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Original Research

Implementing Artificial Intelligence in Dental Education: An International Survey of Experiences and Opinions of Dental Students

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ABSTRACT

Objective: Innovative educational tools support student-centered learning by enhancing the explanation, interpretation, and visualization of radiologic findings. The study aimed to evaluate the utilization of artificial intelligence (AI)-based educational decision-support system by participants, as well as their perspectives and expectations regarding AI and its implementation in the curriculum.

Methods: Undergraduate dental students of two nationalities participated in a cross-sectional online survey. The assessment of their perceptions and attitudes toward AI in dental education was done by a 17-question questionnaire. Descriptive statistics were presented utilizing the median, min-max, mean, standard deviation, and interquartile range. The Mann-Whitney U test was applied to compare the responses of individuals. The Chi-Square test was conducted to investigate the association of gender and nationality concerning the use of AI.

Results: The study included 102 dental students (62 males, 40 females) from two different nationalities (62 Turkish, 40 American). The findings showed that the majority of dental students thought using AI in dental education was beneficial. AI usage distribution showed no significant difference by nationality or gender, but concerns about AI replacing dentists and its role in dental education differed significantly between nationalities.

Conclusion: Students largely offered a favorable attitude toward AI. These results can assist lecturers in formulating effective approaches to optimize the benefits of AI in dental education, address any issues, and integrate AI into the dental curriculum.

Keywords: dental education, medical education, maxillofacial radiology, oral healthcare

INTRODUCTION

The use of tools for artificial intelligence (AI) in health information systems, including deep learning and machine learning, has been made possible by developments in computer and informatics Technologies [1,2]. Many successful teaching strategies have been made possible by our expanding understanding of learning. Virtual reality– and AI-enabled learning platforms are reshaping dental education by facilitating competency-based learning in motor skills, theoretical knowledge, and clinical decision-making [3,4]. Dental education encompasses all undergraduate training, ensuring the continuity of lifelong learning throughout professional practice [5].

Recently implemented successful AI applications in radiology include abnormality detection, anatomical segmentation, evaluation of image quality [6,7].

The implementation of AI in the dental curriculum has not received sufficient exploration. Dental schools should make sure that the teaching methods are clearly in line with the educational needs of their students and that the curriculum is supported by basic theoretical frameworks [8].

AI is radically changing several industries, including analysis of digital images, growth modeling and prediction, three or four-dimensional data segmentation, and healthcare control and interaction procedures [8]. The scalability and robustness of the educational curriculum may be improved by incorporating AI [9]. AI will help undergraduate students and also professionals make diagnoses and prognoses more quickly and accurately by reducing the amount of work they must do to understand digital data [10].

Main Points

1. **AI enhances dental education** by supporting student-centered learning and improving the explanation, interpretation, and visualization of radiologic findings.
2. **Students' perspectives are largely positive** toward the integration of AI, highlighting its potential to enrich educational outcomes and clinical competencies.
3. **Cross-national differences exist**, particularly in concerns about AI's future role and the possibility of replacing dentists, reflecting cultural and educational contexts.
4. **Systematic integration of AI into curricula** is recommended to strengthen diagnostic accuracy, critical thinking, and decision-making skills among dental students.

AI in education has advanced with innovations like "teacher bots," which are teaching assistants with the responsibility of delivering lessons, giving feedback, and monitoring student progress [11-13]. Research indicates that the augmented application of this methodology in education can assist students in recognizing knowledge deficiencies and obtaining tailored assistance [11,12,14]. Furthermore, it relieves educators of routine tasks, allowing them to more effectively respond to student requirements and provide personalized and flexible learning experiences [14].

AI applications may change the understanding techniques for explaining, interpreting, and visualizing radiologic findings during undergraduate education by changing from lecturer-centered to student-centered education. It is hypothesized that the integration of artificial intelligence–based tools into oral radiology education would positively influence dental students' perceptions, experiences, and expectations regarding AI. The objective of this investigation was to evaluate and compare the feedback, viewpoints, and experiences of undergraduate dentistry students who utilize and do not utilize AI.

