

EDUCATION BASED ON TECHNOLOGICAL RESOURCES IN DENTISTRY: A PARADIGM SHIFT

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ABSTRACT

Dentistry is constantly evolving, adopting tools based on digital flow, such as patient scheduling, digital photography, more efficient and comfortable work areas with equipment adapted to the patient, as well as impression taking employing scanners (dental molds) that allow the process to be carried out quickly, cleanly and reliably. In addition, the construction of prosthetic materials (inlays, onlays, veneers, prostheses) can be carried out immediately using 3-D reproduction equipment, such as Computer-Aided Design Computer-Aided Manufacturing (CAD-CAM). Dental education must use these tools to train future health professionals in an area that, if neglected, could represent a disadvantage for professionals in training. Therefore, it is essential to periodically review the curricula and the available evidence to make the necessary adjustments and meet the demands of the health system and the population. This author proposes a paradigm shift that should begin with a transforming axis so that the transformed axis receives current, dynamic knowledge aligned with current trends.

Keywords: Education, dentistry, digital technology.

RESUMEN

La odontología evoluciona constantemente, adoptando herramientas basadas en el flujo digital, como la programación de pacientes, la fotografía digital, áreas de trabajo más eficientes y cómodas con equipos adaptados al paciente, así como la toma de impresiones mediante escáneres (moldes dentales) que permiten realizar el proceso de forma rápida, limpia y fiable. Además, la construcción de materiales protésicos (inlays, onlays, carillas, prótesis) puede realizarse de forma inmediata utilizando equipos de reproducción en 3D, como el diseño asistido por ordenador (CAD-CAM). La educación odontológica debe utilizar estas herramientas para formar a los futuros profesionales de la salud en un área que, si se descuida, podría representar una desventaja para los profesionales en formación. Por ello, es fundamental revisar periódicamente los planes de estudio y la evidencia disponible para realizar los ajustes necesarios y atender las demandas del sistema de salud y de la población. Este autor propone un cambio de paradigma que debe partir de un eje transformador para que el eje transformado reciba conocimientos actuales, dinámicos y alineados con las tendencias actuales.

Palabras clave: Educación, odontología, tecnología digital

INTRODUCTION

Dentistry is a service-oriented profession, which requires that its teaching-learning processes be continuously adapted to social, demographic, scientific, and technological changes. This approach aims to train experts with a comprehensive graduate profile, based on knowledge, skills, and attitudes aligned with social needs and current reality. In this context, dental practice is developed in a constantly evolving digital environment, incorporating tools based on digital flow that optimize the management and execution of clinical procedures. These technologies include digital scheduling systems, high-precision clinical photography, and workspaces designed to improve efficiency and comfort for both the patient and the professional. In addition, digitalization has revolutionized the taking of dental impressions using intraoral scanners, which allow three-dimensional models to be obtained quickly, accurately, and hygienically, thus facilitating the immediate fabrication of prosthetic restorations, such as inlays, veneers, and prostheses. This process is enhanced by advanced three-dimensional reproduction technologies, such as computer-aided design and manufacturing (CAD-CAM) and 3D printing, which optimize precision, quality, and production times in oral rehabilitation.¹

The dental training should integrate digital tools in the teaching-learning process to ensure the training of competent professionals. The omission of these resources could generate gaps that are difficult to overcome in their academic and clinical development.

Information and communication technologies (ICT) play a central role in educational innovation. The generations of digital natives, including current students, demand their strategic incorporation in teaching, which has prompted dental schools to adopt these tools. However, it is necessary to evaluate whether their implementation effectively contributes to the improvement of academic performance.¹

The Regional Conferences on Higher Education (CRES) have been convened by the International Institute of UNESCO (2018) in which important statements are made about the future of education in Latin America, "It is imperative and indispensable that today our institutions of higher education are actively committed to social, cultural, political, artistic, economic and technological transformation". We must educate tomorrow's leaders with a social conscience and with a vocation for Latin American and Caribbean brotherhood. States and higher education

institutions must develop linkage strategies and collaborative programs at the undergraduate and graduate levels, guaranteeing resources for innovation, science, technology, and research, thus avoiding the disconnection between higher education and the productive environment.²

The training of teachers as strategic learners is the first link in the adoption of new methodologies since their training has a direct impact on the quality of learning.³ The implementation of technology in dental education not only responds to a pedagogical need but also facilitates the adaptation of students to scientific and technological advances in clinical practice.

