ORIGINAL ARTICLE

When e-learning takes centre stage amid COVID-19: Dental educators' perspectives and their future impacts

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Abstract

Introduction: The COVID-19 pandemic has necessitated an unprecedented shift from face-to-face teaching to e-learning. Previous surveys revealed the negative impact of COVID-19 on dental education and the physical and psychological well-being of dental students. This qualitative study aimed to investigate the perspectives of dental educators towards e-learning during the pandemic and the impact of this experience on their future adoption of e-learning.

Materials and Methods: Semi-structured interviews with dental educators from the National University of Singapore were conducted over Zoom. Audio recordings were transcribed verbatim and subjected to thematic analysis. Data saturation was reached. Consolidated criteria for reporting qualitative research (COREQ) was followed.

Results: Fifteen out of 22 (68%) eligible dental educators were interviewed. Educators had minimal prior e-learning experience. They encountered difficulties in engaging students, assessing students' understanding and adapting their teaching. A practical challenge was to ensure the well-rounded training of competent dentists with adequate patient-interaction skills through e-learning. Self-motivation of the audience, class size, type of teaching and complexity of the material were perceived as factors influencing the suitability of the e-learning format. Educators reported an increased confidence after this emergency e-learning experience. Some considered sustaining or expanding e-learning in their future teaching practice and highlighted the need for continued investment and institutional support, training on the pedagogy of e-learning modalities and curriculum redesign to accommodate blended learning approaches.

Conclusions: Although the shift to e-learning during the COVID-19 pandemic presented a myriad of challenges, dental educators gained experience and confidence which may accelerate the pace of future e-learning adoption and innovation.

KEYWORDS
blended learning, COVID-19, dental education, online learning, qualitative study, technology-enhanced learning

1 | INTRODUCTION

E-learning has been heralded as a revolution in education for decades,[1] and there has been an increasing global push towards e-learning in higher education.[2] E-learning has permeated virtually every sector of higher education due to the many benefits it offers to the community of learners, teachers and schools.[3] The breadth and complexity of professional training for healthcare providers, together with the shortage of teaching staff, make e-learning an attractive proposition for healthcare education.[4] Dentistry is no exception, and has made leaps and bounds in the development and application of associated technologies, such as haptic and virtual simulation, augmented reality for clinical training and incorporation of massive open online courses (MOOCs).[5,6]

In the diverse context of healthcare education, e-learning has been found to be at least as effective as traditional instructor-led classroom activities.[3-5] However, despite the growing body of evidence, the use of e-learning is highly variable amongst medical and dental schools.[6,7] Although computer-based technology is commonly leveraged in teaching and learning, undergraduate dental education is typically conducted in a physical face-to-face manner.[8] Whilst students consider e-learning as a positive supplement to traditional methods of learning, teaching staff often harbour passive or even negative attitudes towards e-learning.[9,10] Teachers' reluctance to change and lack of motivation have been identified as significant barriers impeding the widespread adoption of e-learning, amongst other practical concerns such as technophobia and lack of resources.[11,12] The uncertainty of a new teaching modality often leads to a retreat into safe and reliable, even if uninspiring, places and an inclination to remain with the status quo.[13]

The novel coronavirus (COVID-19) pandemic has led to a disruption in dental education worldwide.[14,15] Social distancing policies have forced a shift to e-learning modes wherever possible, and dental educators are suddenly faced with the challenge of adopting various forms of online instruction.[16] The impact of COVID-19 on dental education has attracted scholarly attention. Steered by the Association of Dental Education in Europe (ADEE) executive, a survey has captured the initial response of European dental schools to the COVID-19 crisis and pointed out the need for further studies to profile the full range of COVID-19 impact in diverse national contexts over medium-to-long term.[17]

Questionnaire surveys amongst dental students have shown that COVID-19 has adversely affected dental education and the physical and psychological well-being of learners in India,[18] Italy[19] and Nigeria.[20] The purpose of this qualitative study was to investigate the perspectives of dental educators towards e-learning amid COVID-19 and the future impact on dental education. The research questions were how dental educators view e-learning, how they approach it, what challenges and opportunities they perceive, and how their experience during COVID-19 shaped their intention for future adoption of e-learning. These insights, currently widely absent in the literature, will be useful for planning further development of e-learning ecosystems for dental education.