MATERIALS AND METHODS

This international study was approved by the Scientific Research Ethics Committee of Lokman Hekim University Scientific Research Ethics Committee (Desicion Number: 2023/94, Date: 2023-06-13) and the University of Mississippi Medical Center Institutional Review Board (IRB Tracking Number: UMMC-IRB-2024-161, Date: 2023-06-15). The study was designed and conducted in accordance with the ethical standards of the institutional and national research committees and the Declaration of Helsinki and its later amendments or comparable ethical standards. Written informed consent was obtained from all participants before they participated in the study.

The sample size was determined pragmatically based on the number of eligible undergraduate dental students who completed the AI-supported training module during the study period, and the study was designed as exploratory. Therefore, an a priori power calculation was not performed. To support interpretation, effect sizes were reported for group comparisons. For Mann–

Whitney U tests, rank-biserial correlation (r_rb) was used as the effect size measure, and for chi-square tests, Cramer's V was reported. With n=62 (Turkish) and n=40 (American) and a two-sided α=0.05, the current sample provides approximately 80% power to detect a Mann–Whitney effect of AUC $\geq$ 0.665 (equivalent to r_rb $\geq$ 0.33, i.e., a medium effect), while smaller effects would require larger samples.

The AI-supported radiology training module was integrated into the dental curriculum for use in oral radiology education. The CranioCatch (CranioCatch, Eskişehir, Türkiye) artificial intelligence–supported radiology training module was used as the central educational intervention in this study. The system is designed as an educational decision-support tool for oral and maxillofacial radiology and aims to enhance students' ability to recognize and correctly identify anatomical landmarks on digital panoramic radiographs.

The module operates using AI-assisted image analysis techniques that support the identification and localization of predefined anatomical structures. Rather than functioning as an autonomous diagnostic system, CranioCatch provides guided, interactive training in which students actively engage in image interpretation tasks. The primary educational focus is on anatomical landmark recognition, spatial orientation, and radiologic interpretation.

Students accessed the system through a standardized user interface, where panoramic radiographs were presented sequentially. For each case, students were instructed to identify specific anatomical landmarks by interacting directly with the image. Upon completion of each task, the system delivered immediate visual feedback by displaying reference annotations and highlighting discrepancies between the student's response and the system-supported reference. This feedback mechanism was designed to facilitate self-directed learning and reinforce correct anatomical identification.

The training workflow, task structure, and level of difficulty were standardized for all participants. All undergraduate dental students included in the study, both Turkish and American, received the same AI-supported training using the CranioCatch module as part of their oral radiology education. The duration, content, and exposure to the training sessions were consistent across institutions, ensuring comparability between groups and minimizing instructional variability.

Informative training sessions on the application's usage were conducted, after which each student was provided with a personal username and password. Virtual classrooms were created by radiology expert instructors, and students were enrolled in these classes. Each student accessed the application via computers or tablets and participated in the lessons assigned to them within the virtual classroom. The application was employed to develop dental students' competencies in detecting and identifying anatomical landmarks on digital panoramic radiographs, and it provides immediate feedback via the application.

A survey was conducted at the conclusion of the academic year to obtain the opinions and insights of undergraduate dental students actively using this application in oral radiology education.

Undergraduate dental students who were actively enrolled in the dental curriculum and had completed or were currently attending oral and maxillofacial radiology courses were eligible to participate in this study. Additional inclusion criteria were voluntary participation, provision of informed consent, and completion of the full questionnaire. Students who declined participation or submitted incomplete questionnaires were excluded from the study.

The study employed a cross-sectional survey design, and the sample size was determined based on the number of eligible students who met the inclusion criteria during the study period. Given the exploratory nature of the study and the use of descriptive and non-parametric statistical analyses, the sample size was considered adequate to evaluate students' perceptions, experiences, and attitudes toward artificial intelligence and to allow meaningful comparisons between groups.

