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Future of dental education: digitalization, career outlook, and perspectives of dental students and early-career dentists

Yasin Batuhan Gavgali[1*] and Tuğçe Kavaz[2]

Abstract

Background This study aims to assess the opinions of dental students and postgraduate dental practitioners in Turkey regarding the digitalisation of dentistry and the future career outlook of the profession. It focuses on understanding participants' views on digital competence, the integration of digital technologies into dental education, and their intentions related to practising abroad.

Methods A cross-sectional questionnaire study was conducted among undergraduate students (4th- and 5th-year) and postgraduate trainees (PhD and specialty students). The survey explored perceptions of digitalisation in dentistry, professional expectations, and factors influencing career decisions. Descriptive statistics were used for data summarisation. Data were collected between September 2023 and June 2024. Statistical significance was set at $p < 0.05$.

Results The required sample size was calculated as 376, and data collection was completed with 378 participants after excluding incomplete or invalid submissions. Participants who were new to the profession or had recently begun postgraduate training reported predominantly theoretical knowledge and hands-on exposure with digital applications in dentistry. Additionally, a significant association was found between responses to two questions examining intentions to practise abroad with or without economic considerations ($p = 0.001$), suggesting that financial factors alone do not fully explain the desire to work internationally.

Conclusions Participants perceived a decline in the social prestige of dentistry in recent years, and many expressed hesitations about recommending the profession to close relatives. Although some showed interest in practising abroad, their motivations extended beyond financial concerns, indicating that professional satisfaction, educational conditions, and perceived occupational value also contribute to these intentions.

Keywords Digitalization, Professional career choice, Digital dentistry, Dental education, Dental students

*Correspondence:
Yasin Batuhan Gavgali
yasin.gavgali@std.medipol.edu.tr
[1]Prosthetic Dentistry PhD Department, Institute of Health Sciences, Istanbul Medipol University, Istanbul, Turkey
[2]Department of Prosthetic Dentistry, School of Dentistry, Istanbul Gelısım University, Istanbul, Turkey

Introduction

The term digitalisation has become increasingly common across daily life and professional fields. With the rapid development of technology, digital solutions have become widespread from daily life to professional environments, offering significant convenience. This transformation aims to enhance access to universal healthcare services by improving processes ranging from patient follow-up to diagnosis and treatment, particularly within the health sector [1]. One of the most prominent reflections of this digital transformation is observed in the field of dentistry, where digital systems provide faster, more accurate, and more patient-oriented solutions compared with conventional methods [2].

Among the key technological developments contributing to the digitalisation of dentistry are digital intraoral scanners, computer-aided design and manufacturing (CAD-CAM) systems, artificial intelligence-supported radiographic analysis tools, haptic simulation devices, three-dimensional printing technologies, and virtual reality (VR) applications that support practical training [3, 4]. In addition, the recent use of artificial intelligence-based crown and bridge design software demonstrates the expanding scope of digital applications in dental practice [5, 6]. The period during which almost all dentistry students—particularly those studying in Turkey—grew up coincides with the global rise of digitalisation [7]. As today's students routinely use digital technologies in their daily lives, dental education is increasingly expected to align with this shift. Although many institutions have begun adding digital dentistry courses, the introduction of intraoral scanners alongside traditional impression methods represents only the early stage of this transition [8]. At the same time, there are differing opinions among dental students in Turkey and other countries regarding their career pathways following undergraduate education [9, 10]. In recent years, interest in postgraduate education has increased notably compared with previous periods, driven by the desire for academic specialisation and the aim of enhancing professional career opportunities [11, 12]. In Turkey, after completing the five-year undergraduate dental programme, graduates may pursue one of three pathways: (1) an academically oriented doctoral (PhD) programme administered through university examinations, (2) clinically intensive specialty (residency) training accessed through the national Dentistry Specialisation Examination (DUS), or (3) direct transition into private practice. All postgraduate training pathways and professional regulations operate under the joint authority of the Ministry of Health and the Council of Higher Education (YÖK), which together oversee programme standards, institutional approvals, and the legal framework governing dental education and clinical practice. These structural differences may influence students' perceptions of digitalisation, their expectations of clinical preparedness, and their long-term career decisions [10, 13].

The aim of this study is to evaluate the opinions of dental students and postgraduate dental practitioners in Turkey regarding the digitalisation of dentistry and the future career outlook of the profession. Two primary hypotheses were established. The first hypothesis proposes that there is no significant discrepancy between undergraduate and postgraduate participants in their views on whether digitalisation in dentistry is still in its early stages. The second hypothesis assumes that financial conditions alone do not determine participants' intentions to pursue professional careers abroad, suggesting that additional educational, professional, and motivational factors may play a role.