2 | METHODS

The 32-item consolidated criteria for reporting qualitative research (COREQ) checklist was used to guide the reporting of this study.[21]

2.1 | Setting and participants

This study was conducted amongst dental educators of the Faculty of Dentistry, National University of Singapore, which is the only dental school in Singapore. The medium of instruction is English.

Singapore was amongst the first countries attacked by the novel coronavirus. COVID-19 hit the shores of Singapore in the end of January 2020. When the Ministry of Health raised the Disease Outbreak Response System Condition to Orange shortly after, the University responded swiftly and decided to replace most of the classroom lectures and tutorials with e-learning. Co-located within a hospital building, the dental faculty suspended all in-person teaching from 10 February 2020, requesting all instructors to shift to e-learning. A team was formed to provide administrative and technical support for this transition.

This study was approved by the institutional review board for research ethics (NUS-IRB #SSHSPH-016) and was part of a larger study on e-Learning perspectives of tertiary education teachers.[22] Staff members were invited to participate in this study in May 2020. The eligibility criteria were (i) academic staff member of the school; (ii) scheduled for teaching in that semester (January to May 2020); and (iii) had to convert at least one physical teaching session with undergraduate dental students into an e-learning session due to the COVID-19 social distancing measures. Potentially eligible participants were identified via communication with module coordinators. Informed consent was obtained from each participant prior to the interview.

2.2 | Data collection

Each participant was interviewed by a single interviewer (CG) over Zoom, a cloud-based videoconferencing service,[23] as strict physical distancing measures were in place at the time. The interviews were audio-recorded using the in-app recording function. All interviews were completed between May 2020 and July 2020, immediately after the semester ended.

The interviews were semi-structured and followed an interview guide. Seven main open questions were included; each with several follow-up probing questions: (i) What does eLearning mean to you? (ii) What do you think about eLearning in general and in your subject area? (iii) What did you think / how did you feel when the university decided on the shift to eLearning as a response to COVID-19? (iv) How did you respond to the shift to eLearning; and why? (v) What were the barriers and facilitators you faced, and how did they impact your teaching? (vi) How did your experiences during the recent outbreak change your perception towards

eLearning? and (vii) What are your future plans related to eLearning in your teaching?

Questions in the interview guide were prepared through discussions amongst co-authors by referring to the scientific literature. The interview guide was then pilot tested on one individual with the relevant background, and refinements to the interview guide were made iteratively throughout the data collection as topics emerged. Interviewees were assured of the anonymity of their participation and confidentiality of their responses. They were also asked to complete a brief demographic questionnaire before the interview.

The interviewer utilised open-ended questions, with follow-up probing to elicit description and elaboration of participants' prior and current experiences, their perspectives of e-learning and intention for future adoption. The interviewer maintained a neutral and non-judgmental stance, and avoided leading questions.

2.3 | Data analysis

The audio files of the Zoom interviews were de-identified and transcribed verbatim. The transcripts were subjected to thematic analysis through line-by-line coding, in order to capture all the details that are relevant for the research questions.[24] The first three (20%) of the transcripts were coded by the two coders (CG and LLZ), with the remaining transcripts coded independently by the primary coder (CG), and any new emergent themes discussed between the authors again. Similar content was clustered into categories and consequently organised into analytical themes. An inductive approach was used to derive the themes from data. Reflexivity was maintained, and several lengthy reiterative discussions occurred regarding the codes and themes identified by the two coders. Where needed, the opinion of a third researcher (GXL) was sought. The process of open coding led to a clustering of substantive codes with similar content into themes. The second round of coding was then carried out in which we returned to the data and labelled them using the finalised codes and themes.

All interviews were coded in the order they were conducted. Although all 15 interviews were included in the analyses, data saturation was reached by the 10th interview, since no new themes emerged afterwards. The themes observed were described using examples from the transcripts and illustrated using verbatim excerpts. Descriptive statistics were used to report demographic data.

