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Information and Communication Technology in Dental Education: Benefits and Drawbacks.

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ABSTRACT:

In today's world information and communication technology offers benefits to dental education through online tutorials, virtual stimulation and video based teaching etc that would stimulate face to face teaching in classrooms and clinics later. Several studies have shown that virtual learning significantly improves a student thought process; helps integrate and link theoretical ideas with clinical practice. Technology also helps students to repeatedly return to resources allowing them to take the responsibility of their study at their own pace.
The aim of dental education is to produce a dental surgeon with prescribed packages of knowledge upon graduation and be able to practice safe and ethical dentistry for the human race. In the past medical and dental education was teacher centric with students mainly learning what the teacher chose to teach them but recent advances in education, because of information and communication technology, health sciences education is also becoming more and more student centric.
Benefits :*Use of technology and e learning aids such as online tutorials, video based learning, simulation training in dental education" etc, improves knowledge, makes teaching and learning more stimulating, attractive, interesting, fun to explore, and eye catching . Rich media resources such compact and digital video discs (CDs, DVDs), online videos, animations etc enhance 3D visualization, exploration, branching, manipulating and interacting by the student. These resources also help prepare students prior to face to face class room teaching. Video based teaching helps them return to resources at anyplace and anytime following a class or for continuing professional development later. More importantly online teaching and learning is always available anywhere and at anytime.*
Drawbacks: *Among all the advantages and glamour of e learning it has few worrying points: 1) Quality of these learning resources. Learning materials should have well defined learning objectives, should be peer reviewed to ensure content validity, accuracy, currency, use of evidence based data and use of best practices.*
2) Significant cost of technology, 3) Attitude of academics towards use of technology, Faculty resistance based upon intellectual property concerns or concerns that students will elect to not attend lectures.

The present article is an update on the potential of information and communication technology in dentistry. It seeks to encourage open access to e learning material, platform and programs and also outlines the strategies and recommendations to improve the quality of dental education in India.

Keywords: e learning, virtual reality, digital dentistry.

INTRODUCTION

Motivation is a form of initiating and directing behaviour towards a particular goal. Cognition as defined by **'Bichard'** is the manipulation of encoded representations in memory (2003). These two are closely associated terms as motivation affects as to how learners process information thus enhancing cognition and bettering learning outcomes. **'Don Tapscott'** in his book "growing up digital" termed the present generation as the "next generation" (1998). Students having grown up on digital media arrive on campuses equipped with smartphones, tablets and laptops and with wide access to information via e books, internet etc the balance of power between the teacher and the students has changed with the teacher not being the sole knowledge provider**(Pyle ,2012).** The task of academics engaged in teaching is to stimulate student's motivation and cognition. With today's technogical advancement curriculum developers in dental education worldwide have moved towards digital resources.

Dentistry is clinical discipline incorporating both art and science that makes dental education a demanding area of education which requires a budding dentist to not only acquire large amount of knowledge of dental and medical subjects but also acquire clinical acumen, problem solving abilities and put these skills into action in the clinics later on. Currently Training of dental students includes a combination of preclinical operative training which includes theoretical teaching and practical exercises in the laboratory under intense supervision, followed by clinical practical skills development by patient consultation, physical examination, if required special tests like radiographs, scans, biochemical tests etc, to synthesize and integrate this information with his own knowledge and experience in order to diagnose and manage the patients problem. Training also involves a period of internship where a student manages patients individually but under closed supervision. This time-tested method unfortunately sometime subjects the patients to discomfort, risk of complications and prolonged treatment times **(Mihaela Dutã 2011).** To gain proficiency in simpler treatment methods a lot of time is consumed and a student remains inadequately trained for more complex scenarios.

The aim of dental education is to produce a dental surgeon with prescribed packages of knowledge upon graduation and be able to practice safe and ethical dentistry for the human race .In the past medical and dental education was teacher centric with students learning what the teacher chose to teach them but recent advances in education, information and communication technology the health sciences education is becoming more and more student centric. Information and communication technology offers benefits to dental education through: online tutorials, virtual and augmented reality stimulation, video based teaching using interactive white boards, etc to stimulate and enhance face to face teaching in the classrooms and clinics later (Masud etal 2013).Several studies have shown that virtual learning significantly improves a student's thought process, helps them integrate and theoretical ideas with clinical practice. Studies (**Durham et al,2009)**have suggested that video based teaching has enabled a large percentage of students to improve their capability to deal with patients in fear and pain and also help them put theoretical knowledge into clinical action sooner than otherwise. Online tutorials and assessment help students to repeatedly return to resources anywhere and anytime, allowing them to take responsibility of their own study at their own pace **(Linjawi,2009).**

Aims: Against this background, the aims of this paper are to provide an overview of the recent developments and future potential of the use of information and communication technology in the field of dental education.