The questionnaire was given to 102 undergraduate dentistry students, and the research was conducted from May 2023 to August 2023. All participants completed questionnaires.

The questionnaire consisted of multiple-choice questions on the use of AI applications/software during dental education. The questionnaire comprised a total of 17 questions. (Figure 1) Overall assessment of answers was recorded and analysed. The 17-item questionnaire was developed based on previously published surveys assessing attitudes toward artificial intelligence in dentistry and medical education, particularly those reported by Yüzbaşıoğlu [2], Keser and Namdar Pekiner

[15], and related studies in the literature. An initial item pool was generated by the research team and subsequently reviewed by two experts in oral and maxillofacial radiology and two experts in dental education to ensure content relevance, clarity, and representativeness of the construct. Minor linguistic and conceptual revisions were made in accordance with expert feedback, thereby supporting face and content validity.

Internal consistency was evaluated for the Likert-type attitudinal item set reflecting a coherent domain (perceived educational benefits and experience with the AI-supported module; Q8, Q9, Q11–Q17). Because the questionnaire included heterogeneous item formats (dichotomous and Likert-type) and was designed to capture multiple constructs, it was not treated as a single unidimensional scale, and no overall total score was calculated for the full 17-item instrument. The attitudinal subscale demonstrated good internal consistency (Cronbach's $\alpha = 0.825$; $N = 101$).

Statistical Analysis

Statistical analysis was done using SPSS software version 18.0 (IBM, USA). Descriptive statistics for continuous variables were reported using the median, min-max, mean, standard deviation, and interquartile range, as the data did not meet the assumptions of normality. For categorical variables, frequency and percentage values were utilized to summarize the data. To compare the responses of individuals from two distinct nationalities, the Mann-Whitney U test was employed. To control for multiplicity arising from conducting separate Mann–Whitney U tests across the 17 questionnaire items, p values were adjusted using the Holm–Bonferroni procedure, and adjusted p values were interpreted at a two-sided significance level of 0.05. The correlation between gender and nationality with respect to AI usage was assessed using the Chi-Square test, and a significance level of $p < 0.05$ was accepted as statistically significant.

RESULTS

The study included 102 dental students (62 Turkish, 40 American; 62 males, 40 females). A 17-item questionnaire assessed their AI usage and attitudes toward its application in education. The attitudinal subscale (Q8, Q9, Q11–Q17) showed good internal consistency (Cronbach's $\alpha = 0.825$; $N = 101$). 32.4% of 102 students reported the use of AI. There was no statistically significant difference in the distribution of artificial intelligence usage by nationality and gender (Table 1). Effect sizes were calculated to quantify the magnitude of group differences. The largest between-country difference was observed for Q7 ($r_{rb} = 0.49$), while Q4 showed a smaller difference ($r_{rb} = 0.29$). For AI usage (yes/no), the association with nationality was weak (Cramer's $V = 0.045$), and the association with gender was also weak (Cramer's $V = 0.131$).

Questions 3 through 7 addressed the potential changes that AI may bring to the future of dentistry and whether students have any concerns regarding these changes. Questions 8 through 14 explored the effects of AI. Questions 15 through 17 focused on the potential future benefits of AI and expectations regarding its use. Students were instructed to evaluate the feedback on a scale from 1 to 5, ranging from strongly agree to disagree strongly. The Shapiro-Wilk test was conducted to evaluate the normality assumption; however, due to the absence of a normal distribution in the data, the N-par test was utilized. The Mann-Whitney U test was employed to assess variations in replies to the questions between students of two distinct nationalities (Table 2). Significant differences were found in the responses to questions four, seven, eleven, fourteen, and fifteen between students of two different nationalities (Table 3). After adjusting for multiple comparisons using the Holm–Bonferroni procedure across the 17 questionnaire items, only Question 7 remained statistically significant ($p_{Holm} < 0.001$). The previously observed differences for Question 4, Question11, Question 14, and Question 15 did not remain significant after adjustment (all p Holm > 0,05). Additionally, American students rated the extent to which the AI-based oral radiology education met their expectations on a scale from 1 to 4 (extremely well to slightly well) (Table 4).

