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A Cross-Sectional Survey on Knowledge and Awareness of Digital Dentistry in Prosthodontics Among Interns and Postgraduates of Dental Colleges in Mumbai and Navi Mumbai

Dr. Saurabh Sarode [1], Dr. Vishwas Kharsan [2], Dr. Gauri Phansalkar [3], Dr. Harshit Agarwal [4], Dr. Ankush Jadhav [5], Dr. Priyanka Chaugule [6]

[1] Post Graduate Student, Dept Of Prosthodontics And Crown &Bridge Institute, Nair Hospital Dental College, Mumbai 400008. Email: sarode744@Gmail.Com

[2] Professor and Head, Department of Prosthodontics and Crown & Bridge Institute: Nair Hospital Dental College, Mumbai 400008. Email: drvishwaskharsan@gmail.com

[3] Post Graduate Student, Dept of Prosthodontics and Crown & Bridge Institute: Nair Hospital Dental College, Mumbai 400008. Email: gphansalkar98@gmail.com

[4] Post Graduate Student, Dept of Prosthodontics and Crown & Bridge Institute: Nair Hospital Dental College, Mumbai 400008. Email: harshit.dental@gmail.com

[5] Post Graduate Student, Dept of Prosthodontics and Crown & Bridge Institute: Nair Hospital Dental College, Mumbai 400008. Email: ankushsantosh7@gmail.com

[6] Post Graduate Student, Dept of Prosthodontics and Crown & Bridge Institute: Nair Hospital Dental College, Mumbai 400008. Email: chaugulepriyanka26@gmail.com

Corresponding Authors. Saurabh Sarode; Email: ssarode744@gmail.com

Abstract

Background. Digital dentistry is increasingly integrated into prosthodontic practice, but training opportunities for dental trainees may vary.

Aims. This study assessed awareness, educational exposure, hands-on experience, perceived curriculum adequacy, and barriers to implementation.

Methods. A cross-sectional survey was conducted among interns and postgraduate students using a self-constructed, validated questionnaire. The questionnaire covered awareness of digital dentistry, attendance at lectures/workshops, undergraduate curricular exposure, exposure to specific digital technologies, hands-on use and tools used, perceived adequacy of curricular training, attitudes toward curriculum expansion, primary knowledge sources, perceived barriers, and expected future impact. Data were summarized as n (%) and compared between postgraduates and interns using Chi-square or Fisher's exact tests.

Results. A total of 100 responses were analyzed (51 postgraduates, 49 interns). Awareness was high (98% had heard of digital dentistry; 89% knew prosthodontic applications). Workshop/lecture attendance was 43%, higher among postgraduates than interns ($p<0.001$), while undergraduate curricular exposure was 31%. Reported exposure was highest for scanners (85%), CAD/CAM (81%), and digital impression systems (77%). Hands-on experience in prosthodontics was reported by 40%, more often among postgraduates than interns ($p<0.001$), with intraoral scanners most commonly used. Only 17% felt curricular training was sufficient, and most supported adding more digital dentistry content. Online resources were the most common knowledge source (50%), and cost/financial issues were the most reported barrier (46%).

Conclusion. Trainees showed strong awareness and positive attitudes toward digital dentistry, but practical exposure and perceived curriculum adequacy were limited. Structured hands-on training and resource support may help bridge this gap.

Keywords: Digital dentistry; Prosthodontics; Dental education; CAD/CAM; Intraoral scanner; Cross-sectional survey

INTRODUCTION

Digital dentistry has rapidly shifted from a niche innovation to an essential component of contemporary restorative care. In prosthodontics, digital workflows such as intraoral scanning, computer-aided design/computer-aided manufacturing (CAD/CAM), and three-dimensional (3D) printing are increasingly used for diagnosis, treatment planning, and fabrication of fixed and removable prostheses. Compared with conventional methods, these technologies have the potential to improve accuracy, standardization, and efficiency, while also supporting better communication with patients and laboratories (Joda et al., 2017).

Despite this growth, implementation remains uneven. Many institutions face practical constraints such as high initial investment, limited infrastructure, and restricted access to equipment for routine student training (Turkyilmaz et al., 2019). In addition, digital dentistry requires a specific skill set that includes software familiarity, scanning technique, and an understanding of how digital steps influence fit and function (Abduo et al., 2018). When exposure is limited to demonstrations or self-learning, students may develop theoretical awareness without gaining meaningful hands-on competence.

