

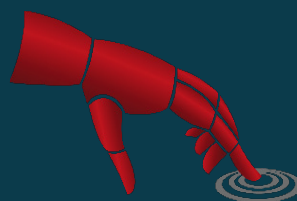
DenTeach™: A Technological Solution to Train Dental Students from Home

Problem & Solution During COVID-19 Pandemic

Using the Internet of Dental Things (IoDT)

WHITE PAPER

DenTeach™ DT-Rightway™ Dental Articulator



Tactile Robotics
Feel the Intangible

How does the COVID-19 pandemic impact dental colleges?

The coronavirus disease 2019 (COVID-19) is assessed as a global pandemic by the World Health Organization (WHO). To slow the spread of COVID-19 at both national and community levels, various measures have been implemented such as COVID-19 testing, contact-tracing and quarantine, social and physical distancing, and international travel bans.

Social distancing measures for the general public include flexible work arrangements such as teleworking, distance learning, cancellation of a public event to prevent crowding, closure of non-essential facilities and services, local or national movement restrictions, staying-at-home measures, and coordinated reorganization of health care and social services networks to protect hospitals. During the time of the global pandemic, people are encouraged to sustain virtual social connections within families and communities. COVID-19 social distancing policies led to a widespread lockdown of schools and universities, including dental education institutions. To a large degree, this has resulted in the extension of the semester, and deferral of exams and graduation dates. COVID-19 lockdown has serious repercussions for dental education. Theoretical courses have still been delivered during the COVID-19 pandemic, but the delivery of hands-on courses such as restorative dentistry has been challenging while instructors and students self-isolate at home without access to dental equipment. The duration of this teaching interruption is still uncertain, and dental colleges must keep in mind the possibility of a second or third wave of COVID-19. Hence, it is necessary for dental colleges to look for a reliable, yet inexpensive, solution to ensure the continuation of dental practical skills education. Dental schools are actively for a technological solution to train dental students from home during the COVID-19 pandemic.

Using a substitution that allows the professors to teach and the students to learn, shadow, and practice at the same level of quality experienced before the COVID-19 pandemic is a MUST.

New technologies will be needed to ensure that this is done objectively, based on data, in a way that is easy for dental schools to perceive and understand.



benefits of a high-tech substitution to dental school colleges

- A long-term investment to hold for more than a year or throughout a crisis
- A strategic investment using the advanced concept of the Internet of Dental Things (IDoT)
- Reduce the impact of unpredictable events, such as COVID-19 on the quality of learning
- Establish a better curriculum and grade more objectively by using fact-based metrics
- Reinforce learning by capturing student performance
- Objective and fair student assessments (grades)
- Link technology to current and future platforms
- Utilize technology in teaching, clinic, and research
- Attract professors and students to work collaboratively through Cloud
- Continuously improving their relative accreditation index



benefits of a high-tech substitution to dental students

- Enhance the hands-on experience and use technology to improve performance
- Demonstrating objective assessment techniques (metrics)
- Finding new ways to reduce subjectivity
- Improving class performance trends
- Utilizing new methods that mimic real-life scenarios for teaching
- Emulating a real dental clinic
- Holistic teaching and learning using sight, sound and touch
- Researching and adopting new technology

Introduction and purpose

In the dentistry sector, the use of classroom and hands-on training by experts has been a training mechanism of choice for educational institutions. In this traditional model, dental students acquire technical dental skills through years of hands-on training in dental laboratories, pre-clinics, and clinics, and receive supervision and feedback from their mentors relative to dental performance skills. Specifically, mentors conduct a procedure that offers the apprentices the opportunity of observing, assisting, and finally performing that procedure under the supervision of their mentor. That is how apprentices acquire years of hands-on training and deliberate practice in mastering the required skills. In other words, apprentices have learned the nuances of the required skills by working on artificial materials, cadaveric organs, and case observations, and have received largely qualitative feedback on their performance from their mentor.

The traditional novice-expert apprenticeship model is quite time-consuming. Moreover, students need their mentor to be present in order to practice and learn the key skills of operations. Additionally, more quantitative measures are needed to objectively assess aspects of technical skills; the knowledge acquired and subsequently relayed through generations of dentists still remains largely qualitative. As a result, trial and error often constitute a major part of learning psychomotor skills for an apprentice. With limited operating hours and training resources, there is an increasing demand to improve training efficiency and provide a quantitative (objective) evaluation of dental performance.



Stakeholder needs

For the purpose of this white paper, the stakeholder will include education institutions (dental colleges and universities), college professors (teaching, clinical, research), and dental and dental hygiene students.

Institutions and Professors

North American dentistry teaching and learning institutions (i.e., colleges and universities) are very competitive, and are always looking for new ways to enhance their attractiveness to students and other schools by ultimately producing better dental professionals. Teaching professors also need to find new ways to do “more with less”. Instructor-led teaching, while necessary, is time-consuming and costly. Investments in technology and other advanced teaching/learning methods can reduce the burden on precious instructor resources, leaving room to focus on continuous improvement and teaching outcomes, including producing better and better dental professionals for society. Hence, new innovative methods and techniques are required to teach more students (per instructor), accelerate student learning and procedure proficiency, and enable students to self-learn through practice.