In Turkey, digital dental technologies have gained prominence in both academic and clinical settings, yet their incorporation into undergraduate and postgraduate training remains uneven. Dental education in Turkey typically consists of a five-year undergraduate programme followed by two distinct postgraduate pathways: doctoral (PhD) education and specialty (residency) training. PhD programmes are administered by universities and focus on research, scientific inquiry, and academic development, whereas specialty training is centrally regulated through the national Dentistry Specialisation Examination (DUS) and emphasises intensive clinical practice. These structural differences may shape how trainees perceive digitalisation, professional preparedness, and career expectations.

Although digital dentistry is rapidly advancing worldwide, research exploring the views of Turkish dental students and early-career dentists remains limited. Few studies have simultaneously assessed digital competence, attitudes toward digitalisation, and career outlook—including intentions to work abroad—within a single framework. This gap highlights the need for a comprehensive evaluation of how emerging dentists perceive the opportunities and challenges associated with digital transformation.

The present study aimed to investigate the perceptions of undergraduate and postgraduate dental trainees regarding digitalisation in dentistry, their perceived digital competence, and their expectations for the future of the profession. Two primary hypotheses were formulated: (H1) no significant discrepancy between undergraduate and postgraduate participants in their views on whether digitalisation in dentistry is still in its early stages.; and (H2) financial considerations alone would not fully explain participants' intentions to work abroad, suggesting the influence of broader professional and educational factors.

Methods

This study was conducted with 4th- and 5th-year undergraduate dental students in the clinical training stage, as well as postgraduate dentists enrolled in specialty or doctoral programmes across various dental faculties in Turkey. Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee.

Study design and data collection

A survey-based cross-sectional design was used. Data were collected between September 2023 and June 2024. The questionnaire was developed in Google Forms (Google Inc., California, United States) and distributed digitally via social media platforms and WhatsApp groups commonly used by dental students and postgraduate trainees. To prevent multiple submissions from the same user, the "limit to one response per email address" feature was activated, ensuring that each participant could complete the survey only once.

Participants and inclusion criteria

The inclusion criteria were: (1) being a 4th- or 5th-year undergraduate dental student or a postgraduate trainee (PhD or specialty student); (2) studying in Turkey during the data collection period; (3) aged between 20 and 35 years; and (4) voluntarily consenting to participate. Both Turkish and English versions of the questionnaire were prepared to accommodate the presence of international students.

Sampling strategy and sample size calculation

A convenience sampling strategy was used in this study. A simple random sampling formula was applied only for estimating the required sample size. Based on an estimated population of approximately 17,000 undergraduate and postgraduate dental students in Turkey, the minimum sample size calculation was based on assumptions of simple random sampling; however, participant recruitment ultimately depended on voluntary responses obtained through digitally distributed survey links. Assuming a significance level of $\alpha = 0.05$, a desired power of 95%, an expected proportion of $p = 0.50$ (selected due to the absence of prior information and because it maximises the p·q product), and a margin of error of ± 0.05, the minimum number of participants required was determined as 376 (Yamane, 2010) [14]. Although the target was 400 participants, after excluding incomplete or invalid responses, the final sample consisted of 378 participants.

Questionnaire development

The questionnaire consisted of two sections. The first section included five demographic questions. The second section contained 20 items addressing digitalisation in dentistry and the future of the profession. No previously validated scale was used; instead, an original questionnaire was developed by reviewing related studies in the literature. Due to the scarcity of instruments evaluating digitalisation, career outlook, and international practice intentions simultaneously, new items were created to reflect the aims of this study. Content validity was ensured by consulting two academic experts in prosthetic dentistry and dental education. However, no psychometric validation, reliability testing (e.g., Cronbach's alpha), or construct validity assessment was performed, and therefore the questionnaire should be considered a non-validated instrument.

Measurement tools

A five-point Likert scale was used to measure participants' attitudes and perceptions (1 = Strongly Disagree, 5 = Strongly Agree) [15]. Dichotomous (Yes/No) questions and multiple-choice items (single or multiple answers allowed) were also included to capture broader perspectives [16]. Both Turkish and English versions of the survey were provided.

Statistical analysis

Data were analysed using SPSS Statistics 22 (IBM Corp., New York, USA). Descriptive statistics (minimum, maximum, mean, standard deviation, frequency) were calculated. For comparisons of qualitative variables, Chi-square tests, Fisher–Freeman–Halton exact Chi-square test, and Continuity (Yates) correction were used. Statistical significance was set at.

$p < 0.05$.

Results

A total of 378 participants aged between 20 and 35 years took part in the study, including 136 males (36%) and 242 females (64%). The mean age of the participants was 23.73 ± 2.37 years. The distribution of the participants is presented in Fig. 1 below.

Most participants reported that digitalisation is not sufficiently integrated into undergraduate or postgraduate dental education. Despite recognising the limited availability of digital infrastructure in many institutions, the proportion of respondents who reported that they would consider postgraduate education in such faculties remained low. However, a high proportion expressed positive opinions regarding the integration of digital technologies into future professional practice.