However, data on how dental trainees currently learn about digital dentistry, particularly their level of curricular exposure, practical experience, attitudes toward its value, and perceived barriers, remain limited in many settings (Zitzmann et al., 2020). Understanding these factors is necessary for planning targeted educational strategies that are realistic within institutional constraints.

The present study aimed to assess awareness and academic exposure to digital dentistry among interns and postgraduate students, evaluate exposure to common digital technologies and hands-on experience in prosthodontics, and explore perceptions regarding educational needs and future impact. In addition, the study sought to identify the primary sources of knowledge and the main barriers to implementation as reported by trainees, to inform curriculum planning and training prioritization.

METHODS

Study design and setting

The present cross-sectional, questionnaire-based survey was conducted over 2 months, from December 2025 to January 2026, at a dental institute in Mumbai. The study protocol was approved by the institutional ethical review board (Reference letter number: C-234/Prostho/ND15/2025). The survey targeted respondents affiliated with a dental teaching institution/clinical training environment. The study protocol should be reported in accordance with STROBE guidelines and the modified Declaration of Helsinki. Informed consent was obtained from all participants before recording their responses.

Participants and eligibility criteria

Participants were eligible if they were currently enrolled as interns or postgraduate students undergoing clinical training in the dental institutes of Mumbai city. Respondents were excluded if they declined to participate or submitted incomplete questionnaires that could not be used to estimate the primary variables. Participants were assured that their data would be anonymous and used only for the present study.

Questionnaire design

Data were collected using a structured questionnaire consisting of closed-ended and open-ended items. The instrument captured: (i) basic academic details (designation and postgraduate branch, where applicable); (ii) awareness of the term “Digital Dentistry” and awareness of its applications in prosthodontics; (iii) exposure through lectures/workshops and undergraduate curriculum; (iv) exposure to specific digital technologies (e.g., CAD/CAM systems, digital impression systems, intra-/extraoral scanners, 3D printing) using a multiple-response format; (v) hands-on experience with digital tools and the specific tools used; (vi) perceived adequacy of curricular training (Yes/No/Unsure); (vii) perceptions regarding quality improvement, recommendation for increased curricular content (Likert-type responses), interest in further training, and perceived future impact; and (viii) perceived barriers to implementation. The questionnaire was validated internally by five experts and externally in a homogenous population of 20 participants. The questions were modified as deemed by the pilot and these responses were not included in the final data analysis.

The questionnaire was created in Google Forms and circulated to potentially eligible participants through social media groups and emails. administered as a Google form. Completed responses were compiled into an MS Excel datasheet for analysis.

Data management and statistical analysis

Data were checked for completeness and internal consistency prior to analysis. Descriptive statistics were reported as frequency and percentage. For inferential analyses, respondents were compared by designation (postgraduate vs intern). As per the analysis plan for this manuscript, respondents who did not report a designation were classified with interns for group comparisons. Associations between designation and categorical outcomes were tested using the Chi-square test of independence; Fisher's exact test was applied when expected cell counts were small. Where relevant, effect sizes were reported using Cramér's V for Chi-square tests, and odds ratios (OR) with 95% confidence intervals (CI) for key binary comparisons. For sparse multi-level variables, categories were collapsed a priori to satisfy test assumptions while preserving interpretability (e.g., Strongly Agree vs Agree/Neutral for curriculum reinforcement). A two-sided p-value <0.05 was considered statistically significant. The statistical software used (e.g., SPSS/version or equivalent) should be specified in the final manuscript.

RESULTS

Participant characteristics

A total of 100 respondents completed the questionnaire. For analysis, respondents who did not report their designation (n = 2) were grouped with interns, yielding 49 interns (49.0%) and 51 postgraduate students (51.0%). The specialty-wise distribution of the postgraduate students (n=51) is depicted in Figure 1.