3 | RESULTS

Twenty-five teaching staff were identified as potentially eligible and were approached. Three of them clarified that they had not started e-learning yet and were thus excluded. Amongst the 22 eligible participants, 15 (6 females, 9 males) joined this study. The response rate was 68%. The mean age of the interviewees was

TABLE 1 Characteristics of the dental educators interviewed

	Mean (SD)
Age (years)	46 (11)
Tertiary teaching experience (years)	13 (10)
Sex, *n* (%)	
Female	6 (40)
Male	9 (60)
Prior use of e-learning, *n* (%)	
Never	4 (27)
Seldom/rarely	8 (53)
Sometimes	2 (13)
Often/very often	1 (7)
Self-rated digital literacy skill level, *n* (%)[a]	
Non-existent	0 (0)
Novice	5 (33)
Basic	6 (40)
Intermediate	4 (27)
Advanced/expert	0 (0)

[a]Information communication technology (ICT)/digital literacy skill level as defined by the ability to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesise digital resources, construct new knowledge, create media expressions and communicate with others, in the context of specific life situations.[26]

46 years, and their tertiary teaching experience averaged 13 years (range: 3–40 years) (Table 1). Only 3 (20%) reported incorporating e-learning elements into their regular teaching practice sometimes or more often before the pandemic, and 10 (67%) rated themselves as having more than a novice technological ability as measured by the ICT scale.[25]

Each interview lasted 30–70 min, with an average of 55 min. Analysis of the 15 interview transcripts revealed themes that were categorised into four overarching areas: prior experience, current experience, perspectives towards e-learning, and future adoption and enablers of e-learning. The themes and subthemes, alongside with their implications and possible suggestions, are presented in Table 2.

3.1 | Prior experience

3.1.1 | Varied exposure to e-learning

Interviewees had been exposed to e-learning modality to varying extents, as learners and/or as educators. Those early appointees had participated in a mandatory university-wide e-learning initiative following the SARS outbreak in 2003. The initiative aimed to increase awareness of e-learning and the preparedness of staff members for continuing teaching and learning in the event of public health crisis. A series of e-learning workshops were organised to equip staff members with the basic methods and tools.

TABLE 2 Overarching topics, themes and sub-themes and their implications

	Implications and Suggestions
Prior experience	
Varied exposure to e-learning modality	Given the co-existence of interest towards and concerns over the adoption of e-learning in dental education, effective management plans need to be considered to address the issues prior to its implementation[a,b]
Minimal use of e-learning in teaching practice	
Reasons for limited prior adoption of e-learning	Advances in technology and e-learning modalities have paved the way for teaching innovations to be introduced in dental education. This can change previous negative mindsets towards the use of e-learning[a,b]
Time-consuming nature of e-learning	
Shortcomings of previous e-learning platforms	There must be an impetus for educators to venture beyond their comfort zone, manage the unknown & experiment with new teaching methods[a,b]
Inertia and lack of incentive	
Current experience during COVID-19	
Challenges faced	Build and support a community of online educators through sharing sessions aimed to build capacities in instructional adaptation[a,b]
Technical challenge	
Loss of audience feedback and inability to adapt teaching	Train academic staff on usage of e-learning platforms; upskill administrative staff to support technical troubleshooting and delivery management of e-learning activities[a,b]
Responsibility to ensure academic rigour and clinical competence	Activate new engagement strategies: live polls (MCQs, word clouds, clickable images); gamification; forums; group chats on social media[a]
Copyright and privacy of patient data	Explore use of alternative online tools (e.g. live polls, synchronous/asynchronous quiz) to assess the "Knows" and "Knows How" levels of the "Miller's pyramid"[a]
	Maintain academic rigour with the use of alternative methods of assessment; increased use of formative assessments; reviews/feedback[a]
	Ensure clinical competence on patient communication: use Internet Protocol (IP) camera observation system to video record clinical session; reviewed by calibrated teachers; feedback to student[b]
	Educators to be trained in correct methods to mask patient identifiers and remove metadata; establish protocols for the use of clinical photographs to ensure compliance with data confidentiality and privacy regulations[b]
Advantages	Cultivate responsible independent learning and allow students to progress at their own pace with asynchronous access to teaching material[a,b]
Increased accessibility and flexibility	Enhance students engagement and bonding using chat function etc[a,b]
Avenues to engage different types of learners	Video recording or livestreaming clinical demonstrations[b]
Suitability for some teaching purposes	
Educators' perspectives towards e-learning	
Perceived factors influencing effectiveness of e-learning	Postgraduate and continuing education courses may be more amenable to e-learning compared to undergraduate education[a,b]
Motivation of the audience	Customise didactic teaching to small groups by either engaging more instructors or running multiple sessions[a]
Class size	Consider the appropriateness for conversion to e-learning (i.e. topics that require content/facts dissemination may be more amenable to e-learning as opposed to content that requires more discourse and processing)[a]
Type of teaching and complexity of material	Introduce blended learning formats for topics of greater complexity[a]
Renewed vision for e-learning	Leverage on this wave to sustain the momentum for continued use of e-learning, rather than relapsing to a previous state of inertia[a,b]
Taking the plunge (contemplation to action)	Organise regular capacity building sessions to help academic staff maintain a passion and skills for e-learning[a,b]
Instilled confidence and willingness	University level initiatives to sustain the efforts (e.g. digital education teaching excellence award, competitions for interactive e-materials)[a,b]
Future adoption and enablers of e-learning	
Sustainability of e-learning in teaching practice	COVID-19 accelerated the pace of e-learning adoption in dental education. Its impact is likely to remain after the pandemic subsides[a,b]
Possibility for long-term adoption (Interim or inevitable?)	Disseminate updated evidence and best practice to support educators' informed decision[a,b]
Uncertainty about evidence base	
Harnessing full potential of e-learning (more than just "e-")	Maximise what technologies can offer and use them in the most innovative ways to cater to different types of learners[a,b]
Leverage state-of-art technology	Embrace active learning; accept new role as a facilitator of learning rather than a content disseminator[a,b]
Possible shift in pedagogy	