Table 1. Artificial Intelligence Usage Distribution by Nationality and Gender

Variable	Group	Yes n (%)	No n (%)	p value
Nationality	Turkish students	19 (30.6%)	43 (69.4%)	0,646*
	American students	14 (35.0%)	26 (65.0%)	
	Total	33 (32.4%)	69 (67.6%)	
Gender	Male	16 (40.0%)	24 (60.0%)	0.185*
	Female	17 (27.4%)	45 (72.6%)	

** Statistically significant at level p<0.05 (Pearson Chi-Square)

Table 2. Descriptive Statistics

Questions	n	Minimum	Maximum	Median [IQR]	Mean ± Std. Dev.	p values
Q3 (AI will revolutionize general dentistry in aspects of diagnosis and treatment planning)	102	1.00	4.00	2.0000 [1]	1.81 ±0.72	0.175
Q4 (AI will replace dentists in near future)	101	1.00	5.00	4.0000[1]	3.66 ±0.88	0.006*
Q5 (AI will improve the way we do dentistry.)	102	1.00	4.00	2.0000[1]	1.70 ±0.62	0.888
Q6 (I am worried with applications of AI in Dentistry)	102	1.00	5.00	3.0000[1]	3.28 ±1.01	0.179
Q7 (The human oral and maxillofacial radiologist will be replaced by AI in near future)	102	1.00	5.00	3.0000[2]	3.16 ±1.02	0.000*
Q8 (AI will improve my learning ability about anatomical structures)	102	1.00	4.00	2.0000[1]	1.73 ±0.57	1.000
Q9 (AI use in oral radiology makes it more exciting learning experience)	102	1.00	4.00	2.0000[1]	1.84 ±0.71	0.090
Q10 (I have used artificial intelligence application in the field of dental education-training before)	102	1.00	2.00	2.0000[1]	1.66 ±0.47	0.318
Q11 (AI applications should be part of dental education-training)	101	1.00	3.00	2.0000[1]	1.89 ±0.63	0.034*
Q12 (The use of AI applications in dental education is beneficial in teaching dental radiologic anatomy to dental students)	102	1.00	3.00	2.0000[1]	1.80 ±0.56	0.301
Q13 (The use of AI applications in dental education is beneficial in teaching dental radiological problems (caries, periapical lesions, residual roots, etc.) to dental students)	102	1.00	3.00	2.0000[1]	1.75 ±0.55	0.667
Q14 (AI application should be part of residency dental education-training)	101	1.00	5.00	2.0000[0]	2.04 ±0.76	0.045*
Q15 (This presentation/demo improved my understanding of AI)	102	1.00	4.00	2.0000[0]	2.01 ±0.71	0.007*
Q16 (AI will help in practice management and patient education)	102	1.00	4.00	2.0000[0]	2.04 ±0.77	0.536
Q17 (I understood and enjoyed the AI annotation process)	102	1.00	5.00	2.0000[1]	2.00 ±0.82	0.065

Table 3. Questions with responses that differ between two nations

Question	Nationality	Median (IQR)	Min–Max	n	Raw p value	Holm–Bonferroni–adjusted p
Q4 (AI will replace dentists in near future)	Turkish	4.0	1–5	61	0.006	0.098
	American	4.0	2–5	40		
Q7 (The human oral and maxillofacial radiologist will be replaced by AI in near future)	Turkish	3.0	1–5	62	<0.001	**0.000**
	American	4.0	1–5	40		
Q11 (AI applications should be part of dental education-training)	Turkish	2.0	1–3	61	0.035	0.485
	American	2.0	1–3	40		
Q14 (AI application should be part of residency dental education-training)	Turkish	2.0	1–3	61	0.046	0.592
	American	2.0	1–5	40		
Q15 (This presentation/demo improved my understanding of AI)	Turkish	2.0	1–4	62	0.007	0.110
	American	2.0	1–3	40		