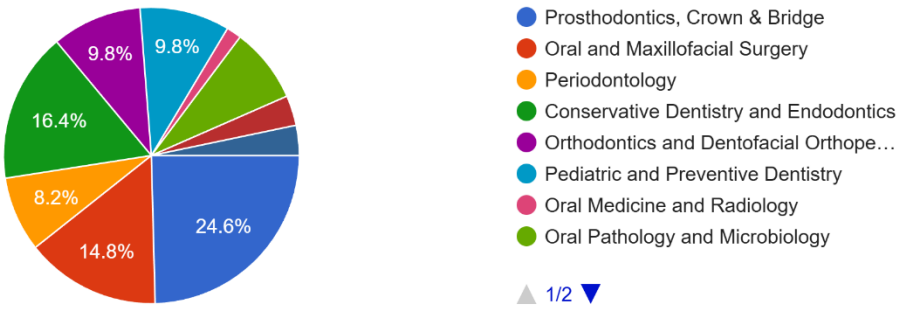

Figure 1: Specialty-wise distribution of the participants

Awareness and academic exposure to Digital Dentistry

Awareness of Digital Dentistry was consistently high among participants, with both interns and postgraduates reporting familiarity with the term and its prosthodontic applications (Table 1). When comparisons were made between postgraduate students and interns (the intern group includes the two respondents with missing designations), there was no statistically significant difference in (i) having heard the term "Digital Dentistry", (ii) reporting undergraduate curricular exposure, or (iii) awareness of prosthodontic applications. In contrast, attendance at Digital Dentistry lectures/workshops was significantly higher among postgraduate students than interns.

Table 1. Awareness and academic exposure to Digital Dentistry by designation (N = 100)

Outcome	Response	Overall n (%)	Postgraduate (n=51) n (%)	Intern (n=49) n (%)	Test	χ^2	df	p-value
Heard the term "Digital Dentistry"	Yes	98 (98.0)	51 (100.0)	47 (95.9)	Fisher exact	-	-	0.238
	No	2 (2.0)	0 (0.0)	2 (4.1)				
Attended lectures/workshops on Digital Dentistry	Yes	43 (43.0)	33 (64.7)	10 (20.4)	Chi-square	20.01	1	<0.001
	No	57 (57.0)	18 (35.3)	39 (79.6)				
Exposed to Digital Dentistry in UG curriculum	Yes	31 (31.0)	19 (37.3)	12 (24.5)	Chi-square	1.90	1	0.168
	No	69 (69.0)	32 (62.7)	37 (75.5)				
Aware of applications of Digital Dentistry in Prosthodontics	Yes	89 (89.0)	47 (92.2)	42 (85.7)	Chi-square	1.06	1	0.303
	No	11 (11.0)	4 (7.8)	7 (14.3)				

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Knowledge about Digital Technologies:

Exposure to core digital technologies was common across respondents, including CAD/CAM systems, digital impression systems, 3D printing, and intra-/extraoral scanners (Table 2). When compared by designation, exposure to intra-/extraoral scanners was significantly higher among postgraduate students than interns, whereas exposure to CAD/CAM systems, 3D printing, and digital impression systems did not differ significantly between the two groups (Table 2). A substantial proportion of participants reported hands-on experience

with digital tools in prosthodontics; however, postgraduate students reported it significantly more often than interns. Among those who reported hands-on use, the most commonly used tool category was intraoral scanners, either alone or in combination with CAD/CAM and/or 3D printing (Figure 2). Perceived curricular adequacy was low overall. A significantly higher proportion of postgraduate students reported that the curriculum provided sufficient training in Digital Dentistry than interns did. Nevertheless, most respondents either disagreed or were unsure regarding curricular sufficiency.

Table 2. Exposure to digital technologies, hands-on experience, and perceived curricular sufficiency by designation (N = 100)

Outcome	**Overall n (%)**	**Postgraduate n (%)**	**Intern n (%)**	**Test**	**Test value**	**df**	**p-value**	**Cramér's V**
Exposure to CAD/CAM systems (Yes)	81 (81.0)	42 (82.4)	39 (79.6)	Chi-square	0.124	1	0.725	0.04
Exposure to 3D printing (Yes)	63 (63.0)	36 (70.6)	27 (55.1)	Chi-square	2.571	1	0.109	0.16
Exposure to digital impression systems (Yes)	77 (77.0)	42 (82.4)	35 (71.4)	Chi-square	1.684	1	0.194	0.13
Exposure to intra-/extraoral scanners (Yes)	85 (85.0)	49 (96.1)	36 (73.5)	Chi-square	10.019	1	0.002	0.32
Hands-on experience with digital tools in prosthodontics (Yes)	40 (40.0)	30 (58.8)	10 (20.4)	Chi-square	15.366	1	<0.001	0.39
Curriculum includes sufficient training on Digital Dentistry (Yes)	17 (17.0)	14 (27.5)	3 (6.1)	Chi-square	8.057	1	0.005	0.28
Curriculum includes sufficient training on Digital Dentistry (No)	67 (67.0)	28 (54.9)	39 (79.6)	-	-	-	-	-
Curriculum includes sufficient training on Digital Dentistry (Unsure)	16 (16.0)	9 (17.6)	7 (14.3)	-	-	-	-	-