TABLE 2 (Continued)

	Implications and Suggestions
Enablers for successful implementation	Institutional policy and future directions, that is whether future e-learning will be optional, mandated or even discouraged[a,b]
Institutional policies and support	Key resources for e-learning: funding; manpower; and equipment (green screens; dedicated space for recording; video editing software etc.)[a,b]
Continued investment	
Equipping students and teachers	Self-reflect on teaching and benchmark against the best practice (e.g. checklist provided by the Chronicle of Higher Education)[a,b]
Curriculum redesign	Peer reviews & feedback from institutional teaching/learning centres[a,b]
	Consider moving didactics to asynchronous e-learning to allow for more in-person curriculum time for tutorials or clinical teaching[a]
	Thoughtful re-timetabling to allow grouping of sessions which require in-person presence vs off-site attendance via e-learning[a,b]
	Cross-university collaboration to create/share content repositories[a,b]
	Remain agile and innovative for more future-proof dental education[a,b]

[a]Relevant for theoretical/didactic teaching.
[b]Relevant for preclinical and/or clinical teaching.

"So essentially we had something called an e-learning week previously, in preparation for something like this (pandemic)" (#7).

3.1.2 | Minimal use of e-learning

Their experience of actually using e-learning platform to teach dental students was however minimal. The most common e-learning activities were conducting e-assessments and using a virtual learning management system for the dissemination of lecture slides. What they had heard and learnt about e-learning from different sources did not necessarily translate into regular adoption of e-learning in their teaching practice.

"That was just one thing we were required to do as a part of this (pandemic) preparedness the university wanted to see… So we just did it. It was something that had to be done." (#7)

3.1.3 | Reasons for limited prior adoption

The educators perceived e-learning, particularly preparing pre-recorded lectures, as time consuming. Technological limitations of previously used e-learning platforms, including poor sound quality and lack of use-friendliness, limited their adoption. Other main reasons for limited use of e-learning elements were a lack of need or incentive due to the relatively small dental class size (~60 students) and an inertia to stick to the status quo.

"I guess the thought never exactly crossed my mind. Yeah. Like I wouldn't say that I didn't do it because I didn't want to… I also didn't feel like I wanted to do anything very differently from what I was doing." (#1)

3.2 | Current experience during COVID-19

3.2.1 | Challenges faced

Technical challenge
The educators, depending on their technological competency and digital literacy, had varying preparedness for the sudden transition to e-learning. Some expressed a frustration with inadequate equipment, difficulty in finding a quiet space to conduct e-learning, and issues with Internet stability and speed at home. A few also struggled with using the synchronous platform and relied heavily on colleagues and IT support team.

