A DECADE OF TECHNOLOGY-ENHANCED LEARNING IN GLOBAL DENTAL EDUCATION PROGRESS AND CHALLENGES

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AIM

To evaluate the progress, impact and challenges of technology-enhanced learning (TEL) in global dental education over the past decade, and explore future opportunities for integrating TEL into dental curricula.

LEARNING OBJECTIVES

To understand the evolution of TEL in dental education, its role in enhancing learning outcomes and professional development and the key challenges that need to be addressed for its effective implementation.

LEARNING OUTCOMES

By the end of this paper readers will be able to:

- Identify the advancements in TEL and their influence on dental education outcomes, including knowledge retention, clinical skills development and personalised learning experiences.
- Analyse the role of networked learning and social media in fostering global collaboration and professional development among dental students and professionals.
- Evaluate the challenges in TEL implementation, such as the digital divide, educator training needs, and the integration of TEL into hands-on clinical practice.
- Discuss the future directions for TEL in dental education, including the potential impact of artificial intelligence, mobile technologies and real-time clinical feedback on teaching and learning.

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ABSTRACT

Over the past decade, technology-enhanced learning (TEL) has significantly reshaped dental education worldwide, providing innovative approaches to teaching and learning. This paper examines the progress and challenges associated with the adoption of TEL in global dental curricula, particularly in the UK. It highlights the impact of digital tools such as virtual reality (VR), simulation systems, and networked learning platforms on enhancing clinical skills, improving knowledge retention, and promoting global collaboration among students and educators. The role of social media in professional development is explored, emphasising its utility in informal learning and interprofessional education. The COVID-19 pandemic accelerated TEL integration, underscoring its benefits and exposing disparities in access to technology. Key challenges, such as the digital divide, educator resistance, and the need for effective training, are discussed. Looking ahead, advancements in artificial intelligence, mobile technologies and real-time clinical integration present promising opportunities for further TEL development in dental education. Addressing current challenges will be essential to ensuring equitable access and maximising TEL's potential in preparing future dental professionals.

KEY WORDS

TEL, Education, Technology

Introduction

Over the last ten years, technology-enhanced learning (TEL) has become a key part of dental education across the globe. The use of digital tools and platforms has transformed how both students and educators approach teaching and learning, presenting both opportunities and challenges. In the UK, TEL has grown rapidly, especially in response to the changing needs of the academic community and the unforeseen challenges brought on by the COVID-19 pandemic. This article will look at the progress in adopting TEL within dental education over the past decade, the hurdles faced, the impact of networked learning, how social media is being used for professional development, and the future of TEL integration in dental curricula.

The Evolution of TEL in Dental Education

The role of TEL in dental education has changed considerably, spurred on by advancements in digital technology and an increased awareness of its potential to improve learning outcomes. Early TEL initiatives were relatively modest, mainly centred around digitising lecture materials and introducing online assessments. However, as technology advanced, its use in education became more sophisticated, offering interactive learning experiences that went beyond the basics.[1]

The International Federation of Dental Educators and Associations (IFDEA) established the Global Network on Dental Education, which has been crucial in promoting TEL. Through its efforts, the network has encouraged global collaboration in creating adaptable e-learning frameworks. These frameworks have led to the development of e-learning modules, virtual simulations, and other digital resources that are now essential parts of dental education worldwide.[2]

The Impact of TEL on Dental Education Outcomes

TEL has had a noticeable effect on learning outcomes in dental education. Studies show that it can improve knowledge retention, boost clinical skills, and enhance student motivation and engagement.[3] For instance, the use of virtual reality (VR) and simulation tools has been shown to improve students' ability to apply theoretical knowledge in practical settings, particularly in areas such as local anaesthesia administration.[4] The potential of multisensory feedback VR systems has also been recognised, providing dental students with more immersive and realistic training environments, further aiding their development.[5]

TEL has also enabled more personalised learning experiences, allowing students to progress at their own pace and revisit challenging concepts as needed. This flexibility has been particularly beneficial in dental education, where the mastery of complex clinical skills often requires repeated practice and reinforcement.[6]

Networked Learning and Collaborative Platforms

The concept of networked learning, which involves connecting learners through digital networks, has gained prominence in dental education. Networked learning environments facilitate collaboration among students, educators and professionals, transcending geographical boundaries. These platforms allow for the sharing of resources, the exchange of ideas and peer-to-peer learning, which can enhance the educational experience.

