Implementing Simulation, Haptics, and 3D Printing in Dental Education

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INTRODUCTION: The University of Texas Health Science Center at Houston School of Dentistry (UTSD) curriculum in Clinical Simulation encompasses all four years of the DDS and the two years of the DH programs. Utilizing a standardized family of virtual patients delivered through the electronic health record (EHR), the curriculum in simulation is designed to supplement clinical education by emphasizing the integration of foundational knowledge and hands-on experience to enhance and improve student learning and performance.

MOTIVATION: Significant advances in digital technologies have enabled a paradigm shift in dentistry – ranging from the acquisition and management of patient records to the planning and fabrication of restorations and orthodontic appliances. Clinicians engaged in private practice generally embrace these emerging technologies quickly, while academic institutions appear to lag in adoption – leaving students a step behind in their training. Interestingly, the digital technologies present invaluable potential to advance dental education beyond the boundaries of the classroom and patient recruitment.

OBJECTIVES:
- To adopt modern technologies, specifically simulation, haptics, and 3D printing, to expand the scope of training for our students while exposing them in a hands-on fashion to the leading edge of dental technology. Our specific objectives include:
  - To expose students in a hands-on fashion to the leading edge of digital dentistry
  - To expand the scope of Clinical simulation to include custom 3D-printed models
  - To apply Clinical Simulation & 3D-printed models to standardize education & assessment
  - To promote student exposure to and engagement in dental & craniofacial research

SIGNIFICANCE & RATIONALE: Clinical Simulation provides an opportunity to develop innovative and exploratory thinking, necessary technical skills, and the ability to explore activities not frequently observed in students’ daily clinical activities in a standardized manner. The incorporation of digital imaging in concert with 3D printing technologies will enable departure from current practices through fabrication of standard and physical models tailored to the records of the simulated patient and/or the anatomy desired by the instructor, while exposing the student to the work flow at the leading edge of digital dentistry.

IMPLEMENTATION: UTSD implemented Clinical Simulation in the dental curriculum in 2011. A 3D printer was acquired this year and has already been utilized in research and education in a wide variety of ways. The timeline below presents highlights of past and future milestones of the ongoing efforts.

RESOURCES & COLLABORATION: The UTSD start-of-the-art Clinical Simulation Lab contains 105 stations and provides the students with a safe learning environment for activities such as medically compromised patients, prescription writing, emergencies, ethics, interprofessional education, orthodontics, temporomandibular joint disorders, lasers, cone beam computed tomography, intracranial digital imaging, among others (Fig. 1). UTSD has 4 cone beam computed tomography scanners and a variety of intraoral and desktop model scanners. The UTSD Houston Center for Biomaterials & Biomimetics provides support staff and a fully equipped resource for material development and characterization. In addition, UTSD has a close working relationship with other UT Health schools to promote interprofessional training. As a member of the largest medical center in the world (the Texas Medical Center), UTSD benefits from collaborative engagement and sharing of resources at the cutting edge of biomedical sciences and patient care.

OUTCOMES OF INNOVATION: UTSD will survey all graduating students and UTSD alumni within 1, 3, and 5 years of graduation to gather data, including (1) the degree to which the student felt exposed to digital dentistry as well as the degree to which they felt prepared to incorporate digital technologies into their practice, and (2) the perceived value and efficacy of exposure to 3D printing technologies during dental training. Additional metrics will include the perceived quality of education with respect to orthodontic/scalpel and temporomandibular joint disorder management. Faculty will be surveyed with respect to ease of use and perceived efficacy, and administration will assess the fiscal impacts of the use of the technologies.

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