

Blended learning in dental education: a scoping review

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Abstract

Background: Blended learning (BL) is a flexible, student-centered approach offered in modern education that enhances the effectiveness of learning through a combination of face-to-face and online instruction. Its application in dental education is limited, in spite of its wide acceptance and successful implementation in medical education. **Objective:** This scoping review explores the implementation, design, advantages, and challenges of blended learning in dental education, offering a broad evaluation of its effectiveness across specialties and academic levels. **Methodology:** PRISMA-ScR guidelines and Arksey and O'Malley's five-stage framework were followed in this review. A comprehensive literature search was conducted across databases like PubMed, Scopus, and ScienceDirect using keywords such as "blended learning", "hybrid education", "educational models" and "dental education." Out of 356 retrieved articles, only 30 peer-reviewed studies published between 2015 and 2024 met the inclusion criteria and were included for the present scoping review analysis. **Results:** Findings reveal

favorable outcomes following application of BL in dental education, with consistent positive perceptions among students and faculty. BL was seen to significantly improve academic performance and satisfaction in disciplines such as oral surgery, orthodontics, dental pharmacology, and endodontics. Hands-on skills like tooth carving and local anesthesia demonstrated enhanced learning outcomes through the use of video-assisted and hybrid modules. However, challenges such as limited faculty training, digital infrastructure gaps, and resistance to pedagogical change were also identified. **Conclusion:** Blended learning serves as an important adjunct, but not as a substitute for traditional dental education. If planned well, and with adequate institutional and faculty support, BL can help improve academic performance, student engagement, and learning outcomes, thus contributing to an improved dental education curriculum in the future.

Keywords: Blended Learning, Digital Pedagogy, E-Learning, Flipped Classroom, Hybrid Learning, Virtual Learning Environments

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INTRODUCTION

Dental education has traditionally focused on the acquisition of manual clinical skills. However, over the past two decades, the shift from teacher-led to student-centered learning has brought on active student participation, engagement and teamwork. Blended learning (BL), which includes online and in-person teaching, has helped to drive this change by integrating virtual courses and self-paced lessons

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with face-to-face lectures and hands-on clinical sessions.¹

The COVID-19 pandemic prompted a surge in digital learning, leading to the emergent use of blended and hybrid educational models.² This digital transition not only helped maintain educational continuity but also provided an impetus to reassess traditional instructional models and

explore blended learning as a long-term strategy.² BL has since offered a promising way to enhance both the quality and accessibility of dental education.³ Contemporary dental students need to master clinical skills while keeping pace with digital technology. BL supports this need by offering a flexible, engaging, and tailored way to learn.^{4,5} By combining live (synchronous) and self-paced (asynchronous) learning, it allows students to learn at their own pace, and at the same time enhances student engagement and knowledge retention.^{2,6,7} This not only supports flexibility in educational delivery but also aligns with the pedagogical needs and technological fluency of today's generation of students.³

Although the current literature acknowledges the benefits of BL in medical and dental education, a comprehensive synthesis focusing specifically on its adoption in dental curricula is lacking. Most available studies are limited to single institutions or short-term interventions and vary widely in design, content delivery, and outcome measures. Details regarding the pedagogical frameworks used and the impact of BL on student engagement, clinical competence, and academic outcomes are also limited. This scoping review aims to map existing evidence, identify key themes, assess implementation strategies, and highlight research gaps to guide curriculum development and future research directions in dental education.

METHODOLOGY

This scoping review was conducted over a 14-week period, ensuring a balance between an expedited timeline and adherence to systematic and rigorous methodology. The review followed the scoping review framework outlined by Arksey and O'Malley (2005),⁸ which provides a structured approach to mapping key concepts and evidence in a research area. To ensure transparency and completeness in reporting, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist was utilized throughout the process.