Many participants identified the high cost of digital equipment as the primary barrier to adopting digital technologies in dentistry, with 75.4% attributing this to exchange-rate–driven price increases. Limited hands-on exposure to digital systems and technician-related expenses were also reported as secondary barriers.

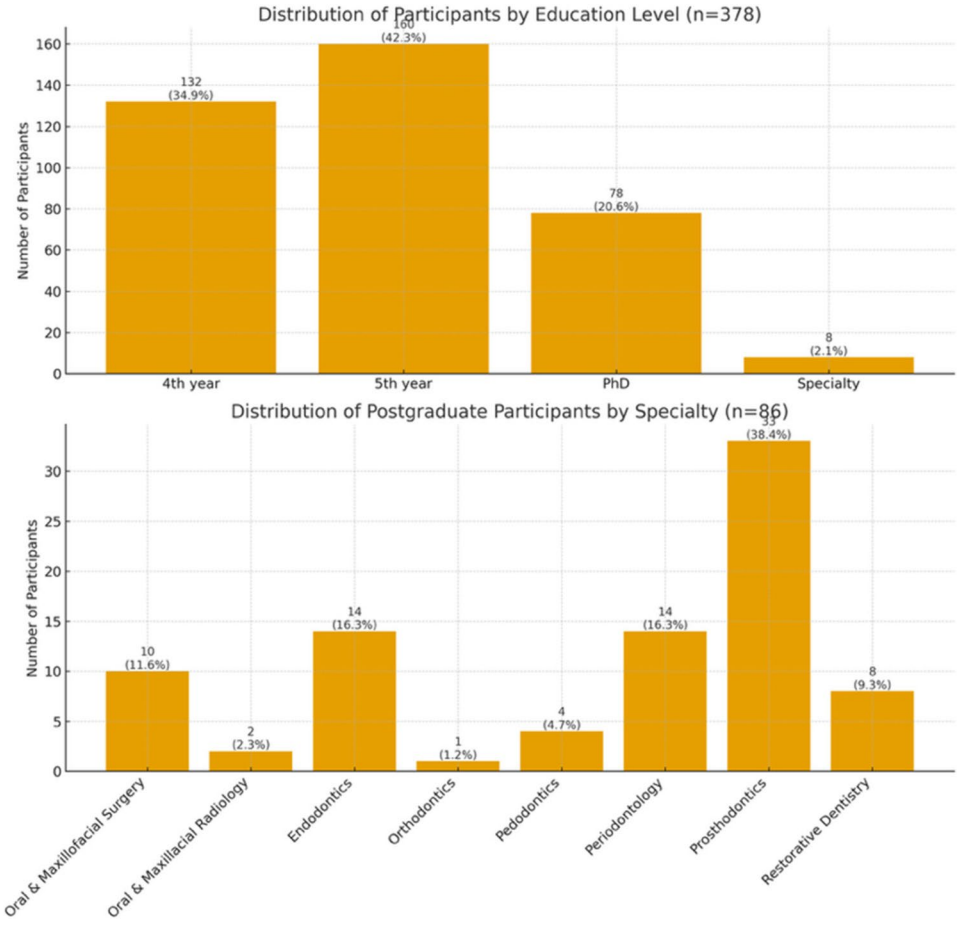

Fig. 1 The distribution of the participants

Regarding artificial intelligence, 44.2% of participants agreed that AI-supported tools could be integrated into dental practice soon, particularly for non-invasive diagnostic applications.

Responses related to career expectations are summarised in Tables 1 and 2. Approximately half of the participants disagreed with the statement suggesting they might consider working in another professional field if a suitable work environment could not be found after graduation.

Perceptions of professional prestige also showed a negative pattern. When asked whether dentistry maintains the same reputation as when they began their undergraduate studies, most participants selected "strongly disagree" or "disagree," indicating a perceived decline in professional standing. Similarly, a majority did not expect dentistry to rise in university-entrance preference rankings (Tables 1 and 2). The distribution of platforms used to follow digitalisation trends is shown in Fig. 2.

Group comparisons — undergraduate students

The comparison of responses between 4th- and 5th-year undergraduate students is summarised in Table 3. Several items (e.g., Q1) demonstrated statistically significant differences between the two groups ($p = 0.033$). Overall, year level was associated with differing perceptions across multiple aspects of digitalisation and professional outlook.

Group comparisons — postgraduate students

Among postgraduate students, comparisons between doctoral and specialty trainees are presented in Table 4. A statistically significant difference was observed for the item assessing whether sufficient emphasis is placed on digitalisation in dental education ($p = 0.030$).

Similarly, when undergraduate and postgraduate groups were compared, a significant difference emerged for the same item, indicating that perceptions regarding the adequacy of digitalisation in dental curricula vary across educational levels (Table 5).

