Computer Assisted Learning: A New Paradigm in Dental Education

Wainscott Hollis, D.D.S.; Laura A. Darnell, D.D.S., Ph.D.;
Timothy L. Hottel, D.D.S., M.S., M.B.A.

continuing education
TDJOURNAL
EXAM #32

ABSTRACT

Computer assisted simulation is an important teaching modality in the preclinical training of students. In order to maximize the potential of this learning tool, the University of Tennessee's College of Dentistry has successfully incorporated DentSim® technology into the restorative curriculum and has recently acquired the technology to make image guided implantology available to students, residents and faculty. This article describes the university's history and experience with simulation as a learning tool. The purpose of this article is to provide information to other educational institutions on the use of virtual reality simulation in the classroom.

KEYWORDS:

simulation, virtual reality, DentSim®

Discussion

One of the most important skills for any dentist is the ability to prepare and restore damaged tooth structure. The skills necessary to master this ability rely on the development of knowledge of the concepts of operative procedures and the dexterity to perform them. Faculty can offer instruction regarding the concepts of cavity preparation and demonstrate these techniques in large group sessions. However, the performance component requires that students repeatedly practice the preparations themselves. In the past decades, dental educators have come to realize that the clinical environment may not be the best environment for teaching. Reasons for this paradigm shift include technical skills that are increasingly more complex due to advances in knowledge, materials and technology. In parallel with the technological advances, financial restraints have increased the pressure for high patient turnover at dental school clinics, leaving less teaching time available to instructors and students.

For decades, dentistry has been investigating the extended use of simulation for its training, especially in the area of the preclinical curriculum.[1] Factors that appear to be driving this interest are a desire to provide a smoother transition for students into the clinic, to support and reinforce ergonomics and to broaden the students' preclinical experience by including additional models mimicking real patient conditions.

In 2002 the University of Tennessee embarked on a mission to create a state of the art dental simulation laboratory. The traditional black bench model was removed and replaced by two modern simulation systems. The first was a Kavo® (Kavo Dental Corp.) system providing the students a workstation, a fully adjustable manikin, electric handpieces and suction **(Figure 1)**. The other simulator, called the DentSim®, provided the same features as the Kavo but additionally incorporates a computer, which evaluates real-time tooth preparation **(Figure 2)**. Both systems provide true clinical simulation for students.

The University of Tennessee recognized that students of the computer generation are accustomed to being taught by computer-assisted learning (CAL) and/or simulation (CAS) and felt the DentSim® would provide such a virtual reality learning tool for dentistry. The advantages of computer-assisted learning are seen in self-paced and self-

Figure 1: Kavo Simulation Lab

Figure 2: First Generation DentSim® Units

Figure 3: Evaluation Screen

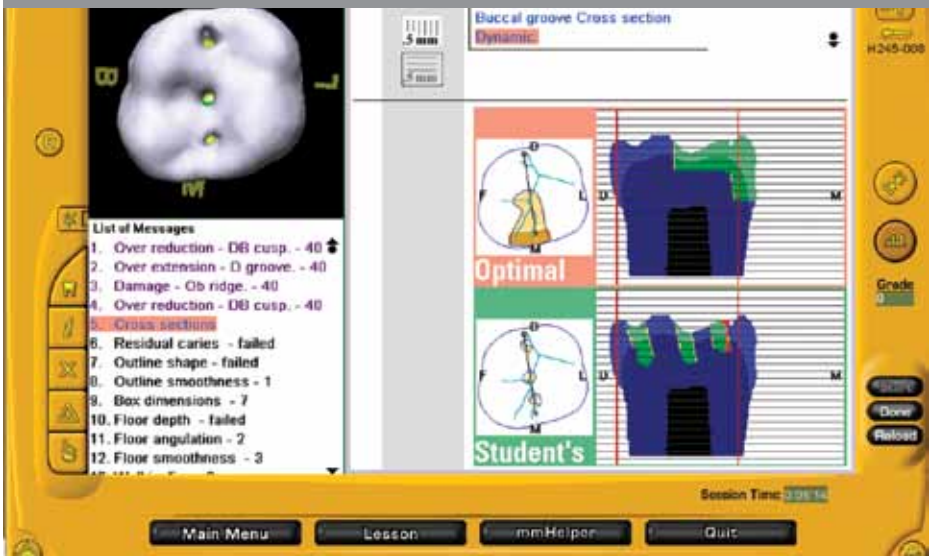


Figure 4: Proper Ergonomics (required for the DentSim® to accurately capture handpiece movement)