Identifying the Research Questions

The review was guided by the following research questions:

1. *What is the potential, scope, and future of blended learning as a teaching methodology in competency-based dental education?*
2. *What are the reported strengths and challenges associated with blended learning?*
3. *What are the perceptions of students and teachers regarding the outcomes of blended learning in dental education?*

Identification of Relevant Studies: A comprehensive search strategy was collaboratively developed and implemented by all authors. Three major electronic databases PubMed, Scopus, and ScienceDirect were systematically searched for relevant literature published in English over the last 10 years (2015 to 2024). Search terms included “*blended learning*”, “*hybrid learning*”, “*educational models*”, and “*dental education*”, applied to titles, abstracts, and MeSH terms where applicable. The search strategy was designed to capture studies that explored BL within the context of dental education.

Study Selection (Inclusion and Exclusion Criteria): An iterative screening process was employed, beginning with the review of titles and abstracts, and followed by a full-text assessment to determine study eligibility. The search was limited to peer-reviewed original research articles with full texts available, published between January 2015 and December 2024, and written in English. Eligible studies utilized quantitative, qualitative, or mixed method designs and specifically investigated the use of BL in dental education. The focus was on dental students and educators (Population), blended learning interventions (Concept), and dental schools or programs as the setting (Context). The inclusion criteria encompassed all dental programs implementing BL, regardless of explicit competency-based curriculum labelling, supporting a comprehensive mapping of models, implementation strategies, and evidence. Grey literature, conference proceedings, editorials, opinion pieces lacking empirical data, research based solely on educational theories without practical implementation, and any articles that did not involve blended learning in dental education were excluded. To facilitate efficient screening, all

selected articles were imported into Rayyan software.

Data Extraction and Charting: A data extraction protocol, based on the PRISMA-ScR flowchart (Figure 1) was drafted and utilized by the reviewers. Out of a total of 356 articles that were screened, only 30 were included for the present review. Two independent reviewers (SS and EP) extracted data from the included studies. Extracted information included journal name, article title, author(s) and

year of publication, study design, study objectives, blended learning methodology, population details, key findings, and reported outcomes. Disagreements in data extraction were resolved through consensus discussions by a third reviewer (PK).

Collating, Summarizing, and Reporting Results: Data were compiled into tabular format to facilitate comparison and synthesis (Table 1). Narrative synthesis was performed to organize findings