In the context of dental education, networked learning has been instrumental in fostering a global community of learners and practitioners. Platforms such as discussion forums, online study groups and collaborative projects have enabled students to engage with their peers from around the world, gaining diverse perspectives on dental practices and challenges (Figure 1 & Table 1).[7] The use of such platforms was particularly beneficial during the COVID-19 pandemic, where face-to-face interactions were limited, yet the need for collaboration remained critical.

The Role of TEL During the COVID-19 Pandemic

The COVID-19 pandemic acted as a catalyst for the widespread adoption of TEL in dental education. As

Figure 1: **Social media allows me to collaborate with peers - as percentage by group[7]**

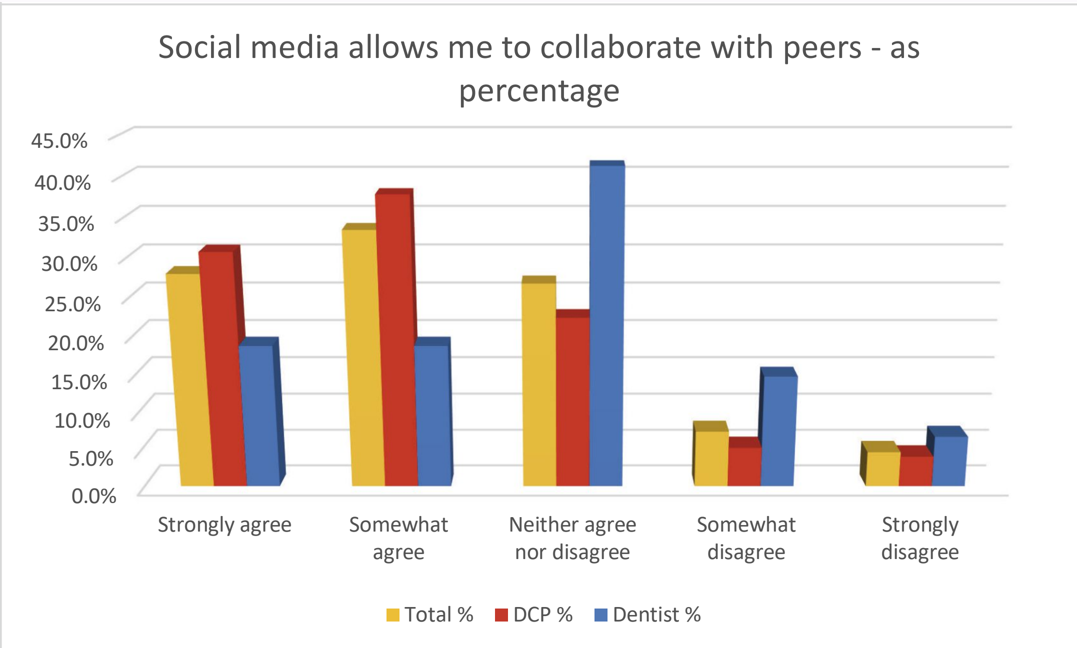

Table 1: Social media allows me to collaborate with peers - as percentage by group[7]

	Dentist count	Dentist %	DCP count	DCP %	Total count	Total %
Strongly agree	14	18.7%	77	30.7%	91	27.9%
Somewhat agree	14	18.7%	95	37.8%	109	33.4%
Neither agree nor disagree	31	41.3%	56	22.3%	87	26.7%
Somewhat disagree	11	14.7%	13	5.2%	24	7.4%
Strongly disagree	5	6.7%	10	4.0%	15	4.6%
Total	**75**		**251**		**326**	

universities and dental schools faced prolonged closures, the need for remote learning solutions became urgent. In the UK, dental educators rapidly transitioned to online platforms, delivering lectures, tutorials, and even clinical instruction through digital means.[8] This sudden shift to TEL highlighted both the potential of technology to support learning continuity and the challenges associated with its implementation.