Globally, the digitization of dental education has advanced at different rates according to local resources and needs. One of the biggest challenges is the constant updating of curricula to integrate digital tools into teaching and professional practice. The effectiveness of this transition will depend on the technological knowledge of teachers, their disposition towards educational innovation, and the organizational conditions of each institution.^{4,5}

Therefore, a paradigm shift is proposed that must begin with the transforming axis of the educational process, ensuring that knowledge is current, dynamic, and based on current trends.

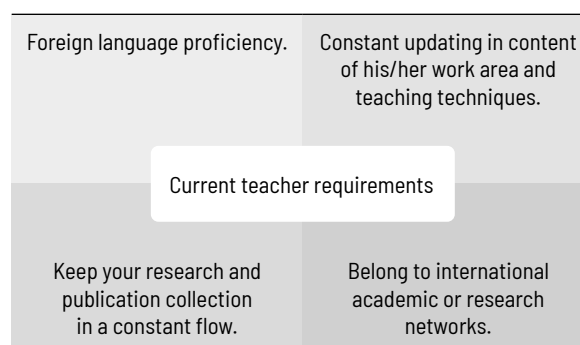


Figure 1. Teacher requirements in today's world. Own elaboration.

Criticism of the Educational System in Dentistry

Despite technological advances, the incorporation of digital tools in dental education remains uneven and slow, leading to significant disparities in student training. The lack of access to innovations such as virtual reality or interactive platforms limits the development of essential clinical skills, affecting the quality of hands-on learning. In addition, the traditional educational model continues

to focus mainly on the technical side of dentistry, leaving aside training in ethics and communication, two fundamental aspects for an effective relationship with the patient.⁶

Young dentists, in particular, lack the skills necessary to clearly and understandably explain new technological procedures to their patients. This deficiency in communication education compromises dentists' ability to build trust, which is crucial for successful treatment. Education must evolve to balance both the technical aspect and the development of interpersonal skills, as comprehensive training is key to providing quality care and fostering effective professional relationships with patients.

Another crucial challenge is the limited interdisciplinary integration with various areas of healthcare. The lack of a collaborative approach hinders the development of more effective treatment strategies and the optimization of healthcare. In addition, this lack of integration hinders the potential of education that fosters interprofessional, supported by technology, which could provide a more comprehensive and enriching approach.⁶

Paradigm shift

The traditional model of teaching in dentistry faces several challenges, and one of the most prominent is the resistance to change on the part of certain teachers. In my opinion, underinvestment in educational technology and the lack of continuing education programs for faculty amplify this gap, especially in regions with limited resources. It is imperative that, in contemporary dentistry, future professionals not only master fundamental knowledge but also become proficient in the use of advanced technologies. Through the implementation of digital strategies in teaching, comprehensive training could be achieved that prepares dentists to meet the challenges of a globalized and technologically demanding market. Making a paradigm shift implies a more active adoption of digital tools in the curriculum, which would not only improve the quality of education but also ensure that the dentists of the future are at the forefront of professional and technological demands.⁷

Education in dentistry is structured in three fundamental components. First, is theoretical learning, based on lectures and methodologies such as problem-based learning (PBL). Second, simulation laboratory training, where students practice on models following a teaching demonstration. Finally, the third part is the clinical training, which represents the major part of the training and

takes place in dental practices, rotations, and clinics, where students apply their knowledge in direct contact with patients under teaching supervision.⁸

Impact of Digital Tools on Education

ICT-based teaching techniques have reduced information obsolescence and facilitated access to interactive educational resources, promoting more effective teaching methodologies.⁹ These tools enhance the development of skills in written, graphic, and audiovisual expression.¹⁰ In addition to enabling the simulation of physical, chemical, and biological processes in three-dimensional environments.¹¹ They also improve communication between teachers and students through synchronous and asynchronous interactions, favoring the exchange of information without spatial or temporal limitations.¹²

The investigation by Cuello et al. showed that the use of mobile devices significantly improves the learning of morphological sciences in medical science students. The incorporation of these technologies in the teaching-learning process not only facilitates access to information but also promotes more interactive, adaptive methodologies, optimizing the understanding and retention of knowledge.¹³