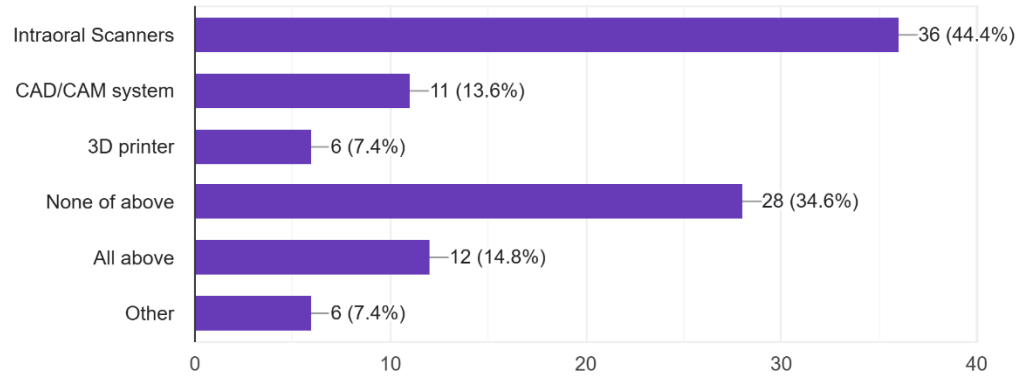

Figure 2: Tools used in Digital Dentistry, tools used by the respondents

Attitude regarding Digital Dentistry:

All respondents endorsed the view that **d**igital tools improve the quality of prosthodontic work; therefore, no between-group testing was applicable for this item. Support for strengthening Digital Dentistry teaching within the curriculum was high overall, and postgraduate students were significantly more likely than interns to select "Strongly Agree" (Table 3).

Interest in pursuing additional education or training in Digital Dentistry was near-universal in both groups; the few non-affirmative responses occurred only among interns and did not yield a statistically significant between-group difference. With respect to the anticipated future impact of Digital Dentistry in prosthodontics, most respondents expected a revolutionary impact. Although this expectation was more frequent among postgraduate students, the difference was not statistically significant ($p>0.05$) on inferential testing.

Table 3. Perceptions, curriculum reinforcement, training intent, and future outlook by designation (N = 100)

Outcome	Category	Overall n (%)	Postgraduate n (%)	Intern n (%)	Test	Test value	df	p-value	Effect size
Digital tools improve the quality of prosthodontic work	Yes	100 (100.0)	51 (100.0)	49 (100.0)	N/A	-	-	-	-
Recommend more Digital Dentistry content in the curriculum	Strongly Agree	75 (75.0)	44 (86.3)	31 (63.3)					
	Agree	20 (20.0)	6 (11.8)	14 (28.6)					
	Neutral	5 (5.0)	1 (2.0)	4 (8.2)					

Recommend more DD content (collapsed for test)	Strongly Agree vs Agree/Neutral				Chi-square (Yates)	5.882	1	0.015	0.243
Interested in further education/training in Digital Dentistry	Yes	98 (98.0)	51 (100.0)	47 (95.9)					
	No	1 (1.0)	0 (0.0)	1 (2.0)					
	(Missing)	1 (1.0)	0 (0.0)	1 (2.0)					
Interested in further training	Yes vs No				Fisher exact	OR not estimable*	-	0.485	-
Perceived future impact of Digital Dentistry in Prosthodontics	Revolutionizing Dental practice	94 (94.0)	50 (98.0)	44 (89.8)	-	-	-	-	-
	Limited impact	4 (4.0)	0 (0.0)	4 (8.2)	-	-	-	-	-
	Not sure	2 (2.0)	1 (2.0)	1 (2.0)	-	-	-	-	-
Future impact	Revolutionizing vs Limited/Not sure				Fisher exact	OR = 5.68	-	0.108	-