Table 1 The highest rate answers to the questions

N:	Question	Rate (%)	Distribution of responses (*n* = 378)	Answer
1	Do you think sufficient emphasis is placed on digitalisation in undergraduate and postgraduate dental education?	47.10	178	I disagree
2	Do you think you have sufficient knowledge about digital innovations used in the field of dentistry?	45.20	171	I disagree
3	Do you think that in the near future, digital impression methods will completely replace conventional methods in dental practice?	39.70	150	I agree
4	If you are doing postgraduate education or if you have to choose again, would you consider doing postgraduate education in any branch in that faculty even though you know that digital innovations do not exist?	30.40	115	I disagree
5	Would you consider integrating digital equipment into your profession in your professional working life?	55.80	211	I strongly agree
6	Do you agree that digitalisation in dentistry is still at the very beginning of the journey?	44.20	167	I agree
7	Do you agree that digitalisation in dentistry is progressing rapidly?	43.70	165	I agree
8	Do you think artificial intelligence-supported systems that can make non-invasive diagnoses will be used in the near future?	44.20	167	I agree
9	Do you agree with the proposition that smile designs made with artificial intelligence for smile design in dentistry will be better than designs made with physician-technician cooperation?	38.10	144	I agree
10	Do you think postgraduate education is necessary after the dentistry bachelor's degree?	41.50	157	I agree
11	Do you think that the reputation of dentistry is at the same level as when you started your undergraduate education?	34.90	132	I strongly disagree
12	Do you agree that the success ranking of dentistry in university preferences will improve?	36.80	139	I disagree
13	Would you advise a relative who will take the university exam to write dentistry?	27.80	105	I'm undecided
14	Do you agree with the idea of working in another professional field when you cannot find the working environment you want after graduating from the faculty?	30.70	116	I disagree
15	Would you consider studying or working abroad if you had the opportunity?	42.30	160	I strongly agree
16	Would you agree with the idea of doing your profession abroad if you had the same purchasing power as you earn in Turkey?	25,9	98	I disagree
17	Which platform do you use most to follow digitalisation in dentistry?	71.20	269	Social Media
18	What do you think is the biggest obstacle to digitalization?	75.40	285	high device prices due to exchange rate difference
19	Have you had the opportunity to use an intraoral scanner before?	57.70	218	No
20	Do you think you have sufficient knowledge about intraoral scanner types and obtaining digital models?	84.70	320	No

Relationship between career intentions and economic factors

A statistically significant association was identified between Q15 and Q16 (Table 6). Participants who expressed a stronger intention to work abroad were more likely to provide consistent responses across both items.

Relationship between previous IOS use and knowledge level

As shown in Table 7, there was a statistically significant relationship between having previously used an intraoral scanner (IOS) and self-reported knowledge of IOS types and digital model acquisition. Participants who had prior experience with IOS use were significantly more likely to state that they possessed adequate knowledge about these technologies ($p = 0.001$).

Discussion

Overview of digital competence and educational exposure

This study evaluated the perceptions and knowledge levels of clinical dental students and postgraduate trainees regarding digitalisation in dentistry, alongside their views on future professional pathways. The findings indicate that although a considerable proportion of participants expressed willingness to integrate digital technologies into their future practice, their actual knowledge -particularly among undergraduate students- was notably limited. This aligns with participants' own views that digital content is insufficiently represented in the current curriculum.

The results suggest that digital transformation in dental education must be supported not only through access to technological equipment but also through structured,