Methods: A literature review was performed using the search terms "virtual learning", "information technology in dentistry", "e-learning in dental education" etc. Further literature search was identified from the reference list of the papers accessed via *Pub med, Springer online, Wiley online* and by searching the *World Wide Web.* The search included abstracts, books and online publications from year 1995 to 2013.

Computer based learning tools in dentistry

The infusion of new digital learning technologies particularly those delivered online is challenging the traditional lecture and clinical settings. The web 2.0 and new media has changed as to how we produce and share information. Computer-based learning tools such as intelligent tutoring systems, medical simulation, virtual reality techniques and the development of Web 2.0 based collaborative authoring and social networking tool has an impact on:

1. education,
2. clinical care
3. And research in both medicine and dentistry.

Education

The ease of access to information in digital formats has changed the traditional role of dental educators from content provider to learning facilitator. Communications or social software tools, such as email, wikis, newsgroups, blogs, facebook, and twitter enhance the collaborative learning between teacher and student and student themselves. Rich media resources on compact and digital video discs (CDs, DVDs) enhance 3D visualization, exploration, branching, manipulating and interacting by the student. These resources also help prepare students prior to face to face class room teaching. Video based teaching helps them return to resources at anyplace and anytime following a class or for continuing professional development later.

Interactive white boards, online tutorials, virtual and augmented reality simulation are the frequently employed tools used in dental education in the western world. Use of technology in developing countries like India is in the infancy stage.

Interactive white boards (IWB) – help broaden the use of e-learning making it easy for teachers to enhance their presentation content by easily integrating a wide range of material into a lecture, such as a picture from the internet, a graph from a spreadsheet or text from a Microsoft Word file, clinical video or animation. The IWBs provide the necessary infrastructure for real-time, large screen engagement with not only WebCT or Moodle resources, but also open-access and online resources and multimedia software. With IWBs, the innovative resources for problem based learning have been technologically upgraded to include interactive 3-D objects and in-house videos of clinical procedures using intra-oral cameras etc **(Y.Yang etal, 2012).** High resolution radiographs and oral photographs can be posted in the learning management system and students can manipulate these objects using

zoom functions etc. to examine evidence in greater depth and with improved visual clarity **(Bridges, Botelho, Green, & Chau, 2012).**IWB's can be integrated with classroom response systems using clickers based on infrared or radio signals, by which teachers can present material and receive feedback from students in order to direct instruction more effectively or else to carry out formal assessments.

Virtual and augmented reality simulation

Currently Training of dental students includes a combination of preclinical operative training which includes theoretical teaching and practical exercises in the laboratory under intense supervision. Preclinical laboratory training is followed by clinical practical skills development that involves patient consultation, physical examination, if required special tests like radiographs, scans, biochemical tests etc, to synthesize and integrate this information with his own knowledge and experience to diagnose and manage the patient's problem. Training also involves a period of internship where a student manages patients individually but under close supervision. This time-tested method unfortunately sometime subjects the patients to discomfort, risk of complications and prolonged treatment times. To gain proficiency in simpler treatment methods a lot of time is consumed and a student remains inadequately trained for more complex scenarios.

Virtual and augmented reality technologies can provide an answer to the above mentioned time tested methods of training of dental students. This technology enables simulation of practical procedures in three dimensions. Virtual and augmented reality technologies can be used to simulate and assess clinical techniques used in dentistry. They can provide unlimited access to practice sessions, the immediate feedback needed for learning, and allow a standardized assessment of the skills acquired by students. Complex scenarios can be repeatedly practiced and mastered. Realisation of the benefits of this technology provides an impetus for the development of newer and more advance systems. A few of these virtual simulation tools are mentioned below.

DentSim

DentSim was one of the first; if not the first, virtual reality system for teaching restorative dentistry. In this system a student is provided with case history information about the simulated patient **(Michaela et al 2011).** There is on-screen visual tracking of the procedure he is performing, real-time digital feedback and evaluation of procedures performed. Since the early 2000s, the system has been used in a number of dental schools in North America and Europe; reports of its evaluations indicate that it is effective in enabling students to work without the need for a supervisor (teacher), to assess their performance critically, and to monitor their performance.

The Geneva System

For the past six years, the Geneva Dental School, Department of Cariology, University of Geneva, Switzerland, has been developing innovative concepts using computer three-dimensional simulation for the teaching of dental anatomy. The aim was to validate the added value of information technology integration into curriculum. The results showed that 70% of the students were satisfied or very satisfied with this module and that the simulation boosted their motivation to learn dental anatomy **(Michaela et al 2011, Curnier, 2010)**.

The Virtual Dental Patient

Developed by AIIA Laboratory Computer Vision and Image Processing Group, Department of Informatics, Aristotle University of Thessaloniki Greece. The VDP was designed to aid students to become acquainted with tooth anatomy, the handling of drilling instruments and the challenges associated with the drilling procedure. The virtual tooth drilling is performed on three-dimensional volumetric dental models from a database that has been constructed by digitising and post-processing (alignment and segmentation) cross-sections of extracted teeth, viewed through an optical microscope(Welk 2006,Gartner 2005,rees 2007,Michaela et al 2011,).