Information technology (IT) has revolutionized dental education, facilitating online platforms and virtual simulators that allow students to develop skills in controlled environments before facing clinical practice.¹⁴ In addition, learning management systems have gained prominence by integrating interactive tools such as quizzes, forums, and weekly assignments, fostering autonomy and more dynamic and personalized learning. This not only improves academic training but also strengthens the capacity of future professionals to develop oral health and prevention programs, reinforcing their impact on the community.^{14,15}

Given these advances, it is essential to review and update dental curricula based on scientific evidence and the demands of the health care system. While some improvements can be implemented within the educational institutions themselves, others require structural transformations and inter-institutional collaboration.¹⁶ In this context, higher education plays a key role in Latin America's development, requiring sustained investment in innovation, science, and technology.¹⁷

Transfer of Knowledge

Dental education must evolve with technological advances to train highly qualified professionals. In this process, teachers act as agents of change by incorporating digital competencies in clinical and research teaching. The use of technological tools, such as interactive anatomical atlases and virtual reality simulators, not only improves the understanding of complex structures but also optimizes the practice of procedures in a safe environment. Similarly, educational applications facilitate the promotion of oral hygiene habits and oral disease prevention, adapting to populations with different literacy levels. These strategies not only modernize teaching but also reinforce equitable access to knowledge, fostering a more efficient, inclusive, and innovation-oriented dental education.¹⁸

Just as a pilot would never fly a plane without first training in a high-tech simulator under the supervision of an instructor, a dental student should not treat a patient without rigorous preparation. Simulation in healthcare, supported by technology, is not a luxury, but a necessity. It allows future professionals to face complex situations in a safe environment, where error does not put lives at risk but becomes a valuable lesson. However, technology alone does not guarantee success. Just as a flight simulator does not make the pilot, digital resources in dentistry require the expert guidance of the teacher, who transforms practice into meaningful learning. This is where the real paradigm shift occurs: technology does not replace teaching, but rather enhances it, ensuring that new dentists arrive at the clinic with consolidated skills and a deep understanding of their role. Training professionals without taking advantage of these tools is like sending a pilot to fly without having set foot in a simulator: an unnecessary risk with irreversible consequences.

The integration of innovative tools and modern methodologies is essential to improve the quality of training in an increasingly complex clinical practice. In this regard, there are several key guidelines that, in my opinion, should be considered to optimize dental education:

Incorporate simulators and augmented reality.

Muscle memory is enhanced through the use of simulators, repetition of procedures, and interactive platforms, thus allowing students to become familiar with complex techniques before applying them to patients. This approach not only promotes the acquisition of practical skills but also contributes to the reduction of anxiety and risk associated with practicing in clinical settings.

Personalized Learning

I consider it essential to tailor learning to the individual needs of students. The use of interactive modules and clinical cases allows for a deeper understanding of complex topics and promotes self-paced progress. This methodology, combined with simulations and hands-on workshops, reinforces both technical competencies and interpersonal skills.^{7,19}

Encourage interdisciplinary collaboration

Throughout my experience, I have observed that digital platforms that connect professionals from different disciplines significantly improve coordination in patient care. By facilitating the exchange of information and a comprehensive understanding of cases, these tools contribute to more complete and higher quality care.^{7,19}

Ensuring the Quality of e-Learning

E-learning is an invaluable tool, but it must be supported by strict technical standards that include verifying that the content is accurate, updated, and reflects the latest practices in dentistry. In addition, it is important to perform regular evaluations to ensure quality and reliability. Therefore, platforms should be intuitive and easy to use, thus enhancing the learning experience for students.²⁰

DISCUSSION

The incorporation of information technology (IT) in dental education has been the subject of debate in recent years. While Mattheos et al. (2008) highlight its potential to optimize learning, questions persist about its effectiveness compared to traditional methods. A critical point in this discussion is the validity of digital simulations versus actual clinical practice. While virtual patients and 3D models offer a safe environment to develop skills, their ability to replicate the complexity of interaction with real patients remains questionable. Is it possible for dental education to rely heavily on virtuality without affecting clinical training? The literature does not offer a clear consensus but suggests that a balance between the two methodologies is key to maximizing the benefits of digitization without compromising practical teaching.²¹