Loss of audience feedback and inability to adapt teaching
A main challenge experienced by educators when conducting e-learning was the loss of audience feedback. Educators explained that the lack of visual cues, such as student facial expressions or body language, affected their "lecturing intuition" (#10). Such loss of visual cues existed even in synchronous sessions with a video function. Although educators preferred students to have their videos switched on, they hesitated to enforce it, citing sensitivity to the students' privacy, differing work environments and Internet capabilities. The experience of conducting an e-learning lecture was described as a "monologue," rather than "a conversation with an audience" (#1). Educators expressed a loss of opportunities for spontaneous interaction with students and lamented their inability to engage students with humour or with personal remarks for fear of being misunderstood over the e-learning platform. The loss of "instantaneous feedback" (#1) impeded their ability to gauge the level of comprehension in the audience, and they were thus unable to adapt their teaching accordingly, or clarify doubts as they would have normally done in a face-to-face class.

"Because when you are teaching (face-to-face) you can just sweep the classroom and kind of get the

facial expression or you know if students are paying attention. If you have like 30% of students sleeping, you know it's time to do something." (#5).

Responsibility to ensure academic rigour and clinical competence
The inability to gauge students' understanding and attention during e-learning greatly worried the educators, as they felt a strong sense of responsibility to safeguard the public and ensure the fulfilment of the curriculum and adequate training of competent future dentists. Some especially struggled with the use of asynchronous methods, as there was a possibility that students would fail to access or learn the material. Educators also worried about the loss of the "human touch" (#2) when using e-learning. Students would have fewer opportunities to develop their patient communication skills, which is regarded as an important part of clinical competence. Educators also expressed that imparting clinical skills and intuition requires close mentorship which is hard to maintain over e-learning.

> "One of the things that I find that our students now are losing is the social interaction. They don't know how to interact and connect with other people like patients. They treat patients like the Frasaco (phantom) head." (#2)

> "Maybe they just need facts, now. Maybe the mentorship, the acumen acquisition by imbibing, is no longer (needed). But I don't think so and it doesn't come across as well on this (e-learning) platform." (#10)

Copyright and privacy of patient data
A handful of educators expressed concerns about copyright and privacy of patient data, considering the possibility of being recorded during the synchronous lectures or their e-learning materials being made publicly available. The appropriate use of clinical pictures and privacy protection of personal data were considered as extremely important when embarking on e-learning for healthcare domains.

3.2.2 | Advantages of e-learning

Increased accessibility and flexibility
The main advantage of e-learning noted by the educators was the greater accessibility and flexibility it offered to both students and teachers in terms of lesson scheduling. This advantage was regarded as especially pertinent for dental education, which relies heavily on part-time clinical faculty, and has postgraduates who move between training institutions.

Avenues to engage different types of learners
Despite a lack of engagement lamented by several interviewees, some in fact observed increased attention and participation of some students as compared to face-to-face lectures. A possible reason cited was students being less tired or distracted whilst staying at home during this pandemic. E-learning could also benefit students who were more reserved, by reducing the "physical intimidation of a lecturer" (#12). The chat function on Zoom was found to be especially useful for providing an additional avenue for engagement.

> "I think because the students cannot see me, and they can maintain some anonymity… It emboldens them to ask a question and not have to worry about me giving them a look (which) says, 'this is a stupid question'." (#9)

Suitability for some teaching purposes
Educators also reflected that in some scenarios, e-learning may be even more ideal than face-to-face classes. For example, video recordings or live-streamed surgeries appeared to be more effective than the traditional way of physical observation with students crowded around the instructor.

3.3 | Educators' perspectives towards e-learning

3.3.1 | Perceived factors influencing effectiveness of e-learning

Whilst the educators did not formally assess the outcomes of their classes, they observed some factors which could influence the effectiveness of e-learning.

Motivation of the audience
Educators perceived a general lack of intrinsic motivation amongst undergraduate dental students, which could be a major barrier to effective e-learning. Because of this, e-learning was viewed as more suitable for postgraduate students or continuing education with graduate dentists.