Figure 1: PRISMA Flowchart for the review

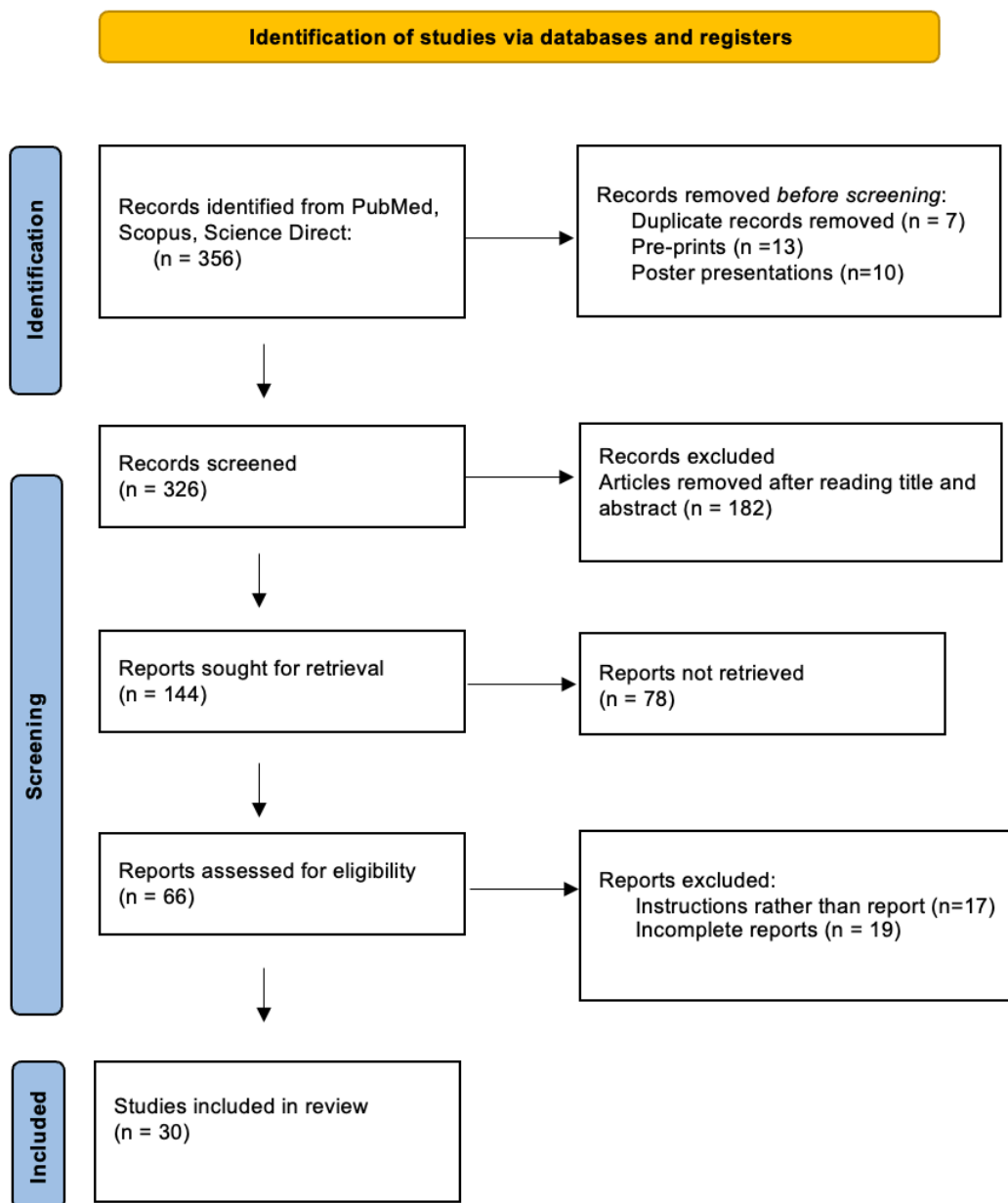


Table 1: Characteristics of the included studies in the present scoping review

| Sl. No | Author(s)/Year | Study Title | Journal Name | Study Design | Purpose | Findings & Conclusion |
|--------|---|---|-------------------------|--|---|---|
| 1 | Goh CE et al. ² (2022) | When e-learning takes centre stage amid COVID-19: Dental educators' perspectives and future impacts | Eur J Dent Educ | Interview-based study | Explore educators' perspectives on e-learning during COVID-19 and future adoption | Educators gained confidence in e-learning; prefer blended learning, especially for PG education; role shift from disseminators to facilitators recommended. |
| 2 | Ferro AS et al. ³ (2019) | Innovative Trends in Implant Dentistry Training and Education | J Clin Med | Narrative review | Discuss modern learning modalities including AI, AR, VR | Digital tech will replace ineffective traditional models; AI, VR, ML are key future trends. |
| 3 | Ali K et al. ⁴ (2023) | Blended learning in undergraduate dental education: a global pilot study | Med Educ Online | Questionnaire survey | Explore global blended learning trends in UG dental education | Faculty support blended learning; students find online less interactive; need for adaptation to learning needs. |
| 4 | Duš-Ilnicka I et al. ⁵ (2024) | Blended intensive programme's implementation in dental education | BMC Med Educ | Online questionnaire survey | Study technical aspects and implementation of a blended program | Blended learning broadens learning; clinical components need in-person delivery. |
| 5 | Wimardhani YS et al. ⁹ (2023) | Perceptions of Online Learning in Dental Education during COVID-19 | Dent J | Questionnaire-based study | Assess faculty perceptions in SE Asia on online learning | Positive outlook; support for blended learning beyond COVID-19. |
| 6 | Eachempati P et al. ¹⁰ (2016) | Blended learning for reinforcing dental pharmacology | Indian J Pharmacol | Cross-sectional study | Analyze student reflections on blended learning in pharmacology | Successfully implemented; reinforced student learning. |
| 7 | Solanki L et al. ¹¹ (2023) | Virtual Schooling in Dental UG & PG Education: KAP Survey | Cureus | Cross-sectional KAP survey | Evaluate UG and PG students' KAP on virtual learning | Blended model preferred; good knowledge and attitude shown. |
| 8 | Khalaf ME et al. ¹² (2023) | The Dental Educational Environment of Online and Blended Learning | Dent J (Basel) | Descriptive cross-sectional | Assess student perceptions of online and blended learning environment | Positively perceived by students. |
| 9 | Nasseripour M et al. ¹³ (2022) | Clinical experiences of staff and students in blended teaching | Front Oral Health | Qualitative study (purposive sampling) | Examine clinical teaching practices in blended format | Concerns on engagement, attendance, and interaction raised. |