Table 2 Likert scale questions distributions

Question	Strongly disagree *n* (%)	Disagree *n* (%)	Undecided (%)	Agree *n* (%)	Strongly agree *n* (%)
1. Do you think sufficient emphasis is placed on digitalisation in undergraduate and postgraduate dental education?	60 (15.9%)	178 (47.1%)	61 (16.1%)	65 (17.2%)	14 (3.7%)
2. Do you think you have sufficient knowledge about digital innovations used in the field of dentistry?	42 (11.1%)	171 (45.2%)	97 (25.7%)	66 (17.5%)	2 (0.5%)
3. Do you think that in the near future, digital impression methods will completely replace conventional methods in dental practice?	19 (5.0%)	66 (17.5%)	70 (18.5%)	150 (39.7%)	73 (19.3%)
4. Would you consider doing postgraduate education in any branch even if digital innovations did not exist?	83 (22.0%)	115 (30.4%)	94 (24.9%)	70 (18.5%)	16 (4.2%)
5. Would you consider integrating digital equipment into your professional working life?	22 (5.8%)	5 (1.3%)	13 (3.4%)	127 (33.6%)	211 (55.8%)
6. Do you agree that digitalisation in dentistry is still at the very beginning of the journey?	15 (4.0%)	75 (19.8%)	86 (22.8%)	167 (44.2%)	35 (9.3%)
7. Do you agree that digitalisation in dentistry is progressing rapidly?	13 (3.4%)	58 (15.3%)	110 (29.1%)	165 (43.7%)	32 (8.5%)
8. Do you think AI-supported non-invasive diagnostic systems will be used in the near future?	24 (6.3%)	51 (13.5%)	85 (22.5%)	167 (44.2%)	51 (13.5%)
9. Do you agree that AI-generated smile designs will be better than designs made through clinician–technician collaboration?	21 (5.6%)	50 (13.2%)	111 (29.4%)	144 (38.1%)	52 (13.8%)
10. Do you think postgraduate education is necessary after the dentistry bachelor's degree?	18 (4.8%)	29 (7.7%)	79 (20.9%)	157 (41.5%)	95 (25.1%)
11. Do you think that the reputation of dentistry is at the same level as when you started your undergraduate education?	132 (34.9%)	118 (31.2%)	75 (19.8%)	45 (11.9%)	8 (2.1%)
12. Do you agree that the success ranking of dentistry in university preferences will improve?	90 (23.8%)	139 (36.8%)	90 (23.8%)	52 (13.8%)	7 (1.9%)
13. Would you recommend a relative to choose dentistry as a university programme?	78 (20.6%)	79 (20.9%)	105 (27.8%)	86 (22.8%)	30 (7.9%)
14. Do you agree with the idea of working in another professional field if you cannot find your desired working environment after graduation?	77 (20.4%)	116 (30.7%)	90 (23.8%)	75 (19.8%)	20 (5.3%)
15. Would you consider studying or working abroad if you had the opportunity?	21 (5.6%)	32 (8.5%)	51 (13.5%)	114 (30.2%)	160 (42.3%)
16. Would you agree with practising your profession abroad if you had the same purchasing power as in Turkey?	72 (19.0%)	99 (26.2%)	60 (15.9%)	74 (19.6%)	73 (19.3%)

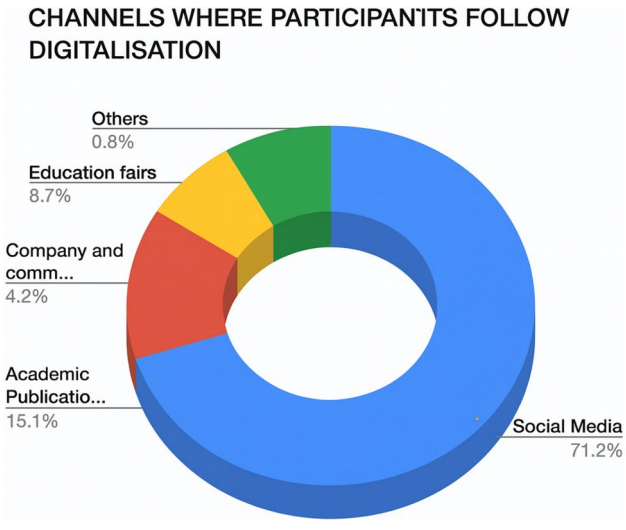

Fig. 2 Sources Participants Use to Follow Digitalisation

comprehensive educational strategies. The study by Sheba et al.[17] similarly reported that students' perceptions of digital dentistry education were generally neutral or negative, highlighting that theoretical exposure is inadequate without sufficient hands-on experience.

Practical readiness and skills acquisition

Despite generally positive attitudes toward digital dentistry, substantial gaps emerged in students' practical knowledge and experience especially concerning intraoral scanners. This reflects findings from Lam et al.[18] who observed that although students find digital scanning easier and more hygienic, many continue to prefer conventional impression methods due to limited applied training. In the present study, only 15.3% of participants believed they had sufficient knowledge of intraoral scanners and digital model acquisition, and only 17.2% agreed (3.7% strongly agreed) that digitalisation is adequately emphasised in dental curricula. These results highlight

Table 3 Comparisons between 4th- and 5th-year students

			4thyear (*n* = 132)	5th year (*n* = 160)	
Q:			***n* (%)**	***n* (%)**	***p***
1	Do you think sufficient emphasis is placed on digitalisation in undergraduate and postgraduate dental education?	Strongly disagree	15 (11.4%)	32 (20%)	0.033*
		Disagree	57 (43.2%)	79 (49.4%)	
		Undecided	29 (22%)	20 (12.5%)	
		Agree	24 (18.2%)	26 (16.3%)	
		Strongly agree	7 (5.3%)	3 (1.9%)	
2	Do you think you have sufficient knowledge about digital innovations used in the field of dentistry?	Strongly disagree	13 (9.8%)	23 (14.4%)	0.263
		Disagree	61 (46.2%)	83 (51.9%)	
		Undecided	37 (28%)	31 (19.4%)	
		Agree	20 (15.2%)	23 (14.4%)	
		Strongly agree	1 (0.8%)	0 (0%)	
12	Do you agree that the ranking of dentistry in university preference lists will improve?	Strongly disagree	31 (23.5%)	38 (23.8%)	0.093
		Disagree	43 (32.6%)	59 (36.9%)	
		Undecided	31 (23.5%)	41 (25.6%)	
		Agree	26 (19.7%)	16 (10%)	
		Strongly agree	1 (0.8%)	6 (3.8%)	
14	If you cannot find your ideal working environment after graduation, do you agree with the idea of working in another profession?	Strongly disagree	21 (15.9%)	39 (24.4%)	0.260
		Disagree	46 (34.8%)	53 (33.1%)	
		Undecided	37 (28%)	31 (19.4%)	
		Agree	24 (18.2%)	30 (18.8%)	
		Strongly agree	4 (3%)	7 (4.4%)	