> "Postgraduate teaching is better on Zoom than undergraduate teaching because there are less people and they are more mature. They actually do it because they want to learn and not because they have to finish a lecture. So, it works better for people who are more motivated." (#7)

Class size
E-learning was seen as more conducive for small class tutorials and one-on-one discussions, largely because it was more possible to see all faces on-screen and obtain some visual feedback. However, an interplay between the motivation of the audience and the optimal class size was noted, with larger class sizes possible for a more motivated audience.

Type of teaching and complexity of material

Educators emphasised their reservations about moving dentistry to a full e-learning mode due to the nature of clinical training and hands-on technical skills, whereas didactic classes were viewed as more amenable to e-learning. Educators also noted that for first-year dental students who are new to Dentistry, face-to-face teaching may be necessary even for basic content in order to gauge their understanding, as their prior knowledge was unknown. The complexity of teaching material also played a role. For those content-heavy topics, educators felt that asynchronous methods were advantageous for giving students time "to internalise the information" (#4).

> "The students can read a book and learn, they don't even need a lecture. But they may not understand it fully, and that's where the teaching comes in – the questioning and the application." (#8)

3.3.2 | Renewed vision for e-learning

All the interviewees accepted e-learning in this COVID-19 situation as necessary, and appreciated the timeliness of the decisions made at the start of the pandemic to embark on e-learning. Educators credited the COVID-19 situation for encouraging them to take the plunge to e-learning where they would otherwise not.

> "I think what COVID-19 has done is that it made us more aware ... To be more aggressive in our adoption of e-learning...I suppose it's like a situation of no choice, right? You have to use it. So it kind of accelerated everybody towards a greater adoption of e-learning." (#15)

Whilst there was some initial anxiety over the transition, educators were eventually able to complete their e-learning sessions. They were surprised by how smoothly most of their face-to-face lectures and tutorials translated to e-learning using the synchronous platform, and their experience during COVID-19 had given them greater confidence with using e-learning. They expressed an increased willingness to explore more e-learning methods in the future.

> "I'm more willing to do e-learning compared to previously I was terrified of doing e-learning." (#11)

3.4 | Future adoption and enablers of e-learning

3.4.1 | Sustainability of e-learning in teaching practice

Educators had divided perspectives on the future adoption of e-learning in their own teaching practice. Some saw e-learning as only an interim measure, whereas others believed that e-learning is inevitable in the future.

> "So the way things are going... the only way forward is e-learning... I know we are struggling to find the right balance, but you cannot deny it. Moving forward, technology is going to play a greater part in learning than we would like to accept." (#7)

Some felt that the culture and preference for the tried and tested way of doing things was a barrier to e-learning adoption. Others expressed that their non-adoption was not due to a resistance to change, but rather a lack of evidence to show that e-learning was better.

3.4.2 | Harnessing the full potential of e-learning: More than just "e-"

Educators shared that e-learning should be more than just the use of technology and online versions of an in-person format, or just an electronic platform for dissemination of teaching materials. Instead, they viewed the purpose of e-learning as leveraging a whole range of cutting-edge technologies to improve or complement traditional teaching methods, creation of new content as a resource for students to revisit, or as supplements to in-person classes in order to improve students' understanding and cater to different types of learners. There was an awareness that e-learning requires a shift in their teaching methodology and pedagogy.

> "E-learning means the use of technology, but it's more like the use of technology plus something else. Not just a device to give the lecture, but almost ingrained into the teaching methodology..." (#6)

3.4.3 | Enablers for successful implementation

Institutional policy and support

In order for e-learning to take root, educators felt that it should be broadly accepted by the institution, students and teachers as a possible mode of instruction, with clear e-learning policies at the faculty and university levels to support its implementation. Given the divergence in e-learning competence, faculty-specific workshops are needed to ensure all teachers are given adequate support and time to build the prerequisite skills.