| 10 | Tabatabaei SH et al. ¹⁴ (2022) | Opportunities and threats of e-learning in dental education | Dent Res J (Isfahan) | Mixed-method (exploratory sequential) | Explore opportunities and threats of e-learning | Emphasized infrastructure, training for e-teachers and students. |
| 11 | Prasad P et al. ¹⁵ (2024) | WhatsApp as a Tool in Blended Learning in Dental Education | J Pharm Bioallied Sci | Review | Evaluate role of digital tools like WhatsApp in blended learning | Advocates digital-supported sustainable learning methods. |
| 12 | Madi M et al. ¹⁶ (2024) | Virtual vs Traditional Learning: Student Perception and Satisfaction | Dent J (Basel) | Cross-sectional survey | Compare satisfaction with virtual vs traditional classes | Traditional preferred; integration with virtual learning suggested. |
| 13 | Blond N et al. ¹⁷ (2024) | Blended learning vs traditional for oral surgery competencies | Eur J Dent Educ | RCT | Compare effectiveness in teaching oral surgery skills | Blended learning had positive educational impact. |
| 14 | Arponen H et al. ¹⁸ (2024) | Impact of Remote Teaching on Orthodontics Performance | J Med Educ Curr Dev | Mixed-method pilot study | Assess learning outcomes and feedback in remote orthodontic teaching | Remote teaching produced outcomes comparable to classroom teaching. |
| 15 | Alzer H et al. ¹⁹ (2023) | Blended Learning with Video for Tooth Carving | Adv Med Educ Pract | Retrospective cohort study | Assess effect of video demonstrations in blended learning | Improved tooth carving skills; effective supplementary method. |
| 16 | Bock A et al. ²⁰ (2021) | Blended vs Face-to-Face & E-learning for Local Anaesthesia | BMC Med Educ | RCT / Questionnaire-based | Compare effectiveness of 3 methods for teaching local anaesthesia | Blended learning superior in theory and equally effective in practical skills. |
| 17 | Ullah R et al. ²¹ (2021) | Blended learning in dental anatomy | J Dent Educ | Prospective non-randomized study | Compare outcomes between blended vs traditional anatomy teaching | Improved satisfaction and academic outcomes with blended learning. |
| 18 | Nijakowski K et al. ²² (2021) | Effectiveness of Blended Learning in Conservative Dentistry | IJERPH | Survey-based action research | Evaluate effectiveness in conservative dentistry and endodontics | Positive reception; preferred post-pandemic continuation. |
| 19 | Gatt G, Attard NJ. ²³ (2023) | Multimodal methods vs traditional teaching | BMC Med Educ | 3-year prospective cohort | Assess multimodal teaching on theoretical dental education | Comparable exam performance, improved satisfaction; supports blended approach. |