Figure 5: Original DentSim® Laboratory

directed learning and increase motivation. It is useful for objective, theoretical and practical tests and for training students to handle complex cases. CAL can lead to more structured learning and can support training in evidence-based decision-making.[2,3]

The DentSim® was developed, manufactured and distributed by Denx, an Israeli company. The system is unique in that it uses proprietary tracking and evaluation software to virtually follow the student's progress while preparing a plastic tooth. The University of Tennessee faculty set the parameters for each preparation based on the cavity and crown designs taught in the didactic courses, which establishes the parameters for each preparation. Furthermore, the burs recommended for the same cavity or crown preparations were scanned and made available for the students within the evaluation software. The evaluation component of the software allows students to work seamlessly without waiting for a faculty member to critique their performance since this system provides instant feedback for all procedures **(Figure 3)**.

This allows the student the ability to prepare more teeth in the same amount of time. A study by Jasinevicius et al., demonstrated that students trained using the DentSim® required less faculty intervention and were able to prepare more teeth compared to students on other simulation systems. Students taught by other simulation techniques required five times more instruction from faculty.[4] In addition, the design of the DentSim® requires a student to sit and work in an ergonomic position conducive to the practice of dentistry **(Figure 4)**. Audible signals as well as on-screen displays inform the student if their handpiece or sitting position is less than ideal. Additional audible signals inform the student of his or her progress during the preparation. By providing these tools the student improves his or her cognitive and motor skills at a faster rate.[5-8]

The University of Tennessee purchased 40 Dentism units in 2002 thus making its simulation classroom the largest of its kind in the world **(Figure 5)**. For the first few years the university tested the use of the simulation classroom and its possible integration into the curriculum. In 2004 the curriculum committee voted to add a DentSim® based course to the operative

program. The course, titled "Tooth Preparation," would be a prerequisite for the operative lab course. First-year dental students would commence the Tooth Preparation course on the first day of dental school and it would last for 12 weeks during which time the students would have two timed practicals; the first consisting of two preparations in the mandibular arch and the second consisting of two in the maxillary arch.

Since 2004 the Tooth Preparation course has been an integral part of the first-year dental student's introduction to principles of cavity design. Course evaluations have been high, as students have found significant benefits with the use of the DentSim®. Since 2006, students have evaluated the Tooth Preparation course as it compares to other courses they are taking. The students were asked to rank the course from one to five, with one being far below average and five being far above average compared to other courses. The average ranking was 4.45 **(Figure 6)**. According to the literature, students surveyed felt their experience with the DentSim® better prepared them for other pre-clinical courses (operative, fixed) and eventual patient treatment.[9]

Continuing the trend of Tennessee providing the latest simulation technology for their students, the College of Dentistry, with the financial support from Delta Dental of Tennessee, purchased 20 new DentSim® units in April of 2010. The new units were fabricated by Saratoga, an Italian company, for Image Navigation. These new units are advanced ergonomically, designed by the renowned Italian carmaker Pinin Farina, and the University of Tennessee will be the leader in utilization of these units **(Figure 7)**. The College of Dentistry also added four Image Guided Implantology (IGI) units in the transaction.

The IGI component uses the same proprietary tracking technology to allow surgeons, prosthodontists, periodontists and general practitioners to precisely place dental implants in real time. The exact drill position is tracked in real time and displayed for the user to follow during placement. Due to its tracking technology, Image Navigation advocates that the IGI system removes the need for surgical guides **(Figure 8, 9)**.