Table 5 Comparisons between undergraduate and postgraduate students

		Undergraduate *n* = 292	Postgraduate *n* = 86	
QUESTIONS		***n* (%)**	***n* (%)**	***p***
2)Do you think you have sufficient knowledge about digital innovations used in the field of dentistry?	Strongly disagree	36 (12.3%)	6 (7%)	0.004*
	Disagree	144 (49.3%)	27 (31.4%)	
	Undecided	68 (23.3%)	29 (33.7%)	
	Agree	43 (14.7%)	23 (26.7%)	
	Strongly agree	1 (0.3%)	1 (1.2%)	
11)Do you think that the reputation of dentistry is at the same level as when you started your undergraduate education?	Strongly disagree	88 (30.1%)	44 (51.2%)	0.005*
	Disagree	94 (32.2%)	24 (27.9%)	
	Undecided	64 (21.9%)	11 (12.8%)	
	Agree	40 (13,7%)	5 (5.8%)	
	Strongly agree	6 (2.1%)	2 (2.3%)	

Chi-square test *$p < 0.05$

Table 4 Comparisons between PhD(doctorate) and specialty students

			Doctorate (*n* = 78)	Speciality (*n* = 8)	
QN:			***n* (%)**	***n* (%)**	***p***
1	Do you think sufficient emphasis is placed on digitalisation in undergraduate and postgraduate dental education?	Strongly disagree	9 (11.5%)	4 (50%)	0.030*
		Disagree	40 (51.3%)	2 (25%)	
		Undecided	12 (15.4%)	0 (0%)	
		Agree	14 (17.9%)	1 (12.5%)	
		Strongly agree	3 (3.8%)	1 (12.5%)	
2	Do you think you have sufficient knowledge about the digital innovations used in the field of dentistry?	Strongly disagree	5 (6.4%)	1 (12.5%)	0.096
		Disagree	24 (30.8%)	3 (37.5%)	
		Undecided	28 (35.9%)	1 (12.5%)	
		Agree	21 (26.9%)	2 (25%)	
		Strongly agree	0 (0%)	1 (12.5%)	
3	Do you think that in the near future, digital impression methods will completely replace conventional methods in dental practice?	Strongly disagree	5 (6.4%)	1 (12.5%)	0.839
		Disagree	15 (19.2%)	1 (12.5%)	
		Undecided	18 (23.1%)	1 (12.5%)	
		Agree	28 (35.9%)	4 (50%)	
		Strongly agree	12 (15.4%)	1 (12.5%)	
9	Do you agree that smile designs created by artificial intelligence will be superior to those produced through dentist-technician collaboration?	Strongly disagree	3 (3.8%)	1 (12.5%)	0.546
		Disagree	7 (9%)	0 (0%)	
		Undecided	21 (26.9%)	1 (12.5%)	
		Agree	30 (38.5%)	4 (50%)	
		Strongly agree	17 (21.8%)	2 (25%)	

Fisher Freeman Halton Exact test *$p < 0.05$

the need for curricular reforms that integrate structured preclinical and clinical digital training.

Perspectives on postgraduate education

A strong inclination toward further education was observed, with 41.5% agreeing and 25.1% strongly agreeing that postgraduate training is necessary after a bachelor's degree. This supports findings from Kumari et al.[19], who emphasised the importance of postgraduate education for professional advancement. Nevertheless, postgraduate requirements may vary by career trajectory,

Table 6 Cross-tabulation of students' views on working abroad comparing equal purchasing power and opportunity-driven mobility preferences