Primary source of knowledge about Digital Dentistry

Overall, online resources emerged as the dominant source, followed by workshops, whereas lectures and peer discussions were less commonly cited (Figure 3). This pattern suggests that learners are relying more on self-directed, internet-based learning than structured academic teaching for Digital Dentistry concepts. For inferential analysis, the knowledge-source variable was collapsed into three categories (Online resources / Workshops / Other sources [lectures + peer discussions + "other"]) to satisfy expected-cell assumptions. A significant association was observed between designation (postgraduate vs intern) and primary knowledge source ($\chi^2 = 9.64$, df = 2, p = 0.008; Cramér's V = 0.31), indicating that the preferred source differed by designation.

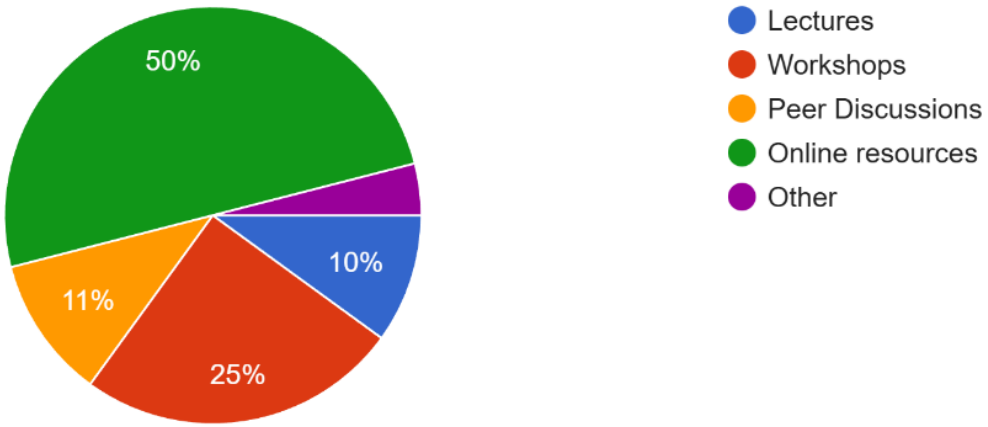

Figure 3: Responses for primary source of knowledge about digital dentistry

Perceived barriers to implementing Digital Dentistry in practice

Barrier responses were collected as free-text entries and were coded into thematic categories for reporting (Figure 4). The distribution showed that financial constraints were the most frequently reported constraint, followed by infrastructure/availability and training/knowledge gaps. A notable fraction of responses were blank/unclear, reflecting non-response or insufficiently specified barriers. For between-group inference, barriers were collapsed into cost/financial vs non-cost/other. Cost-related barriers were reported more frequently by postgraduate students than interns, with a small but statistically significant difference on Pearson chi-square testing ($\chi^2 = 4.06$, df = 1, p = 0.044). The direction and magnitude of association indicated higher odds of reporting a cost barrier among postgraduates (OR = 2.27; 95% CI: 1.02–5.07).

