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Innovations in Education and Technology

Jacquelyn L Fried, RDH, MS

Ms. Jacquelyn L. Fried is Associate Professor and Director of the Dental Hygiene Program in the Department of Health Promotion and Policy at the University of Maryland Dental School. She received a Bachelor of Arts degree in political science and a Certificate in Dental Hygiene from the Ohio State University. She also holds a Master of Science in Dental Hygiene from Old Dominion University. She has been in dental hygiene education for almost thirty years. Ms. Fried is known internationally for her involvement in research, didactic and community activities related to tobacco. Recently she has initiated investigations into the technological aspects of teaching and learning. Ms. Fried is widely published and has authored numerous manuscripts and book chapters. She has been honored for her teaching abilities and is a recipient of The Warner Lambert (now Pfizer)/American Dental Hygienists' Association Award of Excellence.

The purpose of this section is to feature short reports of innovative teaching applications and techniques as well as new technologies available for increased communication and learning in dental hygiene education.

Dental Hygiene Education: New Horizons in Technology

A key force in advancing a profession is the quality of education its members receive. The formal dental hygiene educational process begins with entry level programs. Thus, the provision of quality education primarily rests with dental hygiene educators. New challenges confront the dental hygiene educator of today. Specifically, dental hygiene educators must consider the characteristics of today's students and develop effective teaching strategies to meet their needs.[1]

Society is in the midst of a technological boom that has profound effects on how faculty teach and students learn.[1,2] Dental hygiene education is not immune to these developments and already is responding to critical external forces by offering online courses and computer-based learning activities.[3] The students of today are raised in a world of computers, high-speed internet, instant messaging, and iPods, and the list of new technologies to which they are exposed continues to grow exponentially.[1,4] To be effective, dental hygiene educators must acknowledge the "millennium" students of today and provide learning options that mesh with their orientations and needs.

"Millennials" are students born after 1980 who are described as possessing definitive value systems. Typically, they are inclusive and tolerant of others, hard-working, team-oriented, and structured.[4] Millennials believe that multitasking is efficient, not inconsiderate. Everyday life for them includes checking emails, blogging, viewing videos on their cell phones, and accessing remote sites. They shop on eBay, access information through Google, and "talk" to friends on different continents instantaneously. These students are used to getting what they want when they want it; in other words, quick access.[1,4] The act of quickly accessing and using information is universal; however, when and how this behavior takes place can be very individualized. For example, one student may prefer to shop on eBay at 3:00 AM while another may purchase an item at 12 noon. Instant access allows for self-paced activity-a clear opportunity for the dental hygiene educator.

Computer technology avails students to remote site learning.[1-4] Globalization permits a student in the United States to access a course offered at an African university. Students today learn from the comforts of their living room couches while

still wearing their pajamas. A culture of multi-tasking enables students to walk down the street and send an email simultaneously. MP3 players play music and show movies. Students can brush their teeth while learning their dental anatomy.

Addressing the learning needs of the sophisticated student of today is challenging but doable. Many different types of electronic technology have been developed and are available for teaching the millennials. Reports indicate that electronic learning is not a panacea.[3-7] Diminishing a sense of isolation and maintaining a *community of students* is particularly challenging.[5] However, keeping pace with today's advances and catering to the characteristics of the new learner is incumbent upon institutions of higher learning.

Innovations at the University of Maryland School of Dentistry Division of Dental Hygiene

Remote Site Teaching

The Division of Dental Hygiene at Maryland has been fortunate in that the deans and administration have provided strong support for its program. The University of Maryland, Baltimore's (UMB's) previous Dental School Dean Dr. Richard Ranney proposed an increase in the dental hygiene class size, and in 2005, this vision became a reality under UMB's current Dean Dr. Christian Stohler. At UMB, the entering classes of 2005 and 2006 include 8 more students than the number admitted in Fall 2004.

The vision to increase the number of UMB graduates came to fruition for a variety of reasons. First and foremost, was the realization that there was an increased demand by students to enter the dental hygiene profession. It also became clear that there was a particular need for more dental hygienists on the eastern shore of Maryland and the students in that region were expressing an interest in pursuing a dental hygiene degree. Maryland dental practitioners, the Eastern Shore Dental Society, nondental health professionals, and the citizenry of Maryland verbalized the desire for Maryland to graduate more dental hygienists.

Taking all these factors into account and realizing the capabilities offered by a new state of the art facility, the practicality of starting a remote site dental hygiene program on the eastern shore was within reach.