During the pandemic, virtual simulations and online assessments became essential tools for maintaining educational standards. Studies conducted during this period have shown that, despite initial resistance, both students and educators adapted well to the new learning environment. Many found that TEL not only provided a viable alternative to in-person instruction but also offered unique benefits, such as the ability to review materials multiple times and engage in interactive learning activities from anywhere.[4]

However, the pandemic also exposed significant disparities in access to technology and digital literacy. These challenges underscored the importance of ensuring that all students have the necessary resources and support to engage effectively with TEL.[9]

Social Media and Professional Development

In recent years, the use of social media as a tool for professional development in dentistry has gained considerable attention. Social media platforms such as Facebook, Twitter, LinkedIn, and Instagram have become valuable resources for informal learning, networking and sharing knowledge within the dental community.[10]

Social media allows dental professionals to stay updated on the latest research, trends and best practices, often in real-time. It also provides a platform for engaging with experts and peers, participating in discussions and contributing to the broader professional discourse. In a survey conducted among UK dental professionals, a significant proportion reported using social media for informal learning, highlighting its role in continuous professional development.[11]

Moreover, social media has been instrumental in promoting interprofessional education (IPE) by connecting dental professionals with colleagues from other healthcare disciplines. This cross-disciplinary interaction is crucial in fostering a more integrated approach to patient care, reflecting the collaborative nature of modern healthcare.[11]

Despite its benefits, the use of social media in professional development is not without challenges. Issues such as the reliability of information, maintaining professional boundaries and the potential for misinformation are ongoing concerns that need to be addressed through education and awareness.[7, 10]

Challenges in the Implementation of TEL

While the benefits of TEL in dental education are well-documented, its implementation has not been without challenges. One of the primary obstacles has been the digital divide, which refers to the gap between those who have access to modern information and communication technologies and those who do not.[12] This divide is particularly pronounced in dentistry, where the cost of specialised equipment, such as VR headsets and simulation software, can be prohibitive for some institutions and students.

Another significant challenge is the need for effective training and support for educators. Many dental professionals, particularly those who have been teaching for several decades, may lack the digital literacy skills required to use TEL tools effectively. This can lead to resistance to adopting new technologies and a reliance on traditional teaching methods.[13] Educators must be provided with adequate training to integrate TEL effectively into their teaching practices and to ensure that they can utilise these tools to their full potential.[14]

Moreover, the integration of TEL into existing curricula requires careful planning and consideration. Educators must ensure that TEL complements, rather than replaces, essential hands-on clinical training. This balance is critical in dental education, where the development of practical skills is as important as the acquisition of theoretical knowledge.[7]

Future Directions and Opportunities for TEL in Dental Education

Looking ahead, the role of TEL in dental education is likely to continue growing. As technologies evolve, so too will the opportunities for enhancing teaching and learning in dentistry.

Artificial Intelligence and Personalised Learning

Artificial intelligence (AI) has the potential to revolutionise dental education by providing highly personalised learning experiences. AI-driven platforms can adapt to the needs of individual students, offering tailored content and feedback based on their performance. This level of personalisation can help students address their specific weaknesses and enhance their strengths, leading to more effective learning outcomes.[15]

Mobile Technologies in Dental Education

The proliferation of mobile technologies has opened new avenues for TEL in dental education. Mobile apps, e-books, and other portable learning resources allow students to access educational content anytime, anywhere, thereby facilitating continuous learning.[14] The convenience and flexibility offered by mobile learning tools are particularly valuable in dentistry, where students often need to balance clinical practice with academic study.

Integration of TEL into Clinical Practice

The future of TEL in dental education is not limited to the classroom. There is significant potential for TEL tools to be integrated into clinical practice, providing students with real-time feedback and guidance during patient interactions. This integration could bridge the gap between theory and practice, helping students to apply their knowledge more effectively in real-world settings.[16]

Addressing the Digital Divide

To fully realise the potential of TEL, it is crucial to address the digital divide that persists within dental education. Ensuring equitable access to digital resources and technologies is essential for providing all students with the opportunity to benefit from TEL. This may involve institutional investments in infrastructure, as well as initiatives to support students from disadvantaged backgrounds.[12] Additionally, partnerships between educational institutions and industry could help in reducing costs and improving access to cutting-edge technologies.[15]

Conclusion

Over the past decade, TEL has significantly transformed dental education, offering new ways to deliver content, enhance clinical skills, and engage students. The COVID-19 pandemic accelerated the adoption of TEL, highlighting both its potential and the challenges associated with its implementation. While TEL has demonstrated its value in improving educational outcomes, there are still obstacles to overcome, including the digital divide, the need for educator training, and the integration of TEL into clinical practice.

Looking forward, the continued evolution of TEL, driven by advancements in AI, mobile technologies, and networked learning, promises to further enhance dental education. By addressing the current challenges and seizing new opportunities, dental schools can ensure that they are preparing the next generation of dental professionals for success in an increasingly digital world.

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