactive elements. However, 46.7 percent of the respondents to this question reported that they are considering the use of interactive VPs at their institutions (Table 1). Respondents were asked to explain how the interactive component of their VP experience works (Table 2). Two responses were “interaction with virtual patients occurs in the context of small groups and triple jump examinations” and “faculty control vital signs at med school during emergency type medical scenarios.” When asked which tools or software are used to simulate interactivity (Table 2), responses varied from dental practice management/electronic health record (Exan) and blended learning systems (Echo360) to simulation mannequins and simulated digital records, all of which could be used in conjunction with typodons/mannequin heads. Those using interactive elements were also asked about the amount of time committed to developing and maintaining the interactive aspects of VPs (Table 2). Two responded that “multiple people are involved in this component, meeting weekly for two to three hours” and “it depends on the module, but preparation time could be two to three days.” These three questions were a follow-up to those institutions that indicated they incorporate an interactive component to the VP experience.

Student evaluation is another critical component of the use of VPs. As with any student assessment, specific expectations and evaluation criteria must be defined for students. Respondents
Respondents were asked to describe both a success and a horror story/disaster associated with the use of VPs (Table 2). One respondent reported that treatment planning outcomes were improved but did not state how this was measured. Another suggested that the use of VPs provided a smoother transition into clinical care, but offered no explanation as to how this was determined. One respondent did suggest that students were required to successfully complete VP competencies prior to being eligible to treat patients clinically. No horror stories/disasters were otherwise reported.

Finally, advantages cited by respondents for the use of VPs (Table 1) included the following:

<table>
<thead>
<tr>
<th>Question (as numbered in survey)</th>
<th>Number</th>
<th>Total Respondents</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many virtual patients does a typical student encounter during his or her education?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–3</td>
<td>8</td>
<td>16</td>
<td>50.0%</td>
</tr>
<tr>
<td>4–6</td>
<td>2</td>
<td>16</td>
<td>12.5%</td>
</tr>
<tr>
<td>7–10</td>
<td>1</td>
<td>16</td>
<td>6.3%</td>
</tr>
<tr>
<td>More than 10</td>
<td>5</td>
<td>16</td>
<td>31.3%</td>
</tr>
<tr>
<td>Where are virtual patients used in your curriculum?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted to preclinical only</td>
<td>11</td>
<td>16</td>
<td>68.8%</td>
</tr>
<tr>
<td>Restricted to clinical only</td>
<td>0</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>Integrated in preclinical and clinical</td>
<td>5</td>
<td>16</td>
<td>31.3%</td>
</tr>
<tr>
<td>Have you considered the use of virtual patients in your institution?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>1</td>
<td>15</td>
<td>6.7%</td>
</tr>
<tr>
<td>Have considered</td>
<td>2</td>
<td>15</td>
<td>13.3%</td>
</tr>
<tr>
<td>Are currently considering</td>
<td>7</td>
<td>15</td>
<td>46.7%</td>
</tr>
<tr>
<td>Might consider in the future</td>
<td>5</td>
<td>15</td>
<td>33.3%</td>
</tr>
<tr>
<td>Unlikely to ever use</td>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>What do you think your students think about their interactions with virtual patients?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Really enjoy it</td>
<td>1</td>
<td>7</td>
<td>14.3%</td>
</tr>
<tr>
<td>Seem to like it</td>
<td>5</td>
<td>7</td>
<td>71.4%</td>
</tr>
<tr>
<td>Indifferent</td>
<td>1</td>
<td>7</td>
<td>14.3%</td>
</tr>
<tr>
<td>Not very keen</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Hate it</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>What advantages do you see in using virtual patients in dental education? (check all that apply)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allows student to become familiar with all aspects of the patient record</td>
<td>16</td>
<td>22</td>
<td>72.2%</td>
</tr>
<tr>
<td>Allows student to experience patient treatment scenarios without using live patients</td>
<td>18</td>
<td>22</td>
<td>81.8%</td>
</tr>
<tr>
<td>Allows faculty to test the critical thinking skills of students in controlled setting</td>
<td>18</td>
<td>22</td>
<td>81.8%</td>
</tr>
<tr>
<td>Allows student to learn patient record management prior to patient treatment</td>
<td>16</td>
<td>22</td>
<td>72.7%</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>5</td>
<td>22</td>
<td>22.7%</td>
</tr>
<tr>
<td>How would you rate importance of virtual patients?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very important</td>
<td>10</td>
<td>21</td>
<td>47.6%</td>
</tr>
<tr>
<td>Important</td>
<td>9</td>
<td>21</td>
<td>42.9%</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>21</td>
<td>4.8%</td>
</tr>
<tr>
<td>Less important</td>
<td>1</td>
<td>21</td>
<td>4.8%</td>
</tr>
<tr>
<td>Not important at all</td>
<td>0</td>
<td>21</td>
<td>0</td>
</tr>
</tbody>
</table>
increased reinforcement of basic science information on treatment considerations of patient diseases and conditions; improved connection between preclinical techniques and clinic scenarios; uniform exposure of students to clinical and behavioral situations that would be impossible to achieve in live patients; and full-time availability for live feedback for self-learning. The question of disadvantages for the use of virtual patients was not specifically asked, but associated costs and time to produce and maintain a VP experience would be considered downsides to the incorporation of this technology.