Geographically, the eastern shore of Maryland is separated from the rest of the state by the Chesapeake Bay. From some areas of the eastern shore, the commute to Baltimore (ie, the UMB Dental School) can take more than 3 hours. While many eastern shore students have expressed an interest in pursuing a career in dental hygiene, many students opted not to apply to the UMB program due to the distance and time involved to participate.

The division initiated dialogue with 2 community colleges on the eastern shore of Maryland to determine if a collaborative relationship could be developed. Negotiations between these 2 entities and the Division of Dental Hygiene began in 2004 and a Memorandum of Understanding (MOU) was reached in 2005. To lay the groundwork, a preprofessional dental hygiene Associate of Science (AS) curriculum was established at the 2 eastern shore institutions. The MOU stipulated that students would pursue a pre-professional dental hygiene degree and then, upon completion of their professional studies, be conferred a baccalaureate degree in Dental Hygiene from the University of Maryland. For the professional education piece, didactic courses would be delivered online and clinical experiences would occur at a clinical facility on the eastern shore. Therefore, in addition to increasing the class size at the UM campus, beginning in Fall 2006, additional students will begin their dental hygiene studies online and obtain clinical education at a remote site on Maryland's eastern shore. This satellite program initially will accept 4 "first year" students and hopefully expand to 10 new students at the junior level starting in Fall 2007.

The New Building

The 2006 opening of a new state-of-the-art dental school in Baltimore is the key factor that allowed the curriculum transformation to online learning and hence, accessibility for eastern shore students. In the late 1990s, a bill funding the new dental school facility was passed by the Maryland State Legislature. The building has been designed to house cutting edge technology that will address the needs of the millennial student and will mesh with remote site learning. The technology will allow video-conferencing, online testing, utilization of software that enables students to "hear and see" their faculty,

and sophisticated communication channels to ensure that dental hygiene students, regardless of where they live and study, will share identical curriculum and learning experiences.

The New Technology

It is important to note that many different types of electronic technology are available for teaching the "millennials." The configuration used at the University of Maryland is one methodology. In describing the Maryland approach, emphasis will be placed on the ways this technology fosters effective teaching and learning. Ultimately, it is the appropriate application and usage of technological teaching methods that determines their effectiveness. The packaging of technology, ie, how the different components interconnect, is an important aspect of enhanced learning.[8]

On some level, many dental hygiene educators are utilizing e-learning.[3] Many institutions provide online teaching modules that allow student access to information 24/7.[3] The UM configuration fosters self-paced, self-directed learning by offering a broad scope of technologies that enable students to access information in multiple environments. Basically, the software that UM employs allows students to access learning modules and resources via their laptops at home, in the school's clinical environments, and in the simulation settings. The school's intranet connects all simulation areas to each other and allows the user to call up the same software there as in the clinic.

The Simulation Environment

The simulation environment provides students with preclinical experiences and offers a seamless transition to the clinical setting. Simulation work stations are equipped with phantom patients (Figures 1,2) that promote operator ergonomics (Figures 3,4), an instrument console identical to that provided in clinic units, and mounted flat panel displays and computers.[9] When in this environment, on their screen, students are able to access a simulated electronic patient record (EPR) of choice and essentially use the information to provide treatment to the phantom (simulator) patient. This treatment is identical to the care rendered to a real patient. (Figure 5) This simulation opportunity allows the student to prepare for the actual clinical patient treatment. Online information (eg, pathology, anatomy) related to the patient's care can be accessed at any time to facilitate development of an in-depth and effective treatment plan.

