

Technology in the dental curriculum

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The goal of all dental educational institutions is to prepare their students with the fundamentals and skills necessary to ensure future competency and proper patient care. This includes all aspects of diagnosis and treatment as well as awareness of the current (or future) standard of care in technology, materials and techniques. Today's dental students, more than ever before, have lived and been educated in an interactive world, using technology to enhance the learning process and expecting an immediate response, feedback and results. Current and future technological advances in dentistry, e.g., CAD/CAM, digital radiography and digital record keeping, must be incorporated in existing dental curricula in order to prepare tomorrow's dentists properly.

Fig. 1_Three-dimensional visualization of a virtual wax-up provides easy clarification of dental anatomy.

Fig. 2_Overlaying the original unprepared tooth over the student's preparation provides an immediate relative view in preparation design. In this case, the software was used to evaluate 'mock-board' results among nine students' preps at Georgia's Health Sciences University.

At the same time, many dental schools across North America are experiencing a shortage of funds and faculty, along with an ever-increasing curriculum crunch. There is a nationwide emphasis to address a purported "access to care" issue through increased class size in existing dental schools and the building of numerous new ones. Under these circumstances, in order for any new technology to have a viable chance of being incorporated into an existing dental curriculum, it must save time and money and be a better solution than the current modality.

This article will detail the possibilities of maxi-

mizing the learning experience for students using chairside CAD/CAM systems (E4D Dentist, D4D Technologies, Richardson, Texas) and evaluation software (E4D Compare, D4D Technologies) at the Medical University of South Carolina and Georgia Health Sciences University.

In private practice, chairside CAD/CAM systems offer the advantage of in-office scanning, designing, milling and delivery, providing clinicians with complete control of their schedule, their quality and consistency. They provide a tremendous convenience factor for patients and practices as well as maximizing profitability. While these same advantages provide benefits to the university/teaching environment, there are many more advantages of chairside CAD/CAM systems that can enhance the learning experience and provide unparalleled opportunities for faculty and students.

In the simplest terms, current chairside CAD/CAM systems can be used as learning tools and methodologies to enhance educational objectives in the following categories:

- tooth anatomy and morphology (Fig. 1)
- preparation design (Fig. 2)
- restoration design
- material understanding and selection
- occlusion/articulation (Fig. 3)