Dental and Dental Hygiene Students

A student’s overall aim is to become an exceptional dental professional. Students want to open and start their practice with a high degree of confidence from practical hands-on experience. They want to be effective and efficient in providing their service, while reducing (eliminating) errors and ensuring optimal patient satisfaction and an exceptional professional reputation. Many dental professionals want to be aware of the latest methods and technologies; especially those that support a stellar professional reputation.

While attending a dental learning institution, a student’s primary need is “to pass”. Dental students embrace real-life teaching methods and innovative technologies, especially as they believe it will improve their probability of passing and securing their professional designation. Many students prefer objective performance assessments, as subjective assessments are sometimes concerning and/or disputed. Students are also seeking opportunities to save time and increase the convenience of self-learning and practice (especially if this can be accomplished at home).



Traditional teaching and learning

While there are many different dental classroom layouts, with varying levels of technology used, the current teaching-learning method involves a teaching professor providing visual instruction at a central point in the classroom, and students watching, listening, asking questions, and then duplicating (imitating) tasks. In many classrooms, a single video camera is set up to transmit a top-view video image of the instructor performing a procedure to a video display unit at each student’s work area in which in addition to standard equipment, each student has 1 or 2 typodonts emulating the upper and lower jaw.

Challenges with this teaching-learning paradigm include:

- The student may not have a direct line of sight to the instructor, hence is reliant on the single “top-view” video on their display unit. This provides a single camera angle, which is sometimes not sufficient to understand the procedure and may impede the student learning process.
- Students may not be able to hear the sound of the instructor’s drill; in order to learn proficiently, students need to hear the sound of the drill and its changing pitch as it makes contact with the tooth that enhances their hand-eye-ear coordination.
- Using typodonts on a tabletop does not emulate the proper orientation of a patient; in order to develop proficient psychomotor skills.
- A key element of learning in the field of dentistry is “feel”. Instructor-led teaching or video transmissions cannot provide a true (real life) experience as they do not transmit “feelings” (vibrations, rotation, forces).
- It is time-consuming and difficult for the instructor to see how students are performing unless the instructor moves about the class to look closely at each individual student. With class sizes exceeding 30-50 students and beyond, this is more of a challenge to determine who is performing the procedure proficiently, and who is not.
- Furthermore, the instructor must rely on their personal skills and perceptions, which at times may add subjectivity to the assessment.
- Another key challenge is that students do not receive immediate feedback when practicing in their work area. The primary feedback mechanism is an instructor who may either be helping someone else or who is not available. Furthermore, students are unable to take their workstations and dental units home with them, hence practice must be done in the classroom—this presents a problem, as classrooms are only open at certain times of the day and are closed under particular situations such as the COVID-19 pandemic.

Internet of Dental Things (IoDT): In the modern day, much of the technology we use is connected to the internet. The system that lets one device interface with another without human interference is referred to as the Internet of Things (IoT). Such a system allows for fast and accurate data transfer between devices, and powers many technologies like smart homes and wearables like smartwatches. When applied to the dental field, IoT can facilitate preventative care through smart toothbrushes and implants, and establish new educational opportunities and resources. The Internet of Dental Things (IoDT) is a powerful tool that can be utilized to transform the field of dental education to help universities produce more dental care professionals.

	Traditional	Traditional + DenTeach™	DenTeach™ Advantage
Physical Workstation	- Traditional Student Workstation (Tabletop, Dental Unit, Video Monitor)	- Traditional Student Workstation - Portable DenTeach™ Unit	- Enhanced Student Learning - Industry 4.0 Technology - Portable
Instructor Software	None	- DT-Class Manager™ (Student Selection, Performance Manager)	Objective Performance Assessments
Student Software	None	- DT-Student™ (Video Integration, Augmented Reality, DT-Performer™)	- Integrated Video - Augmented Reality - RT Performance Assessment
Video Feeds	- 1 Camera View (Top View Only)	- 4 Integrated Cameras (Top, Inside, and Side Views)	- 4 Video Angles
Instructor Drill	- Real Drill	- Real Drill - RealFeel™ Sensors	- Drill Vibrations and Forces Synchronized to the Student
Student Drill	- Real Drill	- RealFeel™ Drill (Synchronized to Instructor in Teaching Mode)	- Drill Vibrations and Forces Synchronized to the Instructor
Student Practice	- Typodont (Tabletop) - Cadavers	- Typodont (Tabletop) - Cadavers - Rightway™ Articulator / Typodonts	- Typodont Orientation Synchronized to the Instructor

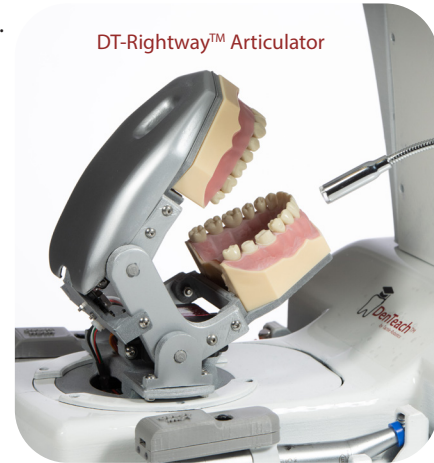
The DenTeach™ & DT-Rightway™ Articulator

Tactile Robotics has developed a new, portable teaching-learning platform called DenTeach™ that complements traditional methods, and is based on the latest Industry 4.0 technologies including the Internet of Things, smart sensors, advanced robotics, big data analysis, 3D printing, augmented reality, and cloud-based computing.