Values are presented as median and range. Group comparisons were performed using the Mann–Whitney U test. Holm–Bonferroni correction was applied to adjust for multiple comparisons across the questionnaire items. After adjustment, only Q7 remained statistically significant ($p < 0.05$).

Table 4. The frequencies of responses of American students

Responses regarding the extent to which the AI-based oral radiology education met students' expectations	Frequency	Valid Percent
Extremely well	14	35
Very well	16	40
Moderately well	5	12.5
Slightly well	5	12.5
Total	40	100

DISCUSSION

This study evaluated the experiences, perceptions, and attitudes of undergraduate dental students toward the use of AI- based educational decision-support system in dental education, with a particular focus on oral radiology. The main findings indicate that the majority of students hold positive attitudes toward the integration of AI into dental education and perceive AI-based applications as beneficial for learning radiologic anatomy and supporting diagnostic understanding. While the overall use of AI did not differ significantly according to gender or nationality, notable differences were observed between students from different nationalities in terms of concerns, expectations, and perceptions regarding the future role of AI in dental education and clinical practice.

Data collection was conducted in 2023, a period marked by rapid growth and public visibility of AI in healthcare and education. This temporal context is relevant because students' perceptions are likely influenced by the increasing presence of AI in both daily life and professional discourse. Accordingly, our findings may be interpreted as a snapshot of attitudes during a fast-evolving phase of AI adoption, and these perceptions may change as institutional policies, educational guidance, and real-world clinical integrations mature.

Recent reviews emphasize that AI integration in dental education should be pedagogically guided and ethically governed rather than technology-driven. While the literature commonly reports potential benefits for learning support, assessment, and

clinical reasoning training, it also highlights concerns such as overreliance, bias, privacy, and threats to academic integrity. [16-21] Therefore, the positive attitudes observed in our study should be interpreted as openness to AI-supported learning, not as unconditional endorsement or evidence of clinical diagnostic validity.

These findings are consistent with recent literature indicating that artificial intelligence is increasingly viewed as a supportive tool in dental education and clinical practice rather than a replacement for professional expertise [22–26]. AI possesses the capacity to enhance efficiency and productivity in the medical field [27]. AI has been used to predict academic success, dropout rates, and student performance [28]. Radiology education necessitates that students acquire the ability to evaluate and interpret imaging characteristics to detect structures, formulate a differential diagnosis, and synthesize imaging features, differential diagnoses, and clinical observations to ascertain the most probable diagnosis [29]. Despite the fact that AI has numerous uses in dentistry, particularly in dental radiology, the future of AI is viewed differently by dentists and dentistry students. AI is viewed by some as unstable and incapable of ever replacing radiologists, even though many people feel it can open up many opportunities in the medical and dental industries and clear the path for a prosperous future[15]. Just a handful of studies examined the knowledge of learners and viewpoints about the application of AI in radiological diagnosis in the future. Consequently, the current study aims to evaluate and distinguish between the perspectives and viewpoints of undergraduate students in dentistry who use and do not utilize.
AI possesses the capacity to augment and assist human endeavors, providing substantial advantages in dentistry education and training [30]. The enhanced incorporation of AI into dental education has led to a growing body of literature examining its use among undergraduate dental students.