Fig. 1

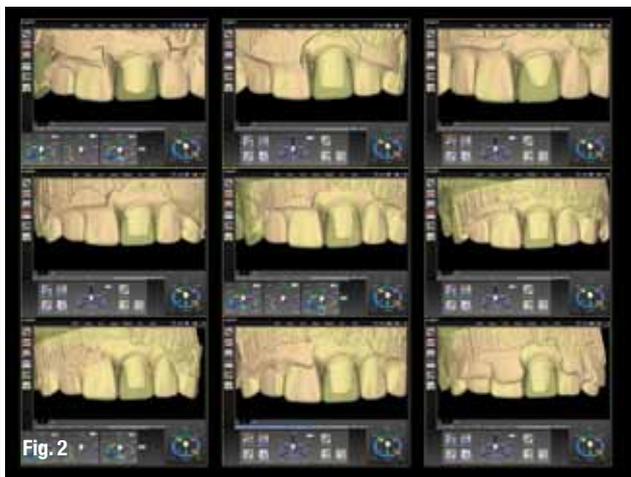


Fig. 2

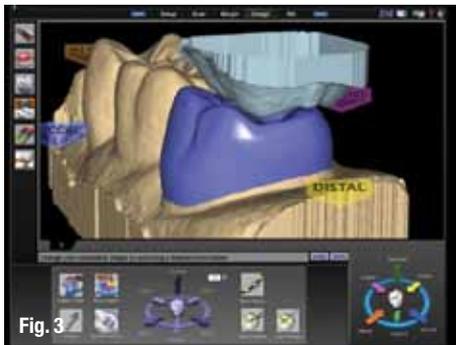


Fig. 3

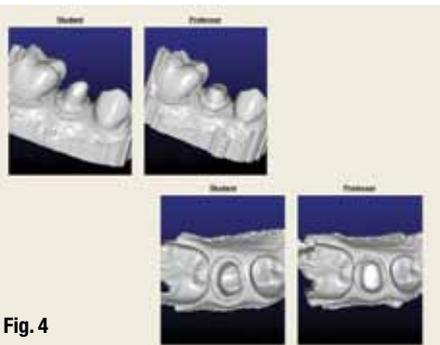


Fig. 4

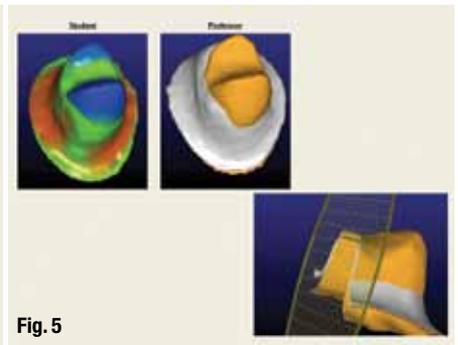


Fig. 5

One major advantage of CAD/CAM from an educational standpoint is the students' ability to magnify preparations on the computer screen and mark their own finish lines. It is remarkable how they grow as student clinicians when they can see at 50x magnification the errors in their finish line designs. The most common errors are lipped margins, bevels, rough spots and feathered areas. Before CAD/CAM, a student would not have the opportunity to evaluate his or her preparations at this level of detail and magnification. As a result, the quality of preparations starting in the pre-clinics and carried over to the clinics has been remarkable and considerably better since the introduction of CAD/CAM.

The addition of CAD/CAM in the pre-clinical curriculum mandates increased knowledge and more curriculum time devoted to the study of ceramic materials. Students are very familiar with all types of ceramics, from leucite reinforced (IPS Empress, Ivoclar Vivadent) to lithium disilicate (IPS e.max CAD, Ivoclar Vivadent), and have hands-on time manipulating, custom characterizing and bonding a variety of materials before they reach the clinics. Students have a profound understanding of advanced ceramics and adhesives that are essential to successful treatment in a modern dental office.

There are some who feared having students utilize digital dentistry would compromise or cause them to lose the fundamentals and conventional techniques that are essential to successful comprehensive care. Ironically, in many ways, CAD/CAM technology has resurrected some principles that were no longer taught. For example, gold inlays and onlays were removed from the curriculum as gold prices increased, patient demand decreased and curriculum load increased. Now, however, using the E4D System, students learn about conservative all-ceramic onlay and inlay preparation principles and design elements.

Before the end of the pre-clinic semester, students will prepare, scan, mill and bond an onlay on the dental simulator in addition to various other anterior and posterior crowns. Furthermore, this treatment option is carried over when they get to the clinics, and more conservative partial coverage restorations, such as onlays, are being treatment planned over more aggressive full-coverage options.

E4D Compare

Software is being developed by D4D Technologies in order to improve the evaluation of students' pre-clinical work. E4D Compare™ objectively compares two similar environments: prep to prep, prep to prep, pre-op to restoration — essentially any combination of comparisons. E4D Compare will automatically and objectively evaluate a student's preparation based on an ideal preparation of the same tooth that a faculty member scanned into the system (Fig. 4), effectively removing all subjectivity from grading. Performance evaluations can be more objective and less likely to be called into question.

This software will scan a student's work, create a 3-D model and superimpose this model onto the ideal, allowing instant feedback and visualization of errors (Fig. 5). The digital model can be rotated and magnified on the screen and viewed from all angles.

Students can instantly get truly objective feedback. Not only will this assist the objective evaluation, but it will also improve the learning process as students progress along their "confidence curves." They can self-evaluate their preparations or restorations and gain reinforcement toward continual improvement on their own, not just when faculty members are present.

Each institution must decide the degree to which this technology will become part of its curriculum. Timing of the various aspects to be incorporated is equally critical. Any change to the curriculum will undoubtedly create a certain degree of angst among the majority of the faculty. It is therefore imperative to present to the entire faculty the advantages of CAD/CAM technology and how it can enhance our students' dental education throughout the curriculum.

It is clear that CAD/CAM technology is the future of dentistry, and the earlier we can teach students the indications and contraindications the better. With quality CAD/CAM systems available from various manufacturers, it is only a matter of time before more institutions adopt this technology as a way to teach students and provide more conservative and economical care to patients.

Fig. 3 Three-dimensional visualization of the opposing dentition provides an easy learning tool.

Fig. 4 E4D Compare provides objective comparisons between proposed (student) and preferred (master) preparations.

Fig. 5 Color coding: red (over reduction) and blue (under reduction) provide immediate feedback and a quick quality check based upon the school's chosen tolerances.