> "If this is going to be long term, then I think more and more training got to go in. But it cannot be say, one person does it or 10 people do it and (the) other 90% of people not able to be the same, because all of us are at different stage(s)." (#13)

Continued investment

Moving forward, educators felt that continued investment, in manpower and equipment, needs to be in place. They noted that for a generation weaned on electronic media, learning materials with high production quality are necessary to engage and to create "lectures worth listening to" (#7). Suggestions to enable this included a dedicated medical educationalist or technologist, improved internet stability, high-resolution webcams and audio microphones, and amply equipped and acoustically designed e-learning rooms.

Equipping students and teachers

Educators also expressed a need to prepare both students and teachers for e-learning and for open discussions about the pedagogy of e-learning to address the challenges. They suggested that model examples of successful e-learning approaches or the provision of a "resource platter" (#15) with different tools stratified by technological competency could help improve future e-learning. In addition to student feedback, educators thought peer feedback on e-teaching would be beneficial and saw an opportunity for online peer reviews during e-learning sessions, or even reviewing recordings of synchronous lectures for self-reflection and improvement.

> "Learning the system takes over so much. The actual teaching technique, by a new medium it goes out the window, you just don't have time to do that...but (if) we get some feedback, (that) might be helpful." (#10)

Curriculum redesign

Several educators reflected on how this shift to e-learning has forced them to re-evaluate their teaching and curriculum. They considered how a blended or hybrid approach could replace some didactic teaching, and face-to-face time could then be used for more clinical sessions, which may not translate well to e-learning. Educators pointed out the need for thoughtful timetabling to move more classes towards e-learning, so that students do not have to be in school regardless for laboratories and clinics. Thus, curriculum redesign would be needed to maximise the potential for blended learning and optimise the use of teaching hours.

> "It begs the question, why especially for a faculty like Dentistry, where students have so much pressure of patients and stuff like that in the clinical years, why do we have to cram lectures and tutorials within those hours when this can be done online." (#4)

> "I think, so we're not there yet. We are just thinking from COVID point of view. We should think of it from the whole curriculum point of view, and incorporate e-learning through it. I think the traditional sense of the school has to change a bit. And I think this might be a good start." (#7)

4 | DISCUSSION

The COVID-19 situation has led to an unprecedented shift towards e-learning as an emergency response to continue operationalising education in institutes of higher learning. In this study, dental educators who mostly had minimal prior adoption of e-learning, provided rich perspectives based on their first-hand experiences with e-learning during the COVID-19 pandemic. Whilst some challenges were highlighted, educators were able to observe the advantages and factors that may influence the effectiveness of e-learning. Enablers for e-learning were also identified for future adoption.

Recent systematic reviews examining medical educators' perspectives towards e-learning have identified some overarching barriers, including lack of technical skills, inadequate infrastructure, time constraints, absence of institutional strategies and support, and negative attitudes.[26,27] In addition to some of these commonly reported issues, our study highlights the need for pedagogical changes associated with e-learning adoption. It has been argued that the practice of e-learning is significantly different from conventional learning and may require a new pedagogical theory.[26,28] E-learning involves a shift towards a less hierarchal relationship between knowledge, teacher and students.[26] It gives students more autonomy in learning and an opportunity to be active learners.[26] Beyond the teacher-student interaction, there are also learner-learner and learner-content interactions,[29] which can be actualised by the Internet, since it connects learners with a broader community and enables collaborative learning in multiple modes (synchronous and asynchronous) and platforms (forums, chats, wikis and blogs). This turns students from passive recipients of knowledge into active participants in the construction, sharing and application of knowledge.[30,31] Whilst teachers traditionally act as the mediator between students and the body of knowledge, e-learning and its technologies promote a potentially dialogical relationship between learners and knowledge.[13] Many new learning interactions that were not perceived possible previously can now be facilitated, such as the coupling of experts from around the world with novices, the opportunity to communicate with a diverse world audience, the instantaneous access to global resources and the ability to compare information, negotiate meaning and co-construct knowledge.[29] Preparing educators for these pedagogical changes will help them to embrace e-learning and utilise its full potential.