Figure 1: Provider with Phantom Patient

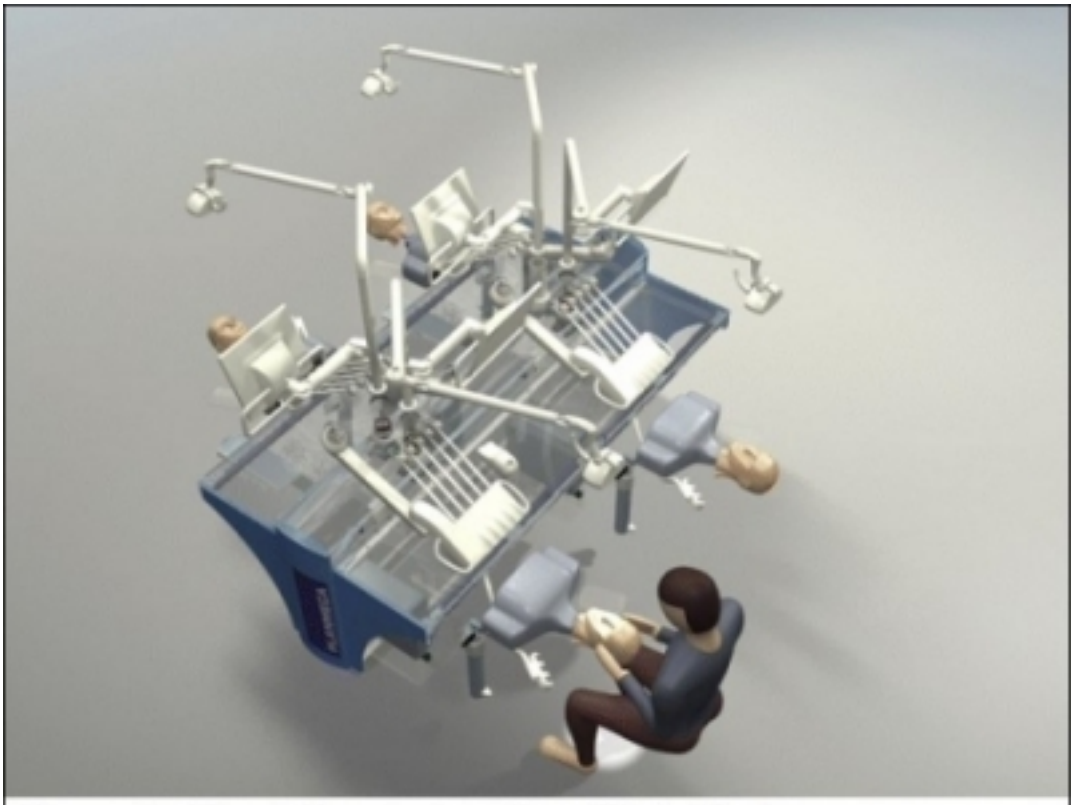

Figure 2: Simulation Laboratory Work Station

Figure 3: Ergonomic Advantages of Simulator

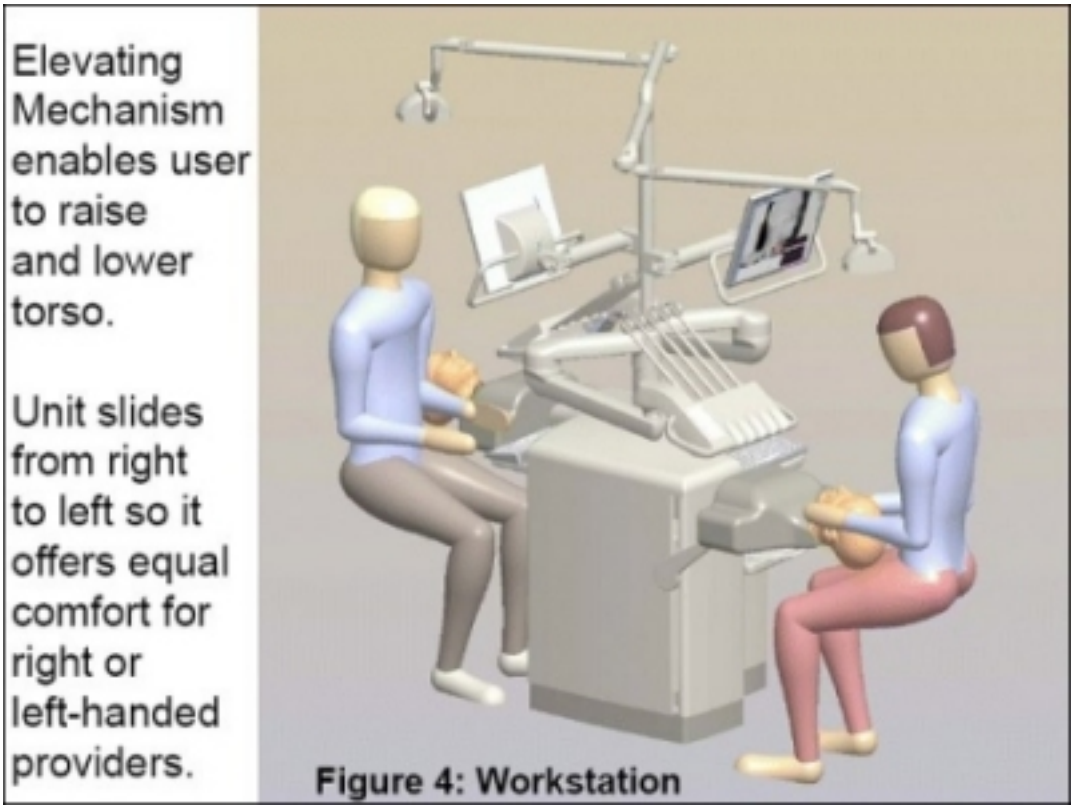

Figure 4: Workstation

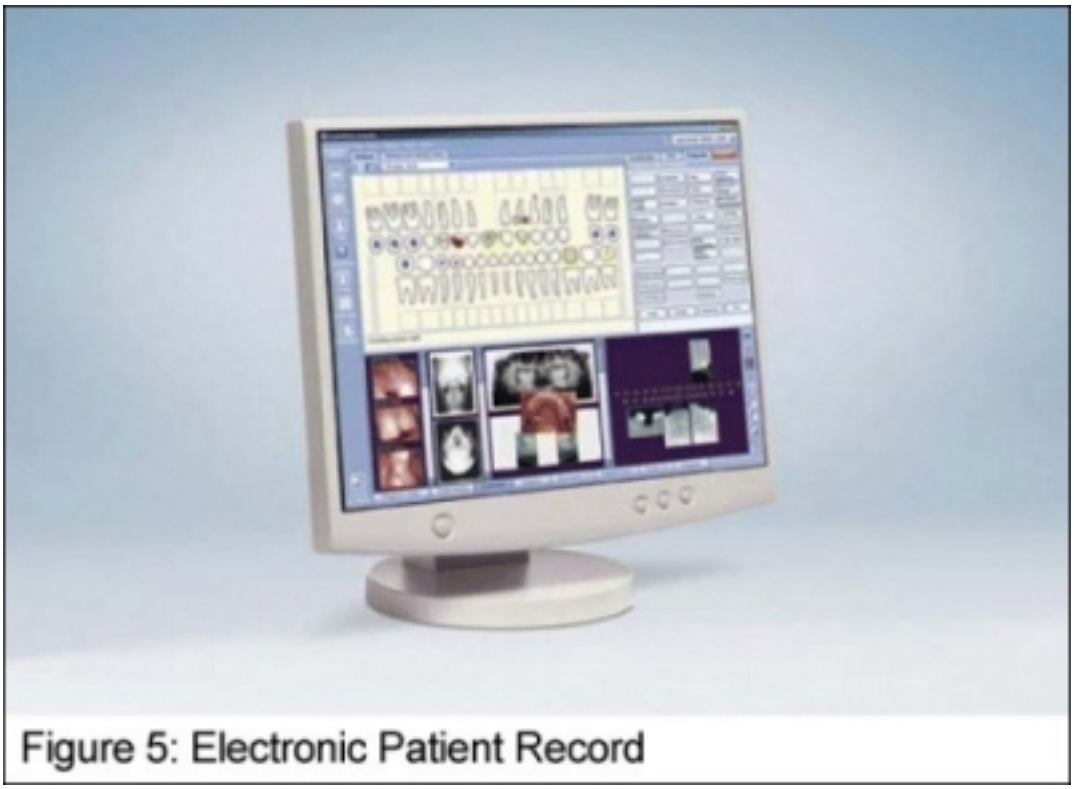

Figure 5: Electronic Patient Record

Video-superimposition software in the simulation areas allow an intra-oral camera, which is attached to the simulation station, to capture an image (eg, student instrumentation) and then permit that image's superimposition on top of the ideal.

In essence, the student's instrumentation visually appears on the screen with the ideal as a comparison. This technology facilitates students' self-assessment of their instrumentation skills and enables real time visual learning.[10-12] Mobile "X-ray" boxes also are available in the simulation area. Students can place the mannekin typodonts into a cradle that houses a digital sensor, permitting the simulation of digital radiography.