### Discussion

As dental students engage patients in the school’s clinic setting, it is often noted that they...
spend an inordinate amount of time in decision making regarding patient treatment. Students struggle with decisions about diagnosis, treatment planning, tooth preparation, selection, patient management, and patient referral. The survey in our study was designed, in part, to elicit responses from schools as to their definition of what constitutes a VP so that a determination of validity could be made. In response to what constitutes a VP, the majority of the respondents chose a “combination of physical and digital elements simulating a real patient.” This response may encapsulate several potential definitions of a VP. One definition may simply be the use of a fictional name and associated medical and dental history to be utilized with a mannequin or typodont as part of a dental restorative course held in a simulation laboratory or clinic. On the other end of the scale, it could be a VP that may involve a computer-generated patient with whom the dental student or practitioner may interact. The VP responses could vary depending on the question asked, and associated exercises could include tooth preparation, which may involve a virtual simulator or haptic device. If one of the intended outcomes of the use of VPs in dental education is to develop practice decision making skills in dental students, then in order for the use of VPs to be truly beneficial, elements must be incorporated that can foster critical thinking.

Respondents to this survey also provided examples of perceived advantages in using virtual patients. One respondent thought that the use of VPs increases the reinforcement of basic science information on treatment considerations of patient diseases and conditions, while another similarly thought that the use of VPs connected the preclinical techniques to those taught in the clinic years. A common reason that many schools have adopted VP technology is to ensure an equal playing field for students in their clinical education. In fact, one respondent, when asked to give an advantage, suggested that the use of VPs allows for more uniform exposure of students to clinical and behavioral situations that is impossible to achieve consistently for all students with live patients.

Twenty-nine percent of the responding schools indicated that they did use interactive elements. However, the survey was not designed to determine the level of interactivity used by the schools that responded positively to this question. In our view, interactive elements that should be incorporated into the VP experiences would include, at a minimum, technology that would lead students down paths of questioning or reasoning as determined by the question or the response of the student, i.e., as a decision tree or logic-directed branching program (software, video, or audio). Responses from schools that provided an explanation for how the interactive component of their VP experience worked did not indicate that there was a decision tree mechanism foundational to the interactive component. Without an interactive component, does the use of a VP become just a fancy case study? For example, for the schools that indicated that they did use VPs for clinic or preclinical education, did they develop what amounts to only an electronic case study? Again, this survey was not designed to discern these differences, and subsequent studies should investigate further aspects of the use of VPs in dental education should be initiated.

Assigning or attaching simulated patient demographics, medical/dental history, radiographs, and clinical findings to preclinical procedures could be viewed as a case study combined with a simulation exercise and not necessarily the creation of an actual VP. In our estimation, VPs should be akin to those case studies as described by Saleh for medical education that are dynamic and not static. All student interactions with VPs should be scripted, and data for VPs should be entered into the electronic health record by faculty members in preparation for student encounters. Students should encounter the patient virtually via computer-generated video/audio or other electronic media. Responses to student queries should vary depending on the number of branching alternatives built into the electronic media.

VPs could be given social media accounts and even e-mail addresses and phone numbers to enhance the patient’s back story or to create behavioral and/or ethical scenarios for learning, as well as to heighten the perception of reality. The ultimate goal would be for students to become so engrossed in the management of the patient that they might engage VPs as if they were real patients. The use of VPs in dentistry is currently in its infancy, but with technological advances and developments in methods of presentation and collaboration between institutions, it is hoped that this goal will eventually be met. It is expected that the development of VPs who are dynamic, having a back story and a virtual life that is enhanced through social media, will create a virtual clinical practice environment that will help to promote an experience that may enrich students’ development of clinical skills. Use of the electronic health record, social media, and other technologies are examples of how realism can be integrated into VPs, as is cur-
Conclusions

The use of VPs in dental education appears to be on the rise. Although only thirty of sixty-seven U.S. and Canadian dental schools participated in our study, the majority of schools responding to this survey indicated that either they are currently using or at some point in the past have used VPs in training dental students. The advantages of the use of VPs in dental education are clear: 1) reinforcement of basic science information within clinical treatment considerations; 2) uniformity of student experiences; and 3) immediate feedback for learning and self-assessment. VPs that employ interactive components may further evolve to better prepare dental students for their first encounter with a live patient.

VPs should include as many elements as possible to parallel the simulated experiences to those of actual patient experiences. As technology evolves, it is important that a workable definition of a VP be formulated as a guiding principle. One suggestion for the definition of a VP might be the following: a digital representation of a realistic patient that is capable of being interactive, i.e., allowing for a relationship between student and patient. There are also many challenges to the use of VPs in dental education, such as the costs associated with producing a good-quality interactive VP and the commitment of resources to gather the data and create and manage VPs. Additionally, incorporating VP technology into existing courses and providing suitable information technology support to ensure that the technology works are challenges for the use of VPs. However, the benefits of VPs in teaching dental students seem to far outweigh the limited disadvantages.

Further studies are needed to determine if the use of VPs in dental education will enhance student learning and provide clinical training that more closely simulates a live patient experience. Additional research is needed to determine if the use of social media and other interactive enhancements with VPs will further reinforce behavioral sciences and ethics. The promise of making the virtual patient encounter a more realistic experience for the dental student is certainly within reach.

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REFERENCES