Q16-Would you agree with the idea of working in your profession abroad if your purchasing power were the same as your income in Turkey?	Q15-Do you agree with the idea of practicing your profession abroad if you had the opportunity?					
	Strongly Disagree *n* (%)	Disagree *n* (%)	Undecided *n* (%)	Agree *n* (%)	Strongly Agree *n* (%)	*p*
Strongly Disagree	14 (66.7%)	8 (25%)	11 (21.6%)	19 (16.7%)	20 (12.5%)	0.001*
Disagree	5 (23.8%)	20 (62.5%)	18 (35.3%)	35 (30.7%)	21 (13.1%)	
Undecided	1 (4.8%)	2 (6.3%)	20 (39.2%)	19 (16.7%)	18 (11.3%)	
Agree	0 (0%)	2 (6.3%)	2 (3.9%)	39 (34.2%)	31 (19.4%)	
Strongly Agree	1 (4.8%)	0 (0%)	0 (0%)	2 (1.8%)	70 (43.8%)	

Chi-square test *$p<0.05$

Table 7 Relationship between students' self-reported knowledge of intraoral scanners and previous opportunity to use an intraoral scanner

Q20-Do you think you have sufficient knowledge about intraoral scanner types and obtaining digital models?	Q19-Have you had the opportunity to use an intraoral scanner before?		
	Yes (*n* (%))	No (*n* (%))	*p*
Yes (*n* (%))	47 (29.4%)	11 (5.0%)	**0.001***
No (*n* (%))	113 (70.6%)	207 (95.0%)	

Yates continuity correction *$p < 0.05$

particularly in clinically oriented fields where MSc or PhD qualifications are not always mandatory. Consistent with this, Sezer et al.[10] found that 85.3% of dental students intended to pursue specialty training after graduation.

Perceived decline in professional prestige

The study also revealed a prominent perception of declining professional esteem. When asked whether the reputation of dentistry remained the same as at the start of their undergraduate education, 34.9% strongly disagreed and 31.2% disagreed. Likewise, responses regarding dentistry's future position in university preference rankings demonstrated similarly pessimistic expectations, with 23.8% strongly disagreeing and 36.8% disagreeing. These findings align with Özdoğan and Tursun[12], who documented concerns among postgraduate students about social prestige and economic security. Although digital technologies are essential for modernising practice, the findings suggest that technological advancement alone does not sufficiently enhance professional satisfaction or perceived prestige.

In contrast, international literature provides a different perspective. Lanzon et al.[20] reported that graduates of postgraduate programmes in the United States often advance into distinguished academic, hospital-based, or specialty roles. These discrepancies imply that the decline in perceived prestige observed in this study may reflect country-specific economic and institutional conditions rather than a universal trend.

Digital literacy and early exposure

In a study conducted by Sharab et al.[21], 65.6% of dental students in the United States were able to correctly define the term CAD/CAM, and 48.5% identified themselves as "advanced" in terms of technology use. These results indicate that the integration of digital content into educational curricula directly contributes to students' knowledge levels and self-confidence. Similarly, in the literature, it is emphasized that the adoption of digital applications by students is directly related to early exposure to and active use of these technologies [22]. By contrast, in the current study, 46.2% of 4th-year and 51.9% of 5th-year students reported inadequate knowledge of digital innovations. This indicates that both theoretical and applied training in digital dentistry remain insufficient in Turkish dental curricula, reinforcing the need for more robust practical integration, workshops, and clinical exposure.

International context of digitalisation in dental education

Although the present findings demonstrate limited exposure to digital dentistry among Turkish dental students, studies from other countries indicate a more advanced and structured level of integration. Schlenz et al.[22] showed that German dental schools incorporate digital technologies—particularly intraoral scanners—early in the preclinical curriculum, which contributes to higher student confidence and familiarity with digital workflows. Likewise, Lam et al.[18] reported that students in Asian institutions perceived intraoral scanning as intuitive and feasible for routine use, largely due to continuous hands-on training embedded in their educational programmes. Taken together, these international findings suggest that digital integration in Turkey remains in an earlier developmental stage and varies considerably across institutions. This highlights the need for nationally standardised curricula, greater institutional investment, and expanded

practical training opportunities to ensure alignment with global advancements in digital dental education.

Professional advantages and challenges of practising dentistry in Turkey

The present findings also reflect broader structural factors shaping the professional environment for dentists in Turkey. Although dentistry is traditionally regarded as a respected and in-demand profession, recent concerns about economic stability, workload, and employment opportunities appear to influence students' perceptions. Özdoğan and Tursun [12] similarly reported uncertainty among postgraduate trainees, particularly regarding economic security and long-term career prospects. While digital technologies offer opportunities for improving clinical quality and professional competitiveness, limited institutional resources, uneven access to equipment, and rising operational costs remain significant challenges. Compared with countries where postgraduate pathways lead to well-defined and prestigious career roles [19, 20], the Turkish context appears to present both advantages—such as high patient demand and a broad clinical scope and disadvantages related to economic conditions and professional stability. These contextual factors may help explain why a notable proportion of participants expressed concerns about the future prestige of the profession and showed interest in pursuing opportunities abroad.