PerioSim©

A prototype of a dental simulator for training in periodontal procedures **(Luciano 2009, Michaela et al 2011)**. It allows trainees to learn how to diagnose and treat periodontal diseases by visualising a three-dimensional virtual human mouth and experiencing tactile sensations while touching the surface of teeth, gingivae, and calculus with virtual dental instruments. It is being used at the department of Periodontology, C. J. Luciano, College of Dentistry, University of Illinois,Chicago.

HapTEL

The HapTEL system has been developed as collaboration between the King's College London Dental Institute and Reading University, U.K. It is based on a haptic unit, which has been adapted from a computer gaming device. It includes two screens that enable the user to look down onto a simulated jaw as if they were treating a real patient, specifically designed software that gives flexibility to the drilling position and lightness of touch, and a foot pedal to control the speed of the bur. Users are able to replay the procedure that they have performed and to assess their skills. The percentage of caries removed and the percentage of hard tissue removed are fed back to them as a score. The scores are stored so that students and their teachers can monitor progress. A range of simulations is available, starting with simple caries in a tooth and progressing to more complex caries **(Luciano 2006, Tse 2010, Michaela 2011).**

Use of this technology has the potential to improve the quality of dental education and the clinical skills of both medical and dental undergraduates before they apply these skills to the care of live patients, thus minimising the risk of iatrogenic damage to patients. The only barrier to this is the cost of such technology especially in the developing countries.

Online tutorials

High speed data sharing has enabled secure access to Video based tutorials, on demand tutorials, online videoconferencing and webinars. This has increased the potential for interaction among participants even who are geographically scattered. Opportunities for continuing education are enhanced by videoconferencing and webinars. Webcasts and podcasts reinforce presentations with a variety of rich media; provide 'on-demand' viewing for the busy dental professional and the ability to replay as often as needed.

Clinical care

Electronic dental records having replaced paper connect patient information to clinical care, administrative, educational and research activities. They are used to collaborate patients clinical information between health care providers hence connect oral health to a patients systemic health and also help in a collective decision making for diagnosis and treatment planning. The vast data resourced through these records could be shared easily for educational and collaborative research among educational institutions.

Teledentistry: Teledentistry is a field that combines telecommunication technology involving the exchange of clinical information and images over remote distances for dental consultation and treatment planning. Teledentistry can improve access to oral healthcare, improve the delivery of oral healthcare, and lower its costs. It also has the potential to eliminate the disparities in oral health care between rural and urban communities. Both "real time consultation" and "store and forward" methods of tele-consultation are used in teledentistry. Video conferencing enables real time consultation .Store and forward teledentistry has its use for consultation and treatment planning of complex cases, community education programmes etc **(Jampani N 2011).**

Research:
Computer science, information science, statistics, biomedical informatics, and other fields are driving significant advances in computational methods for analyzing and processing data. The vast data available in the form of electronic patient records can be used for newer research. Biomedical informatics has a role in making data accessible, connecting existing data sources, and building better tools to analyze medical data and draw meaningful conclusions and secondarily use this available data for research purposes **(Titus K. Schreyer et al 2012).**

DRAWBACKS

Among all the advantages and glamour of e learning it has few worrying points.

Content Validity: Important to note here is that it becomes imperative upon the teacher and the institution to ensure the quality of these learning resources. Learning materials should have well defined learning objectives, should be peer reviewed to ensure content validity, accuracy, currency, use of evidence based data and use of best practices.
Faculty engagement: development of e- learning material requires a significant amount of time, dedication and patience on part of the faculty. Dental and medical academics already engaged in teaching, clinical patient work, involvement in research activities as part of their professional development, find it increasingly difficult to develop e learning resources and also interact online with students. Also the present system offers no rewards, incentives and recognition to academics so as to encourage them to take up technology assistance in their teaching programmes.
Lack of face-to-face interaction: The lack of face-to-face interactions with other peers and the instructor can be a disadvantage for the students and professors. For instance, some students desire the immediate feedback from the professor, which they do not get online.

Also virtual and augmented reality simulation technology offers a virtual patient to the student and without a face to face interaction with the patient the students do not develop an emotional bonding and a humanitarian approach in treating their patients. An example is the preclinical lab training of dental students. Lab classes require a great amount of hands-on work. Online courses cannot offer the hands-on experience that an in class lab could offer. This is not to say that some of the lab exercises can be done by the computer, because it can. However, Internet cannot duplicate the hands on approach students experience with an in preclinical laboratory.

Up-front investment: The learning management systems, simulation technologies etc earlier described for dental education that are being used in western countries require huge upfront investments because millions of dollars have been spent to develop these resources and technologies. The initial cost of tech is the single most important restraint for dental institutions in the developing countries like India.

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