| 20 | Karandish M et al. ²⁴ (2024) | Flipped classroom in orthodontic course | Clin Exp Dent Res | Quasi-experimental | Evaluate knowledge, satisfaction, and skills post flipped-blended model | Enhanced knowledge, practice, and satisfaction observed. |
| 21 | Preshaw PM et al. ²⁵ (2024) | Contemporary educational methods in periodontology | J Clin Periodontol | Systematic review | Assess education methods in UG, PG, CPD in periodontology | F2F trusted; blended methods best for outcome achievement. |
| 22 | Walinski CJ et al. ²⁶ (2023) | Optimizing dental education for Gen Z | J Dent Educ | Review | Review learner-focused teaching for Gen Z | Gen Z prefers technology-based, student-centred approaches; conventional methods less effective. |
| 23 | Hussain F et al. ²⁷ (2018) | Student expectations in blended Master's prosthodontics program | Br Dent J | Questionnaire-based | Evaluate expectations and experiences in blended PG prosthodontics | Positive, meaningful experience reported; supports use of blended model. |
| 24 | Ab Ghani SM et al. ²⁸ (2022) | Blended vs conventional in fixed prosthodontics | Eur J Dent Educ | Randomized controlled trial | Compare performance in easy and difficult tasks | Similar effectiveness; blended learning feasible in preclinical training. |
| 25 | Lele D, Sikdar M. ²⁹ (2024) | Dental teachers' perception of blended learning post-COVID | Int J Clin Pediatr Dent | Descriptive qualitative study | Understand willingness and concerns of teachers for blended learning | Teachers support transition; need training and faculty development. |
| 26 | Shah S et al. ³⁰ (2024) | Challenges in PG blended learning programs | Med Educ | Qualitative exploratory study | Identify challenges in PG blended programs | Barriers include skills, admin, and resistance; recommends faculty training and support. |
| 27 | Maes DM et al. ³¹ (2023) | Blended learning in orthodontics PG education | Eur J Orthod | Questionnaire survey | Compare student and teacher perceptions | Effective and stimulating, but not seen as a full replacement for traditional models. |
| 28 | Iqbal M et al. ³² (2024) | Blended pedagogy for radiographic interpretation | BMC Med Educ | Mixed-method study | Compare test scores and experiences between BP and DL methods | Higher scores in blended group; students favoured BP approach. |
| 29 | Qutieshat AS et al. ³³ (2020) | Blended learning in clinical dental education | J Dent Educ | Cohort study | Evaluate flipped blended learning in clinical dental education | Improved performance and perception; calls for structured support and design. |
| 30 | Chang JYF et al. ³⁴ (2021) | Classroom vs online learning effectiveness in COVID-19 | J Dent Sci | Online questionnaire survey | Compare physical vs online learning during the pandemic | Online readiness noted; blended model proposed as future trend. |