Some simulation units are equipped with haptic devices (Figure 6). Haptic is derived from the Greek word *haptikos* (to grasp or touch) and is defined in English as "tactile or anything related to the sense of touch."[13] Incorporated into haptic devices are tactile cues (eg, the bumpiness of calculus) as well as kinesthetic cues (eg, the resistance of the tooth enamel).[14] By controlling the movement of the selected instrument (eg, explorer, curet, etc.) through the use of a small lever mounted on the haptic hardware, the student learns to differentiate between calculus and tooth structure. With these built in cues, the student can learn scaling on a virtual tooth and learn and discern the different textures of calculus and tooth structure. The way in which the student manages the instrument's movement through the use of the pod handle is projected onto the computer monitor. By watching the monitor, the student can modify his or her "navigation" of the instrument and learn ideal angulation, grasp, exploratory, and activation strokes. Student self-assessment is built into this approach. The student can switch between various instruments at will; this freedom promotes self-paced learning and facilitates students' achievement of preclinical competency.

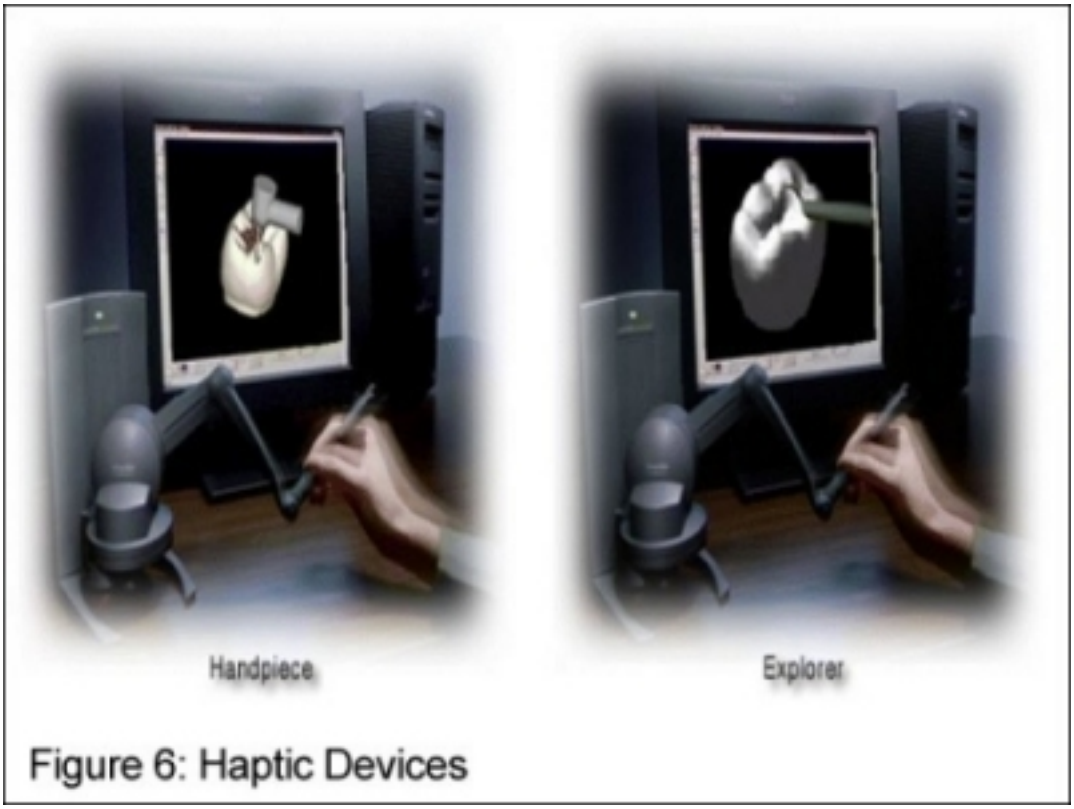

Figure 6: Haptic Devices

Other features of the combined haptic technology and a digitized system include remote faculty access to students' virtual instrumentation and student access to video superimposition when using the haptic device (Figure 6). Remote site access for faculty observation allows faculty to assess students' instrumentation skills from beginning to end, something often traditionally difficult for faculty to accomplish. Students receive concentrated individualized attention, including both "process and product" evaluation. Close monitoring by faculty helps pinpoint students needing additional assistance. This monitoring also can facilitate equitable distribution of faculty; the students needing the most help will have greater faculty coverage than those who do not.