Some studies have shown stereolithographic surgical guides have

Figure 6: Student Evaluations

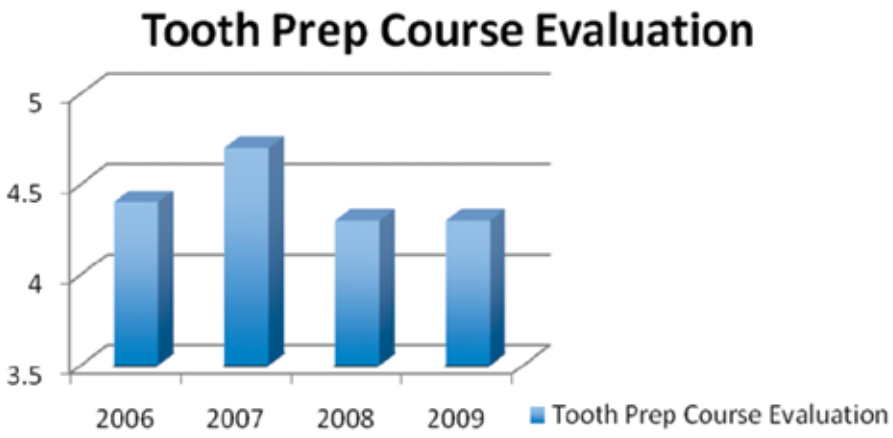


Figure 7: Saratoga DentSim® Units

Figure 8: IGI Unit

Figure 9: IGI Handpiece

Figure 10: Mean Linear Accuracy (mm)[11]

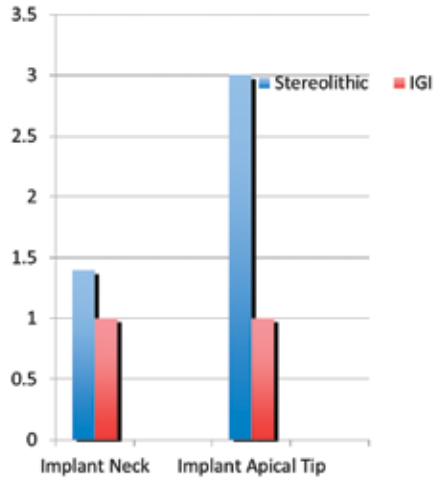
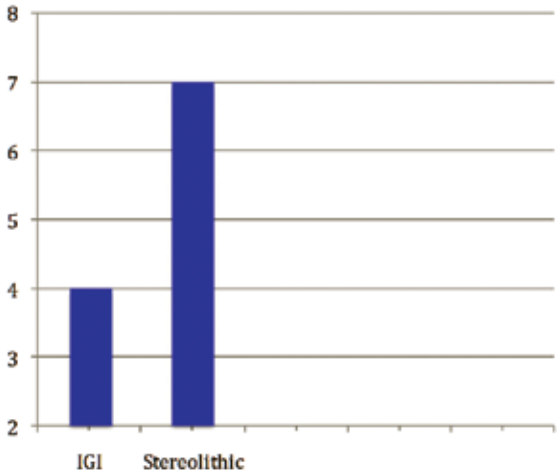


Figure 11: Mean Angular Deviation (Degrees)[11]



significant limitations and are far from being an ideal solution for supporting implant placement. The mean linear accuracy of implants placed with stereolithographic guides is reported to range between 1.1 mm to 1.45 mm at the implant neck and between 1.41 mm to 2.99 mm at the implant apical tip **(Figure 10)**. The mean angular deviation is reported to range between 2 degrees to 7.25 degrees.[10-15]

A recent study by Elian, et al., investigated the accuracy level in placing implants using the IGI. The mean linear accuracy was less than 1 mm at both the implant neck and apical tip **(Figure 9)** and the reported mean angular deviation was less than 4 degrees **(Figure 11)**.[16] The research to date indicates the IGI improves the clinician's cognitive and motor skills for placing implants by providing the ability to conduct multiple surgical rehearsals. The four units associated with the DentSim® lab at the University of Tennessee allow faculty, undergraduate students and graduate students in Prosthodontics, Periodontics and Oral Surgery to input patient CT scans, plan surgeries and practice placing implants in CAD/CAM fabricated plastic jaws. The IGI is just another example of Tennessee's commitment to providing students, residents and faculty with leading-edge technology for pre-clinical training and research.