according to identified themes relevant to the research questions. An iterative process of discussion among reviewers (SS, EP, PK, HS) allowed refinement of themes and subthemes, providing a comprehensive overview of the evidence regarding BL in dental education.

RESULTS

Adoption and Perceptions of Blended Learning:

The review of 30 diverse studies (Table 1) ^{2-5, 9-34} shows a strong global shift toward **BL** as a preferred model in dental education across both undergraduate and postgraduate levels. Educators and students alike reported positive perceptions, with BL being favored for its flexibility, accessibility, and potential to enhance learning outcomes. ^{2,4,7,9,11,12} **Faculty perceived increased confidence** in employing e-learning post-COVID and advocated blended learning for future adoption. ^{2,3} **Students displayed favorable**

knowledge and attitudes toward virtual learning but consistently preferred a blended model over fully online or traditional modes. ^{11,12,16} Faculty and students, alike, viewed **blended learning not as a complete replacement** for traditional education but as a valuable supplement to enhance teaching efficacy. ^{16, 31}

Effectiveness Across Disciplines and Implementation Models:

BL was effectively integrated across various dental specialties, using formats such as flipped classrooms, video-based modules, mobile apps, and simulation tools. **Improved academic performance and satisfaction** were reported in oral surgery, ¹⁷ orthodontics, ^{18,24} dental pharmacology, ¹⁰ dental anatomy, ²¹ conservative dentistry and endodontics, ²² and radiographic interpretation. ³² **Hands-on skills training** (e.g., tooth carving, local anaesthesia) benefited

significantly from video-assisted blended methods, showing comparable or better outcomes than traditional methods.^{19,20} For teaching **clinical components which require in-person interaction**, multiple studies emphasized using hybrid models combining tele-dentistry and face-to-face training.^{5,13,33} **The use of WhatsApp and Augmented and Virtual Reality (AR/VR) simulations** to enhance engagement and support student-centered learning has also been demonstrated.^{3,15,19} WhatsApp has been shown to enhance communication, resource sharing and peer interaction,¹⁵ while AR and VR have helped improve engagement and support student-centered learning, especially in Implant Dentistry. VR-enabled systems, when used for teaching implant treatment planning and surgery, provide tactile feedback, and enable the learner to practice placing dental implants in a virtual environment prior to actual surgery.³

Other Key Highlights:

- **Faculty Development and Institutional Support:** The success of BL depends heavily on training for educators and robust digital infrastructure.^{14,23,29}
- **Barriers and Challenges Identified:** These include administrative resistance, lack of digital skills, and inadequate online engagement strategies, especially in postgraduate programs.^{24,30}
- **Long-term Sustainability:** Some studies support **continued use of blended models beyond the pandemic**, reinforcing their value in future dental education.^{22,25,28} Sustained success, however, depends on context-specific strategies, strong faculty support and adequate technological resources.

Thus, the review demonstrates that while BL is not a one-size-fits-all solution, it consistently supports **better learning experiences, improved outcomes, and future-readiness** across multiple domains within dental education. A structured, context-specific implementation, along with faculty and technological support, is crucial for its sustained success.

DISCUSSION

Blended learning, a pedagogical approach that strategically integrates face-to-face and online instruction, has long been present in healthcare education. However, the **COVID-19 pandemic served as an inflection point**, rapidly accelerating its adoption due to the necessity of social distancing.² The urgent shift to digital platforms during the pandemic highlighted the **flexibility, resilience, and scalability** of BL approaches. What initially emerged as a contingency measure evolved into a **transformational force** in dental education, highlighting the critical need for modern, adaptive educational methodologies. In response to pandemic restrictions, even **informal tools such as WhatsApp** were effectively repurposed as e-learning aids, facilitating communication and peer engagement during emergencies.¹⁵ This underscores the versatility of digital platforms in supporting learning continuity. Across the reviewed studies, there was consistent evidence that **blended learning models were more effective** than purely online or traditional classroom-based formats, especially in maintaining student engagement, performance, and satisfaction.^{4,11,16,17,21}

Blended Learning Enhances Academic Performance and Student Satisfaction

BL has demonstrated notable **academic advantages**, particularly in knowledge-intensive and skill-based domains of dental education. Students exposed to BL modules often **outperformed their peers** in control groups receiving traditional instruction, achieving **higher average scores**, and demonstrating improved conceptual understanding.^{20,21,32} In clinical disciplines like **oral surgery and orthodontics**, students reported significantly higher satisfaction and engagement when trained via BL methods compared to either virtual or classroom-only teaching.^{17,18} Similarly, **video demonstrations** integrated into BL frameworks enhanced the acquisition of psychomotor skills such as tooth carving,¹⁹ reinforcing the role of multimodal resources in skill-based learning. Additionally, the **use of flipped classroom models, online forums, mobile apps, and video modules** allowed for self-paced learning, encouraging deeper engagement and better retention of knowledge.^{24,25,28} For

instance, in a randomized study comparing face-to-face, e-learning, and blended methods for teaching local anesthesia, **BL was found to be superior in providing theoretical knowledge, and was as effective as traditional teaching methods for clinical skill acquisition**, thus validating the pedagogical soundness of this approach.²⁰ Students' **positive perceptions of blended models** have been widely documented. Numerous studies reported increased satisfaction, motivation, and self-confidence among learners, particularly when theoretical concepts were delivered online while practical skills were taught in-person.^{4,11,12,21} These outcomes support the **cognitive theory of multimedia learning**, which emphasizes that well-structured multimodal instruction fosters better knowledge processing and retention.^{35,36}