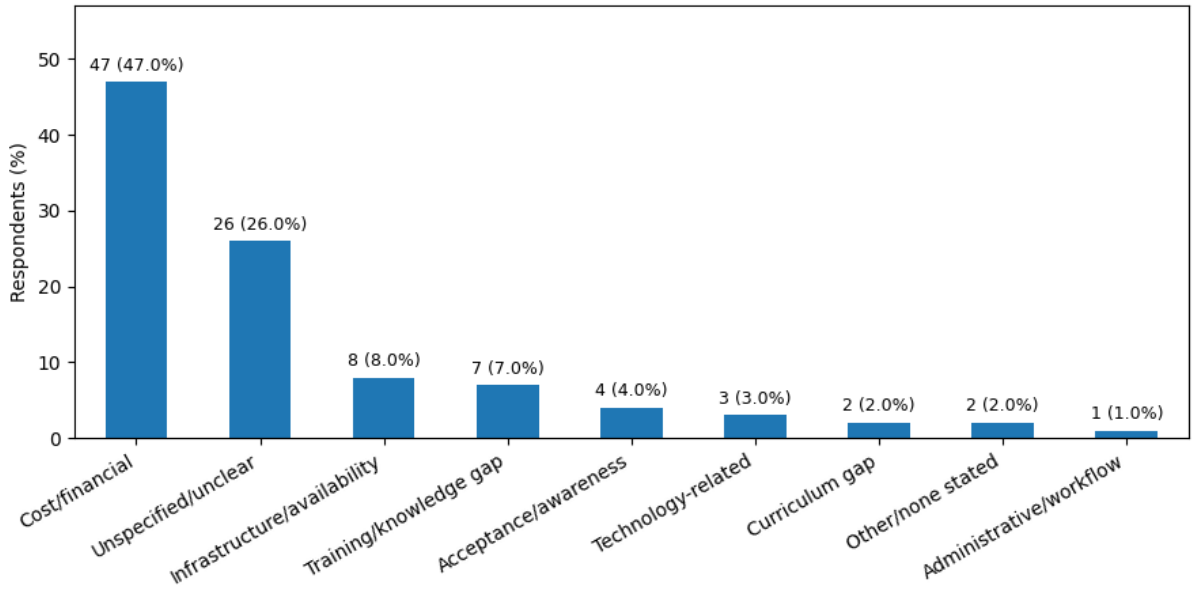

Figure 4: Perceived barriers in digital dentistry by the participants

DISCUSSION

In the present survey, the respondents demonstrated a high level of awareness of digital dentistry and a largely favorable outlook toward its role in prosthodontics. Most participants believed that digital tools improve the quality of prosthodontic work and supported incorporating more digital dentistry content into the curriculum. At the same time, many felt that the existing curriculum does not provide sufficient practical training, highlighting a clear mismatch between perceived importance and the current level of structured exposure.

This pattern is consistent with earlier evidence showing that students generally view digital dental technology positively and that attitudes are closely linked to their intention to use these tools in future practice. Sheba et al. (2021) reported that dental students' perceptions and attitudes toward digital dental technology were associated with their intention to adopt it, suggesting that favorable beliefs can translate into willingness to implement digital workflows, provided opportunities for training are available (Sheba et al., 2021).

Despite this optimism, our findings also reflect a common concern reported across dental education settings: practical barriers continue to slow implementation. Cost (equipment purchase, maintenance, and software/licensing) was frequently identified as the main obstacle, often accompanied by comments related to limited institutional infrastructure and lack of trained manpower/faculty support. Similar constraints have been documented at the institutional level, where administrators and faculty describe cost, infrastructure readiness, and workforce capability as key challenges when expanding digital dentistry education (Alfallaj et al., 2022). These barriers are particularly relevant for resource-limited teaching environments, where adoption requires both capital investment and sustained technical support.

The finding that respondents commonly obtain information from online resources, workshops, and peer discussions suggests that learning is occurring in a fragmented, opportunistic manner rather than through a standardized competency pathway. This matters because isolated exposure may raise awareness without consistently building clinical confidence. Educational interventions that include structured hands-on exercises have been shown to improve students' perceptions and readiness (Nassani et al., 2024). For example, Nassani et al. (2024) reported measurable improvements in student perceptions after a CAD/CAM manufacturing exercise, supporting the idea that practical exposure can strengthen acceptance and skill acquisition (Hall et al., 2023).

Clinically, the overall positive attitude and strong interest in further training indicate a receptive learner population. The results support introducing a staged curriculum model, early conceptual teaching followed by guided hands-on modules (intraoral scanning, CAD basics, and introductory 3D printing), complemented by workshops and supervised clinical integration, to convert interest into capability while addressing resource constraints through phased procurement and shared training facilities.

This study has certain limitations. As a single-center, questionnaire-based survey, the findings reflect self-reported perceptions and may be influenced by recall or social desirability bias. The cross-sectional design also limits causal interpretation, and the sample may not

represent trainees from other institutions with different infrastructure or teaching practices. In addition, some responses, such as perceived barriers, were free-text and required thematic grouping, which may introduce subjective interpretation. Future studies should include multi-institutional samples, use validated questionnaires, and incorporate objective measures of competence (e.g., structured assessments of scanning/CAD skills) to better correlate awareness and attitudes with actual clinical performance.

CONCLUSION

Overall, dental trainees showed high awareness and a positive attitude toward digital dentistry in prosthodontics, with strong support for expanding digital content in the curriculum. However, hands-on exposure and perceived training adequacy were limited, with cost and resource constraints reported as key barriers. These findings support strengthening structured, practical digital dentistry training to better align education with current clinical needs.

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