International career intentions and underlying motivations

The study also explored participants' intentions to practise abroad. A statistically significant relationship was identified between responses to the two items measuring willingness to work abroad under current and equalised economic conditions. The high level of agreement -even when purchasing power was controlled- suggests that motivations extend beyond economic factors, encompassing concerns related to professional development, work satisfaction, and social status. These findings align with Nezir and Kedici [23], who similarly reported a strong desire among dental students to pursue careers abroad due to perceived inadequacies in professional conditions and educational environments. Still, in the present study, when financial equivalence between countries was assumed, the preference to remain in Turkey increased, indicating that economic factors retain a considerable influence.

Sources of information and the role of social media

The prominence of social media as an information source is noteworthy. In this study, 71.2% of participants reported using social media to follow digitalisation trends, consistent with Farghal et al.[24], who observed a similar pattern among undergraduate dental students. While this reflects strong digital engagement, it also raises concerns about dependence on informal, non-academic sources. Strengthening formal digital dentistry education may reduce reliance on potentially unreliable platforms.

Limitations

This study has several limitations that should be acknowledged. First, although the sample size was adequate for statistical analysis, participants were predominantly recruited from metropolitan universities with relatively higher access to digital resources. This may limit the generalisability of the findings to institutions with fewer technological opportunities or different curricular structures. Including dental faculties from diverse socioeconomic and geographic settings in future research would enhance representativeness.

Secondly, another important limitation concerns the questionnaire itself. Although the items were reviewed by two academic experts to ensure content validity, the instrument did not undergo psychometric validation. No reliability analyses (such as Cronbach's alpha), construct validity assessment, or factor structure evaluation was performed. Therefore, the questionnaire should be interpreted as a non-validated tool, and the findings should be considered within the constraints of self-reported measures.

Third, the number of specialty trainees within the postgraduate group was small compared with doctoral students, potentially influencing subgroup comparisons and limiting the statistical power for certain analyses. Future studies with more balanced postgraduate subgroups would allow more robust comparisons.

Fourth, all data were self-reported, which may introduce response bias, particularly in questions related to professional satisfaction, perceived prestige, or migration intention. Participants may have under- or over-reported their views due to personal, cultural, or social desirability factors.

Finally, this study did not evaluate institutional variables such as curriculum content, availability of digital equipment, or faculty expertise, which may influence perceptions of digitalisation. Future research incorporating institutional audits or objective assessments of digital infrastructure could help contextualise students' responses and provide a more comprehensive understanding of the factors shaping digital readiness in dental education.

Conclusion

This study evaluated dental students' and postgraduate trainees' perspectives on digitalisation in dentistry and future career expectations. In relation to H1 ("There is no significant discrepancy between undergraduate and

postgraduate students regarding the perception that digitalisation in dentistry is still in its early stages"), the findings only partially supported this hypothesis. Although many participants agreed that digitalisation remains insufficiently integrated into dental education, statistically significant differences emerged between undergraduate, doctoral, and specialty student groups. These differences indicate that perceptions of digitalisation vary according to educational level, suggesting that H1 is not fully supported.

Regarding H2 ("Financial conditions do not have a determining effect on the intention to pursue a professional career abroad"), the results of this study provided supportive evidence. A statistically significant association between the two items related to practising abroad demonstrated that participants' intentions were influenced not only by economic considerations but also by broader factors such as professional satisfaction, perceived prestige, and career development opportunities. Thus, H2 was supported.

Overall, although many participants perceived digitalisation training as insufficient within the curriculum, more than half expressed a strong intention to integrate digital technologies into their future professional practice. Additionally, concerns about the current and future reputation of the profession were prevalent, particularly among undergraduate students. A consistent trend was observed whereby attitudes toward digitalisation became more favourable as students progressed into postgraduate education, suggesting that increased clinical and technological exposure contributes to more positive perceptions.

These findings highlight the need to strengthen the digital dentistry content of curricula, expand hands-on training opportunities, and address broader professional concerns that influence students' career expectations. Future studies may consider longitudinal and institution-specific approaches to better understand how educational interventions shape technological readiness and professional outlook in dentistry.

Abbreviations

CAD-CAM	Computer-Aided Design- Computer-Aided Manufacturing
3D	Three-Dimensional
VR	Virtual Reality
IOS	Intra Oral Scanner

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

Y.B.G. : designed the study, converted the questionnaire items into a digital format, collected the data, and organized the data into tables.T.K. : Designed the study, contributed to data interpretation and critically revised the final version of the manuscript.All authors reviewed and approved the final manuscript.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. The questionnaire used in this study has been provided in the supplementary materials.

Declarations

Ethics approval and consent to participate

The necessary permissions to carry out the study were obtained from the Istanbul Medipol University Non-Interventional Clinical Research Ethics Committee, and the study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all participants prior to their participation in the study.

Consent for publication

All participants provided informed consent for the publication of their anonymized data

Competing interests

The authors declare no competing interests.

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