DenTeach™ creates a real-life traditional teaching-learning experience by synchronizing the instructor and the student with real-time Video, Audio and Feel (VAF). The DenTeach™ portable platform consists of an instructor workstation (DT-Class Manager™), a student workstation (DT-Student™), advanced wireless networking technology and cloud-based data storage and retrieval.



DT-RealFeel™ Sensor



Physical Setup

DenTeach™ complements the traditional instructor and student working area by integrating into the existing working area (which consists of a tabletop, dental unit, and dental instruments). The DenTeach™ platform integrates into a standard instructor workstation and a dental unit (Student Work Area), and the DenTeach™ platform integrates into a standard student workstation and a dental unit (Student Work Area).

Anywhere-Based Learning

DenTeach™ is packaged in a small portable suitcase for "anywhere-based learning" and can connect to cloud-based data to retrieve procedures and performance metrics. Students are able to take DenTeach™ home, use settings stored on the Cloud to synchronize their DT-Rightway™ Articulator with the orientation of the instructor's articulator, and practice procedures covered in class.



Instructor Work Area

- DT-Class Manager™ software installed on the instructor's computer that provides a full classroom view and selectable student profile and performance index.
- DT-Rightway™ Articulator supporting upper and lower typodonts.
- DT-RealFeel™ sensors that are seamlessly attached to the standard drills.
- 4 mini cameras that record the instructor's hand (top view, side views, and inside view) that transmits simultaneously onto the students' workstations.
- DT-Performer™ software that allows the instructor to select, record, and play over 30 psychomotor performance metrics to objectively measure effort, speed, accuracy and learning curve.



Instructor Work Area

- DT-Student™, a fully integrated laptop with 4 selectable instructor videos, with a student's drill superimposed over the instructor's drill to enable effective imitation or mimicking.
- A working area consisting of 2 typodonts affixed to DT-Rightway™ Articulator.
- A student DT-RealFeel™ drill synchronized to the instructor's movements while in teaching mode.
- DT-Performer™ software that allows the student to select, record, and play recordings that demonstrate over 30 psychomotor performance metrics to objectively measure effort, speed, accuracy and learning curve.

Dentistry Training Methods Comparison Table

The dentistry training methods comparison table compares three training methods that can be used to teach undergraduate dental and dental hygiene students. The three training methods that are compared in this table are traditional teaching methods, traditional teaching methods and DenTeach™, and other dental trainers. This table shows that there are many advantages to using traditional teaching methods combined with DenTeach™.

In-Class Experience

- Enhanced Video, Audio, Feel & Posture (VAFP)
- Quantitative & continuous feedback

Learning Anywhere

- On-demand recording of in-class material
- Guided practice anytime and anywhere

Confident Dentists

- More opportunities to practice
- Uninterrupted and consistent training



Overview

DenTeach™ is an advanced teaching-learning platform that complements traditional methods by utilizing industry 4.0 technology, seamlessly integrating and synchronizing VAF and orientation between the instructor and the student in real-time by using DT-Rightway™ Articulator.

It is portable and can be used in the classroom or at home. Students and teachers can access all their data by connecting to a cloud-based data retrieval system. Furthermore, DenTeach™ is available at a fraction of the cost of other dental teaching and simulation technologies on the market today.

In summary, DenTeach™ enhances the learning environment by synchronizing VAFP between the instructor and the student as follows:

- Video—4 video feeds are integrated into the student's DenTeach™ laptop application. The student's RealFeel™ drill is superimposed over the instructor's drill using augmented reality, thus facilitating easier imitation of the instructor's drill movements.
- Audio—The instructor's voice is transmitted and played via the student's DenTeach™ laptop application. Each student's drill sound is also used to gauge force versus other metrics being recorded in real-time.
- Feel—The student's RealFeel™ drill is synchronized with the instructor's drill; hence the students learn to imitate psychomotor skills quickly.
- Posture—The student's DT-Rightway™ articulator synchronizes with the orientation of the instructor's articulator. This ensures the student always practices procedures using the correct patient orientation.

Tactile Robotics Other Products and Services

DataRX-C™

TeleRX™

DataRX-W™

TR-Tracker™

DataRX-WMO™

XR-Sol™

TeleSignaller™

SC-Sol™

Proud Partners and Collaborators



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