Updating curricula is another central aspect of the discussion on dental education. Isbej et al, emphasize the importance of constantly reviewing and adapting educational programs to ensure evidence-based decisions.¹⁶ However, while this approach is widely accepted, the speed at which technologies are evolving poses an ad-

ditional challenge: Are universities prepared to update their methodologies as fast as the technological landscape is changing? The COVID-19 pandemic put this capacity for adaptation to the test, forcing an abrupt transition to virtual education, although this modality guaranteed continuity of learning, it also revealed significant limitations in the teaching of clinical competencies. Thus, there is a need for hybrid models that integrate technology without undermining the importance of face-to-face training, a proposal that, although promising, faces barriers in terms of infrastructure, teacher training, and equitable access to digital resources.²²

Another point of controversy is the use of mobile devices in education. While some studies, such as Basantes', point out that these devices are mostly used for communication and entertainment, others argue that, with proper implementation, they can be effective educational tools. However, this depends not only on the availability of technology but also on the ability of institutions to design pedagogical strategies that maximize their usefulness without generating distractions. In this sense, is curricular updating sufficient to integrate technology into dental education, or is a more profound change in the educational culture necessary? The answer to this question will define the direction of dental education in the coming years.²³

CONCLUSION

The teaching-learning process must always be mediated by a central axis, the teacher, who is the one who knows the academic guidelines and who, transforming them, imparts the knowledge to the student in the most current way possible, that is why the teacher must be trained to know how to transmit this knowledge, how to make the student internalize it so that the result of this knowledge is a real integration of the theoretical in the practical, and in the most current way from the written to the digital and from the physical to the virtual.

Teaching is changing and we teachers must change with it, the constant flow of technology and modernity drags us with the current, and students will inevitably go with it, but the heads of the university administration must guide education towards a north where all these aspects converge and in which a more ethical, prosperous and affordable future for university education is glimpsed and that it is the one that leads the way to change and improvement of the people. It is evident that many studies are still needed to determine if technology-based resources provide a significant improvement in academic

performance compared to traditional teaching methods, long-term studies and larger cuts should be studied, but introductory studies in each area of science should be the first step, each researcher from his area of expertise should indicate what are the guidelines to know if these technologies make education more interesting, attractive and effective in its transmission to students.

Bibliographic reference

1. Iglesias L, Castro K, Potes I. Las tic, las tac y las tep: innovación educativa en la era conceptual. Universidad Sergio Arboleda. 2021 Jun;(1):[aprox. 20 p.].
2. Henriquez P. Declaración de la III Conferencia Regional de Educación Superior para América Latina y el Caribe. Integración Y Conocimiento. 2018 Dic;7(2):96-105. DOI: <https://doi.org/10.61203/2347-0658.v7.n2.22610>
3. Monereo C. Estrategias de enseñanza y aprendizaje. 12. a edición Editorial Graó, Vol. 3. Barcelona; 2007.
4. Zitzmann N, Matthisson L, Ohla H, Tim J. Digital undergraduate education in dentistry: A systematic review. nt. J. Environ. Res. Public Health 2020;17(9), 3269. DOI: <https://doi.org/10.3390/ijerph17093269>
5. Argüello J. Tecnología educativa y la educación superior. Cienc Lat Rev Científica Multidiscip. 2022 Dic;6(6):10566-79. DOI: https://doi.org/10.37811/cl_rcm.v6i6.4149
6. Dragan I, Dalessandri D, Johnson L, Tucker A, Walmsley A. Impact of scientific and technological advances. Eur J Dent Educ. 2018 Mar 1;22:17-20. DOI: <https://doi.org/10.1111/eje.12342>
7. Shaheen M, Basudan A, Abdulrahman A, Alzawawi A, Fatemah A, Aldulaijan H, et al. Dental Students' Perceptions Towards E-learning in Comparison With Traditional Classroom Learning. Cureus. 2023 Dec 26; 15(12): e51129. DOI: <https://doi.org/10.7759/cureus.51129>
8. Cedeño L, Vintimilla P, Pluas C, Conto F. La enseñanza de la Odontología en el Ecuador, criterios de reformulación de la carrera en la Universidad de Guayaquil. Rev Cuba Educ Super. [Internet]. 2019;2:38. Disponible: <https://www.scienceopen.com/document?vid=d61bb1e3-aabe-4373-af5a-24a999589c17>