Conclusion

Over the past few decades, computerized simulation in dentistry, medicine and other healthcare disciplines has played a major role in producing exceptional clinicians. With the introduction of dental simulators and state of the art DentSim® units into dental education, the training of dental students can be enhanced. With the addition of IGI technology, residents can now take part in this exciting advancement in the clinical training in implant placement. The University of Tennessee's College of Dentistry continues to keep its training programs at the top by providing state of the art simulation for their students. All dental schools want their students to be the best dentists they can be because they are well-educated and feel more confident in the techniques they have learned. The DentSim® and IGI are tools to make this happen.

Acknowledgements

The authors wish to thank Delta Dental of Tennessee and Delta Dental of Arkansas

for their generous donations that help to fund our simulation laboratories.

Disclosure. The authors did not report any disclosures.

References

1. Buchanan J. Use of Simulation Technology in Dental Education. J Dent Ed 2001: 65 (11): 1225-31.
2. Welk A, Splieth C, Rosin M, Kordass B, Meyer G. DentSim – a Future Teaching Option for Dentists. Int J Comput Dent 2004: 7(2): 123-30.
3. Welk A, Splieth C, Wierinck E, Gilpatrick RO, Meyer G. Computer-assisted Learning and Simulation Systems in Dentistry – A challenge to Society. Int J Comput Dent 2006: 9:253-65.
4. Jasinevicius R, Landers M, Nelson S, Urbankova A. An Evaluation of Two Dental Simulation Systems: Virtual Reality versus Contemporary Non-Computer-Assisted. J Dent Educ 2004: 68(11): 1151-62.
5. Maggio MP, Buchanan JA, Berthold P, Gottlieb R. Virtual Reality-Based Technology (VRBT) Training Positively Enhanced Performance on Preclinical Examinations. J Dent Educ 2005: 69 (1): 161.
6. LeBlanc VR, Urbankova A, Hadavi F, Lichtenthal RM. A Preliminary Study in Using Virtual Reality to Train Dental Students. J Dent Ed 2004: 68 (3) : 378-83.
7. Chen ML, Su ZY, Shieh TY, Chiang CH. Influence of Dentistry Students' e-Learning Satisfaction: A Questionnaire Survey. J Med Sys 2010 Feb 12.
8. Imber S, Shapira G, Gordon M, Judes H. A Virtual Reality Dental Simulator Predicts Performance in an Operative Dentistry Manikin Course. Eur J Dent Ed 2003: 7 (4):160-3.
9. Gartner JL, Quinton HA, Brodie AJ. Student Perception of Virtual Reality Dental Simulation use at NSU. J Dent Res 2005: Vol. 84, Special Issue A.
10. Sarment DP, Sukovic P, Clinthorne N. Accuracy of Implant Placement with a Stereolithographic Surgical Guide. Int J Oral Maxillofac Implants 2003 Jul-Aug; 18(4): 571-7.
11. Ozan O, Turkyilmaz I, Ersoy AE, McGlumphy EA, Rosenstiel SF. Clinical Accuracy of Three Different Types of Computed Tomography-Derived Stereolithographic Surgical Guides in Implant Placement. J Oral Maxillofac Surg. 2009 Feb; 67(2):394-401.
12. Ersoy AE, Turkyilmaz I, Ozan O, McGlumphy EA. Reliability of Implant Placement with Stereolithographic Surgical Guides Generated from Computed Tomography: Clinical Data from 94 Implants. J Periodontol. 2008 Aug; 79(8):1339-45.
13. Van Assche N, van Steenberghe D, Guerrero ME, Hirsch E, Schutyser F, Quirynen M, Jacobs R. Accuracy of Implant Placement Based on Pre-Surgical Planning of Three Dimensional Cone-Beam Images: a Pilot Study. J Clin Periodontol. 2007 Sep; 34 (9): 816-21.
14. Di Giacomo GA, Cury PR, de Araujo NS, Sendyk WR, Sendyk CL. Clinical Application of Stereolithographic Surgical Guides for Implant Placement: Preliminary Results. J Periodontol. 2005 Apr; 76 (4): 503-7.
15. Casap N, Wexler A, Persky N, Schneider A, Lustmann J. Navigation Surgery for Dental Implants: Assessment of Accuracy of the Image Guided Implantology System. J Oral Maxillofac Surg. 2004 Sep; 62 (9 Suppl 2): 116-9.
16. Elian N, Jalbout ZN, Classi AJ, Wexler A, Sarment D, Tarnow DP. Precision of Flapless Implant Placement using Real-Time Surgical Navigation: a Case Series. Int J Oral Maxillofac Implants. 2009 Nov-Dec; 23: 1123-7.