Despite its many benefits, most studies emphasized that **BL is best used as a supplement** rather than a replacement for traditional teaching.^{5,13,31} Clinical dental training requires **hands-on interaction and real-time feedback**, which cannot be wholly replicated in virtual settings. Hybrid clinical techniques such as tele-dentistry were found to be effective, but their success depended on **structured curricula and support infrastructure**.^{13,33}

Faculty Development and Institutional Readiness

The **successful implementation of blended learning** hinges on comprehensive faculty development programs and robust digital ecosystems. While **students consistently preferred BL models**, many faculty members expressed **reluctance** to fully adopt these innovations.²⁹⁻³² This resistance stems from factors such as lack of digital proficiency, inadequate institutional support, and unfamiliarity with pedagogical design suited for online delivery.^{23,30} Addressing this **implementation gap** is essential to maximize the long-term benefits of BL.

Studies have emphasized the requirement of continuous professional development for educators to adapt to **technology-enhanced teaching methods**, including training in Learning Management Systems (LMS), digital resource development, and interactive pedagogy.^{23,29,30} Administrative support through policies, funding,

and improved infrastructure is essential to lighten faculty workload and help build long-lasting, effective teaching methods.^{6,31,34,35} The necessity for **interdisciplinary collaboration** between educators, information technology support teams, and curriculum designers has developed into a crucial factor for success. Such collaboration enables the **customization of content**, ensuring alignment with learner needs and institutional goals. An example of BL would be the IPSIT model advocated by the University Grants Commission for higher education in India. The IPSIT model comprises the following phases: (i) Identify resources and learner-centered activities; (ii) Provide resources and announce activities on LMS; (iii) Scaffolding and support to learners; (iv) Identification of learning gaps and feedback; and (v) Testing. This approach may serve as a useful model for dental education authorities globally in formulating their own BL frameworks.^{6,35}

Future Directions and Long-Term Integration

BL is **poised to become the cornerstone** of contemporary dental education. As digital technologies evolve, the opportunity to deliver **personalized, immersive learning experiences** through artificial intelligence (AI), machine learning (ML), augmented reality (AR), and virtual reality (VR) will grow exponentially.^{3,15} These tools can adapt to individual learner profiles, offering real-time analytics and adaptive learning paths that support continuous improvement. Crucially, BL supports the development of **lifelong learning habits**, and practicing dentists can benefit from **flexible, modular online courses** without compromising their clinical responsibilities.^{25,34} This adaptability aligns well with the preferences of **Generation Z students**, who demand technology-integrated, engaging, and student-centric learning environments.²⁶ To keep up with technology and student needs, dental education must adopt a smart and inclusive blended learning plan. This needs ongoing teacher training, updated courses, and full support from institutions to make blended learning a lasting part of dental education.

CONCLUSION

This scoping review highlights the application of blended learning as an effective and adaptable

approach within dental education by integrating online theory with hands-on clinical training to enhance academic knowledge, skills and performance. BL promotes student satisfaction, engagement, and lasting knowledge when online and in-person teaching are used in an appropriately balanced manner. However, the successful implementation of blended learning necessitates institutional investment, faculty training and a

robust digital infrastructure. Although current evidence demonstrates positive outcomes, most studies are limited to single institutions and short durations. Multicentric and longitudinal research studies are needed in the future to ascertain the long-term impact of BL on engagement, clinical competence and overall quality of education.

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