Yüzbaşıoğlu [2] reported students' opinions and perceptions toward AI. Similar to this study, the questionnaire showed that undergraduate students believed in revolutionization in dentistry with the use of AI. (1,81 ±0,72). Unlike this study, a statistically significant difference was reported between genders. A particular dispute was found that AI may be utilized as a "definitive diagnostic tool" in diagnostics. (46.30%). However, the current study reported a strong agreement that AI applications are beneficial in teaching dental radiologic anatomy and teaching the detection of oral diseases, respectively. (1,80 ±0,56; 1,75 ±0,55). Similar to this study, the questionnaire showed that individuals recommended the use of AI in undergraduate dental education. (p=0,034).

Our findings are broadly consistent with the recent Turkish survey by Yılmaz et al. [31], which assessed AI knowledge and attitudes among 4th–5th year undergraduate and specialty dentistry students. Notably, Yılmaz et al. reported that undergraduate students expressed greater concerns regarding the impact of AI on patient understanding and empathy compared with specialty students, and the authors concluded that AI should be considered a complement to dental professionals rather than a substitute, with attention to privacy and data security. Taken together, these findings support interpreting positive student attitudes as openness to AI-supported learning within a structured and ethically governed curriculum rather than as unconditional endorsement of AI as a replacement for clinical expertise.

Hedge et al. [32] evaluated the perspectives of dentistry students, oral health therapists, and dental hygienists regarding the usage of AI. Similar to the current study, a large percentage of the participants (n = 107, 69%) claimed that AI would be advantageous in practice management. (2,04 ±0,77). The concerns about AI applications were investigated. The current study examines students' responses to questions 3, 4, 5, 6, and 7, shedding light on their concerns about artificial intelligence and their perspectives on its potential advancements in dental practice. Unlike the current study, the key issues raised included potential job displacement, limited adaptability in patient care, and challenges related to insurance liability.

Furthermore, the results reveal that students express lower levels of concern about the integration of AI into dentistry and exhibit minimal apprehension regarding the possibility of AI replacing dentists or radiology specialists.

Veerabhadrappa et al. [33] reported that most students supported integrating AI into dental education and practice, while disagreeing that AI would replace dentists; however, they also emphasized barriers such as insufficient knowledge and limited access to AI tools.

Kumari [34] examined the views, thoughts, and expectations of dentistry students in Patna in relation to the incorporation of AI into dental education. In accordance with this study, an important portion of individuals agreed on the value of AI

in dental education. It was reported that AI was perceived to enhance diagnostic accuracy and improve treatment planning. (p=,045)

Critical thinking, cognitive clinical abilities, and related behavioral competencies are crucial for proficient dentists [35]. Critical thinking is a cognitive process that requires the active evaluation and integration of information to form logical conclusions and make well-informed decisions [36]. The literature includes studies highlighting the need to incorporate applications that use AI into the core curriculum of dentistry. Schwendicke et al. [37] reported that the importance of incorporating AI into the core curriculum of dentistry was emphasized through the defined learning outcomes. Sharab et al. [38] recommended introducing structured AI use at an early stage and integrating it systematically across the dental curriculum. In line with these recommendations, the attitudes of students in the present study support the inclusion of AI applications in dental education. Recent studies evaluating dental students' attitudes and perceptions toward artificial intelligence have similarly reported generally positive views regarding the role of AI in dentistry and education, while also drawing attention to existing limitations and the necessity for formalized curricular integration of AI training [39, 40].

The attitudes of students in this study toward incorporating AI applications into dental education further support this perspective.

Our results are in line with Karan-Romero et al. [41]., who reported generally positive perceptions of AI among dental students, with most participants expecting AI to drive major advances in dentistry. Importantly, a substantial proportion did not believe that AI would replace dentists, and many supported integrating AI training into undergraduate education. Together, these findings reinforce the interpretation that students' positive attitudes reflect openness to AI-supported learning rather than unconditional endorsement of AI as a substitute for clinical expertise.