9. Lara P, Duart J. Gestión de contenidos en el e-learning acceso y uso de objetos. RUSC. [Internet]. 2005;2:6-6. Disponible: <https://www.redalyc.org/articulo.oa?id=78020108>
10. Ferro C, Martinez A, Otero M. Ventajas del uso de las TICs en el proceso de enseñanza-aprendizaje desde la óptica de los docentes universitarios españoles. *EduTec Rev Electrónica Tecnol Educ*. 2009;29:3-10. DOI: <https://doi.org/10.21556/edutec.2009.29.451>
11. Ronteltap F, Eurelings A. Activity and interaction of students in an electronic learning environment for problem-based learning. *Distance Educ*. [Internet]. 2010;23(1):11-22. Disponible: https://www.researchgate.net/publication/228812245_Activity_and_Interaction_of_Students_in_an_Electronic_Learning_Environment_for_Problem-Based_Learning
12. Botello H, Rincon A. La influencia de las TIC en el desempeño académico de los estudiantes en América Latina Evidencia de la prueba PISA. [Internet]. 2012; Disponible: https://www.researchgate.net/publication/283274712_La_influencia_de_las_TIC_en_el_desempeno_academico_evidencia_de_la_prueba_PIRLS_en_Colombia_2011
13. Cuello E, Beard L, Álvarez J. Usos de dispositivos móviles en el aprendizaje de las ciencias morfológicas en la carrera de medicina. *Rev Utesiana la Fac Ciencias y Humanidades*. 2018;3:22-36.
14. Yazdanpanahi F, Shahi M, Davaridolatabadi N. Investigating the Application of New Technologies in Dental Education: A Systematic Review. *Acta Med Iran*. [Internet] 2022;60(8):465-72. Disponible: https://www.researchgate.net/publication/364494010_Investigating_the_Application_of_New_Technologies_in_Dental_Education_A_Systematic_Review
15. Guevara D, Flores K, Maturrano A, Mattos M. Educación virtual en odontología durante la pandemia de COVID-19. *Rev Científica Odontológica*. 2021 Oct 6;9(3):e078. DOI: <https://doi.org/10.21142/2523-2754-0903-2021-078>
16. Isbej L, Cantarutti C, Carrasco A, Hassi J, García R, Ortuño D, et al. Desafíos de la educación en odontología. *ARS MEDICA Rev Ciencias Médicas*. 2021 Dec 10;46(4). DOI: <https://doi.org/10.11565/arsmed.v46i4.1842>
17. Santelices A, Rojas J. Climate Change in Latin America Inequality, Conflict, and Social Movements of Adaptation. Vol. 43, *Latin American Perspectives*. SAGE Publications Ltd. [Internet]. 2016. p. 4-11. Disponible: https://www.researchgate.net/publication/303980926_Climate_Change_in_Latin_America_Inequality_Conflict_and_Social_Movements_of_Adaptation
18. Lee J. Dental education now and in the future. Vol. 53, *Journal of Periodontal and Implant Science*. Korean Academy of Periodontology; 2023 Jun;53(3):p. 171-2. DOI: <https://doi.org/10.5051/jpis.235303edi01>
19. Annamma L, Varma S, Abuttayem H, Prasad P, Azim S, Odah R, et al. Current challenges in dental education- a scoping review. *BMC Med Educ*. 2024;24(1):1-10. DOI: <https://doi.org/10.1186/s12909-024-06545-1>
20. Tabatabaei S, Mirzaiean A, Keshmiri F. Opportunities and threats of e-learning in dental education in viewpoints of faculty members: A Mixed method study. *Dent Res J (Isfahan)*. [Internet]. 2022;1. Disponible: <https://pubmed.ncbi.nlm.nih.gov/36426275/>
21. Mattheos N., Stefanovic N, Apse P, Attstrom R, Buchanan J, Brown P, et al. Potential of information technology in dental education. *Eur J Dent Educ*. 2008;12(SUPPL. 1):85-92. DOI: <https://doi.org/10.1111/j.1600-0579.2007.00483.x>
22. Cayo C, Agramonte R. Challenges of virtual education in dentistry in times of covid-19 pandemic. *Rev Cubana Estomatol*. [Internet]. 2020;57(3):1. Disponible: <https://www.redalyc.org/articulo.oa?id=378664876017>
23. Basantes A., Naranjo M, Gallegos M, Benítez N. Los dispositivos móviles en el proceso de aprendizaje de la facultad de educación ciencia y tecnología de la universidad técnica del norte de ecuador. *Form Univ*. 2017;10(2):79-88. Disponible: <https://repositorio.utn.edu.ec/handle/123456789/13582>

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