Wainscott Hollis, DDS, Assistant Professor, Department of Prosthodontics, College of Dentistry, University of Tennessee Health Science Center, Memphis, TN.

Laura A. Darnell, DDS, PhD, Assistant Professor, Department of Restorative Dentistry, College of Dentistry, University of Tennessee Health Science Center, Memphis, TN.

Timothy L. Hottel, DDS, MS, MBA, Professor, Department of Prosthodontics, College of Dentistry, University of Tennessee Health Science Center, Memphis, TN. Contact Dr. Hottel at thottel@uthsc.edu or 901-448-1625.

Questions for Continuing Education Article - CE Exam #32

1. Dental education has been impacted by advances in:
   a. Knowledge
   b. Materials
   c. Technology
   d. All the above

2. For decades, dentistry has been investigating [what] modality for training, especially the preclinical curriculum:
   a. Simulation
   b. Plaster models
   c. Videotapes
   d. All the above

3. Two modern simulation systems are made by:
   a. Kavo® and DentSim®
   b. Midwest and Lares
   c. Coltene and Whaledent
   d. Hanau and Whipmix

4. The DentSim® teaches both operative technique and:
   a. Proper attitude
   b. Proper ergonomics
   c. Orthodontic technique
   d. All the above

5. It has been reported that the Image Guided Implantology (IGI) units removes the need for:
   a. Sterile irrigant
   b. Surgical guides
   c. Pre-operative antibiotics
   d. General anesthesia

Publication date: Fall 2011. Expiration date: Fall 2014.

ADA CERP Recognized Provider

The Tennessee Dental Association is an ADA CERP Recognized Provider.

ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP does not approve or endorse individual courses or instructors, nor does it imply acceptance of credit hours by the boards of dentistry.

Concerns or complaints about a CE provider may be directed to the provider or to ADA CERP at www.ada/org/goto/cerp

ADA C·E·R·P® | Continuing Education Recognition Program

Answer Form for TDA CE Credit Exam #32:

Computer Assisted Learning: A New Paradigm in Dental Education

Publication date: Fall 2011. Expiration date: Fall 2014.

EXAM #32

Circle the correct letter answer for each CE Exam question:

1.	a	b	c	d
2.	a	b	c	d
3.	a	b	c	d
4.	a	b	c	d
5.	a	b	c	d

Please complete the following course evaluation. These answers do not affect the grading process.

Assess your mastery of the material	❑ Full	❑ Partial	❑ No
Your comprehension of material	❑ Excellent	❑ Fair	❑ Poor
Appropriateness of the material	❑ Excellent	❑ Fair	❑ Poor
Was the material adequately in-depth?		❑ Yes	❑ No

Additional feedback should be emailed to the TDA at tda@tenndental.org

Cost per exam per person is $15.00. If you correctly answer four of the five question, you will be granted one (1) continuing education credit. Credit may not apply toward license renewal in all licensing jurisdictions. It is the responsibility of each participant to verify the CE requirements of his or her licensing or regulatory agency. This page may be duplicated for multiple use. Please print or type.

ADA ID Number (Dentist Only):_____

License Number of RDH:_____

Registration Number if RDA:_____

Name (Last/First/Middle):_____

Office Address:_____

City/State/Zip:_____

Daytime Phone Number : ( )_____

Component Society (TDA Member Only):_____

Dr._____

(Auxiliary Staff: Please provide name of Employer Dentist)

All checks should be made payable to the Tennessee Dental Association. Return the Exam Form and your check or credit card information to:

Tennessee Dental Association at 660 Bakers Bridge Ave., Suite 300 in Franklin, TN 37067

The form may be faxed to 615-628-0214 if using a credit card (use your TDA/Bank of America card, MasterCard or Visa ONLY):

Signature:_____

Card #:_____ Exp. Date:_____

Three-digit CVV2 Code (on back of the card following the card number):_____

Name as it appears on the card:_____

Do not write in this space - for TDA Administration purposes only

○ Check #:_____ ○ CC ○ Paid w/doctor's CC