Jeong et al. [42] researched how dentists and dentistry students view and feel about artificial intelligence. Similar to this study, 25% of the participants expressed concurrence or strong concurrence that AI will be essential in the future of dental healthcare services and that AI is superior to a qualified dentist in terms of diagnosis. (1,81 ±0,72)

Similar to this research, 71.9% of dentists and 64.2% of dental students disagreed that AI would eventually replace them in their careers (p=0,006), indicating that artificial intelligence is predominantly perceived as a complementary tool rather than a replacement for professional expertise. This perception is consistent with the findings of Halat et al. [43], who reported that dental students acknowledge the potential of AI in clinical practice while emphasizing the continued importance of human judgment and clinician oversight.

In line with this study, Aboalshamat [44] reported that participants agreed on the impact of AI use in major advancements. (1,70 ±0,62) However, in Aboalshamat's study, participants expressed concerns about AI replacing dentists. In this study, the majority of participants marked "disagree" and "strongly disagree." (3,66 ±0,88).

Likewise, in this study, Roganovic [45] reported that the majority of participants believed that using AI would increase the productivity and caliber of a dentist's job; fewer than half of them agreed that AI should be employed in dental practices. The distribution of artificial intelligence usage by gender and nationality did not exhibit statistically significant differences in the present investigation. These results are consistent with those of Yüzbaşıoğlu [2] and Aboalshamat [44], who also found no statistically significant difference based on gender.

From a dental education perspective, our findings have clear implications for curriculum development and learning strategies. Recent research in medical education highlights that the integration of AI into curricula requires deliberate design to support not only technical skill acquisition but also adaptive learning and ethical competence. National-level curriculum reform studies emphasize the need to build AI literacy, ethical understanding, and adaptive learning experiences into formal medical training programs rather than offering these topics as optional content. [46]

The positive attitudes toward AI observed in our study suggest that students are receptive to structured AI-supported learning environments. This aligns with current recommendations for adaptive and learner-centered education models that leverage AI tools for personalized learning, formative feedback, and enhanced clinical reasoning practice. AI-supported systems such as adaptive learning platforms and AI-generated clinical

scenarios can be embedded into courses to promote active learning, strengthen clinical decision-making skills, and make the curriculum more responsive to individual student needs. [47] Furthermore, curriculum reform frameworks developed in recent years advocate involving both faculty and students in evaluating and adapting curriculum content to ensure that new competencies — including AI literacy, data interpretation skills, and professional judgment in technology-augmented care — are clearly articulated in competency frameworks. Such an approach supports systematic curriculum design and aligns with contemporary educational goals of preparing undergraduates for technology-rich clinical environments. [37, 46] These findings support the inclusion of AI-focused learning strategies and curriculum components that foster not only knowledge acquisition but also critical thinking, ethical awareness, and adaptive expertise — essential competencies for future clinical practice.

Consequently, this study was conducted on dental students from two different nationalities studying at two separate universities. It aimed to gather feedback from students regarding the adoption of AI and its significance in dental education, critical thinking, and the integration of AI into the dental curriculum, as well as their apprehensions over the utilization of AI. Given that multiple questionnaire items were tested separately, the risk of Type I error was addressed by applying the Holm–Bonferroni correction. Following adjustment, only the between-group difference observed for Q7 remained statistically significant, whereas other nominally significant findings did not. Therefore, these latter differences should be interpreted cautiously and considered exploratory, warranting confirmation in larger and more diverse samples.

The findings of this study highlight the growing importance of artificial intelligence as a supportive educational tool in oral radiology education. Rather than replacing dentists or radiologists, AI-based applications appear to be perceived by students as complementary systems that enhance learning, critical thinking, and clinical preparedness. These results underscore the need for structured and well-integrated AI training within the dental curriculum to ensure that students develop the competencies required to effectively and responsibly use emerging technologies. Future research involving broader participant groups, including postgraduate trainees and academic staff, as well as longitudinal designs incorporating performance-based outcomes, would provide deeper insights into the long-term educational impact of AI in dentistry.