Through the school intranet system, all simulation units are networked to each other and to all teaching stations, allowing student to student, faculty to faculty, and student to faculty communication. With the use of microscopes, this networking

system also allows faculty to stream magnified images to all students simultaneously in real time. The benefits of the microscope for teaching purposes are many. First, faculty can project images that are many times larger than the object's actual size; thus, difficult concepts for students to visualize such as proper curette angulation are understood more readily. Microscopes vary in their enlargement capacity. Images can be up to 10 times larger than they really are. Simultaneous visualization supports group questions and enables the immediate provision and demonstration of accurate feedback. Video cameras mounted on the microscope also allow students to tape themselves practicing instrumentation. These images can be displayed for student and faculty review at any time.

Web cam technology also allows for remote monitoring of students in the simulation areas and clinics anywhere in the building. Since all simulator stations and dental chairs are interconnected via the internal building network, a student can be monitored at any time in both environments. Web-camera viewing angles can be adjusted from wide-angle to close up. These different perspectives allow faculty to see the whole person or the actual task being undertaken; "hands only." Scrupulous monitoring of psychomotor skills allows for early identification of problems. Since equipment in the simulation area and the clinic are identical and all software is available at both teaching sites, essentially, the simulation area becomes a "virtual classroom." The availability of the entire didactic curriculum plus internet-based resources allows students to study and practice simulation independently of faculty and at their own pace. These capabilities foster student self-confidence and ease the transition to the clinical environment.

The Clinical Environment

Clinical work spaces are ergonomically designed and house digital units and comfortable, soft leather patient chairs. Dental units include mounted liquid crystal diode (LCD) plasma screens that can display electronic patient records. A specifically designed software program integrates digital radiographic data and patient data on the electronic patient record so the provider can view all of this information on the same screen simultaneously. With all patient data accessible, a comprehensive understanding of the patient is readily obtained. Effective time management and productivity are enhanced. Patients also can view their own oral images on the LCD, affording potential learning and motivational opportunities.

All operator consoles have 5 openings for plug and play instruments of the provider's choice and need. For every unit, one opening houses a triple syringe that is mounted on a side arm. Over 29 options are available for plugging into the other 4 openings; some examples are curing lights, trans-illuminating lights, piezo scalers, hand pieces, intra-oral cameras, and low speed and high speed hand pieces. The digitally run unit knows what instrument a provider is using once it is selected and activates it accordingly. The amount of water and speed used with a particular instrument can be digitally programmed as can the chair position.

Controlling for Disease Transmission

Several devices that are part of the UM technology are designed to reduce the potential for disease transmission. A comprehensive electronic patient record was an example previously mentioned; a "virtual keyboard" is another (Figure 7). Computer keyboards are notorious for harboring bacteria. A "virtual keyboard" essentially is a laser beamed hologram that can be projected onto any flat surface.[13] Its light source emanates from a small projection device which is either directly connected to a PC via *Universal Serial Bus* (USB)[15] or via wireless technology. The device also contains a small camera which uses optical recognition technology to allow the user to tap the images of the keys, complete with realistic tapping sounds, which then feeds into the laptop or PC. Students and faculty can "type" on the "virtual keyboard" and only the projection surface requires disinfection.[16] This feature protects both patients and providers.

Figure 7: Virtual Keyboard and Plasma Screen

Software

Aside from the software system that integrates patient data, software is also needed to enhance students' educational experiences. This system synchronizes curriculum content and applicable information into a student-friendly package, ie, one that is easily accessible, understandable, logically ordered, and useful. An application of this software might include a "library" that catalogues information on pathology. A student could then search for all information available on, for example, fibromas. With this software, available intranet sources, and internet Web sites would be pulled up and displayed. This information then could be used for patient treatment, a case study, or for board preparation.

Summary

When thought out and well-packaged, new technologies provide exciting learning opportunities for students and faculty alike. Although a challenging learning curve exists for all, effective training, a positive orientation spells success.[3,5,16] Faculty mentors who share their personal experiences related to online and remote site teaching can be a valuable resource to other educators trying to incorporate innovative learning technologies. Successful teaching and learning strategies can then be incorporated into curricula, affording dental hygiene graduates the highest level of quality education.

Since the UMB curriculum transformation is new, outcomes data are not yet available. However, there is evidence that how students are taught influences their practice behaviors.[17-18] With the increasing introduction of technology into dental hygiene employment environments, the millennial graduates' exposure to advanced technology learning may help them transition from academics to the real world of dental hygiene practice. This paper has highlighted some of the benefits available in a learning environment geared to the student of the 21st century. Recognizing the needs of today's student population and how individuals learn reinforces the importance and necessity for high technology offerings.[1-2,4] The wave of the future is here and dental hygiene education will be on its crest.

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