The most practical form of e-learning perceived by dental educators for future adoption was hybrid or blended e-learning. Whilst some domains of higher education may lend themselves well to exclusive e-learning, acquisition of clinical skills and competency requires a careful combination of traditional teaching and online learning.[7,32] Blended methods have demonstrated effectiveness in dental education,[33-36] and a key factor for success is the strategic integration of e-learning elements into the current curriculum.[27] Likewise, almost all participants in our study pointed out the need for curriculum redesign and re-scheduling across the entire span of undergraduate training, to harness the affordances of e-learning. Educators reflected that the current experience made them more

receptive to incorporating e-learning and converting traditional teaching to blended approaches. These findings may be used to inform dental institutions' efforts to leverage the emergency e-learning experience and sustain it into the post-COVID-19 era where integration of e-learning could become a "new normal" in undergraduate, graduate and continuing dental education.

Unlike previous public health crisis such as the SARS outbreak, COVID-19 has lasted for a prolonged and undefined period and the recovery may take much longer than many would have expected. The COVID-19 crisis and the unparalleled disruption is far from over. More alarmingly, scientists have warned that such pandemic is not a black swan event and more will emerge as humans encroach upon and destroy natural habitats.[37] The impact of COVID-19 on dental education is likely to remain long after the pandemic subsides. Lessons learnt during this crisis can be carried forward and are likely to transform how we perceive dental education and how we educate future generation of dental professionals.[15] Reflecting on the experience, many educators, whilst expressing their hope that things will return to normal with face-to-face learning, reported that their successful transition to e-learning during the pandemic helped build self-efficacy and more positive attitudes towards future adoption. Whilst educators are intending and actively planning to integrate e-learning into their teaching practice to varying extents, institutions can seize this opportunity to keep the ball rolling in order to fully utilise the many advantages that e-learning offers.

Collectively, the four overarching themes (prior experience, current experience, perspectives towards e-learning, and future adoption and enablers) delineate the impact of COVID-19 and how educators' perspectives evolve throughout the pre-pandemic, pandemic and post-pandemic times. Their minimal prior experiences with e-learning influenced their current experience, as was reflected in the many challenges they faced. The current experience in turn has allowed a renewal in their vision of e-learning, and a thoughtful consideration of the factors influencing the effectiveness of e-learning. From the new vantage point that their current experience affords, the educators were able to further reflect on the sustainability of e-learning in dentistry and a need for a shift in pedagogical thinking.

It is important to note that educators' perspectives on e-learning are not static and are likely to evolve with time. As students and educators acclimatise to e-learning and the endemic nature of COVID-19 becomes more apparent, some of the challenges faced by educators may become less prominent, and new perspectives may take root. For example, as new standards for classroom engagement become the status quo, and institutions invest and firm up e-learning policies, some of the operational challenges may give way to other emergent higher order demands or perspectives. Future research involving follow-up interviews of the participants would be interesting to examine the evolution of educators' perspectives on e-learning.

The methodological strength of this study lies in the high response rate, sufficient number of participants for data saturation and adherence to a reporting guideline for qualitative studies. Since dental curriculum may vary across schools and countries, some of our findings may not be directly generalisable. Nevertheless, it is more than likely that issues highlighted and insights gained from this study are relevant to dental institutions in other countries and will resonate with dental educators across domains. The findings of this study have some practical implications (Table 2), which can be useful for dental schools and teachers whilst they are striving to transform and reshape dental education to meet current and future challenges.

5 | CONCLUSIONS

The COVID-19 crisis forced e-learning to take centre stage in many parts of the globe and is driving a long-overdue revolution in e-learning. Despite the challenges, dental educators gained experience in adapting and improving their educational methodologies during this public health crisis. The experience changed some of their deep-seated mind sets and instilled resilience and confidence, which are likely to accelerate the pace of their e-learning adoption. Our findings have a number of implications for the continued adoption of e-learning. For educators to adopt e-learning sustainably, continued investment in terms of funding, manpower and equipment is a prerequisite. Beyond the use of technological tools, educators need to be trained on harnessing the affordance of e-learning through the adequate application of pedagogies. Whilst educators saw a potential for future adoption of the hybrid approach, discussion on the direction of e-learning and institutional strategy will provide impetus to major strides in dental e-learning. Cross-organisation collaboration could be explored to develop and share the repositories of e-learning resources at national and international levels.

CONFLICT OF INTEREST
The authors do not have any conflicts of interest.

DATA AVAILABILITY STATEMENT
The data presented in this study are available on request from the corresponding author. The data are not publicly available.

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