Limitations

The participant pool was limited to two dental schools, one in Turkey and the other in the United States, which restricts the extent to which the outcomes can be generalized to wider populations. Since the study relied on self-administered questionnaires, the responses may have been influenced by recall errors or a tendency to provide socially acceptable answers. Moreover, the study focused on students' perceptions rather than objective outcomes (e.g., diagnostic accuracy or skill development) and did not assess clinical diagnostic performance; thus, no clinical diagnostic validity should be inferred from these findings. On the other hand, this study is that the participant group consisted solely of undergraduate dental students from two different countries. Although the inclusion of research assistants and academic staff involved in dental education could have provided a more comprehensive evaluation of artificial intelligence from an educational perspective, the primary focus of this study was to assess students' perceptions, experiences, and expectations. Therefore, the findings may not be fully generalisable to educators, postgraduate trainees, or other professional groups involved in dental education. Another limitation is the cross-sectional design, which does not allow conclusions about long-term effects or causal relationships.

Further studies that include broader and more diverse groups of students, apply longitudinal designs, and incorporate performance-based measures would be valuable to better clarify the role of AI in dental education.

CONCLUSIONS

This study highlights the growing perceived value of AI in oral radiology education and supports consideration of its structured integration into the dental curriculum. Overall, participants reported minimal concern about AI replacing dentists or radiologists and expressed a generally positive attitude toward the inclusion of AI in education. Students' responses suggest that AI-supported tools may be viewed as helpful for learning and for supporting diagnostic understanding within an educational context. However, as this study focused on perceptions rather than objective performance outcomes, the findings should not be interpreted as evidence of improved diagnostic accuracy or clinical validity. Future longitudinal and multi-institutional studies incorporating performance-based measures are needed to clarify the educational impact of AI-supported training and to

inform ethically guided curriculum implementation.

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Conflict of Interest: The authors declare that they have no conflicts of interest.

Informed Consent: Informed consent was obtained from all participants prior to their inclusion in the study. Participation was voluntary, and students were informed about the study objectives, procedures, and their right to withdraw at any stage without consequences. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki and approved by the relevant institutional review boards.

Data Availability Statement: The authors value transparency and reproducibility in research while maintaining the privacy of study participants. For this reason, the raw data are not publicly available. However, they can be made available from the corresponding author upon reasonable request.

Ethics Committee Statement: This international study was approved by the Lokman Hekim University Scientific Research Ethics Committee (Desicion Number: 2023/94, Date: 2023-06-13) and the University of Mississippi Medical Center Institutional Review Board (IRB Tracking Number: UMMC-IRB-2024-161, Date: 2023-06-15).

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Figure 1. Questionnaire

1. Gender
- Male
- Female

2. I have used an artificial intelligence (AI) application/software in the field of dentistry before this presentation/demo.
- Yes
- No

3. AI will revolutionize general dentistry in aspects of diagnosis and treatment planning.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

4. AI will replace dentists in near future.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

5. AI will improve the way we do dentistry.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

6. I am worried with applications of AI in Dentistry.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

7. The human oral and maxillofacial radiologist will be replaced by AI in near future.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

8. AI will improve my learning ability about anatomical structures.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

9. AI use in oral radiology makes it more exciting learning experience.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

10. I have used artificial intelligence application in the field of dental education-training before.
- Yes
- No

11. AI applications should be part of dental education-training.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

12. The use of AI applications in dental education is beneficial in teaching dental radiologic anatomy to dental students.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

13. The use of AI applications in dental education is beneficial in teaching dental radiological problems (caries, periapical lesions, residual roots, etc.) to dental students.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

14. AI application should be part of residency dental education-training.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

15. This presentation/demo improved my understanding of AI.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

16. AI will help in practice management and patient education.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree

17. I understood and enjoyed the AI annotation process.
- Strongly agree
- Agree
- No idea
- Disagree
- Strongly disagree