Evaluation of Knowledge, Attitude, and Perception of Artificial Intelligence and its Education Among Dental Students in North Cyprus: A Cross-Sectional Online Survey

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Abstract
Artificial Intelligence (AI) is a highly discussed subject, and its integration into our daily lives has grown significantly. This research evaluated how dental students in North Cyprus perceive and feel about artificial intelligence, with a focus on identifying educational needs to enhance their professional skills. A self-administered multiple-choice questionnaire with 24 questions was conducted. 5 questions focused on gathering basic demographic information, such as gender, age, academic year, AI knowledge self-assessment, dental news sources, and experience in AI development. The remaining 16 questions pertained to AI-related topics. In general, students stated that they have little knowledge about AI (71.4%), and usually get the latest medical and dental news and information through the Internet (65.7%). 43,6% of the participants were strongly agree that AI-related lectures should be included in the regular curriculum for dental hygiene. Male students showed that they have significantly more knowledge about AI than female students. (p<0.05) In general, participants demonstrated diminished confidence in AI. It is seen that the dental education curriculum provided minimal information about AI and most of the students stated that AI-related lectures should be included in the regular curriculum for dental hygiene. Based on these findings, it is important to arrange lectures and seminars aimed at enhancing dental students' comprehension of AI.
Keywords: Artificial Intelligence and Dental Education

Introduction

Artificial intelligence (AI) refers to the utilization of computers or robots programmed to perform tasks in a manner resembling human intelligence. With the exponential growth of information across various scientific domains, including health, AI has emerged as a powerful tool capable of processing and understanding vast amounts of data at speeds beyond human capability. Its applications in healthcare are known for streamlining and enhancing patient-centered care services. Despite the high potential and numerous success stories, the past five years have witnessed a significant advancement in the performance and acceptance of AI in medicine (Başer et al., 2021).
These artificial intelligence methods have primarily been utilized for visual assignments, such as categorizing images (for instance, diagnosing conditions from chest X-rays) or automatically delineating specific areas within an image (such as identifying tumor tissue in brain MRI scans) (Lakhani et al., 2017).

Artificial intelligence, in terms of dentistry field, is revolutionizing the landscape of dentistry as an emerging field. In dental clinics, AI can execute numerous routine tasks with heightened accuracy, reduced staffing requirements, and minimized errors compared to human counterparts. From managing scheduling and coordinating appointments to aiding in clinical diagnosis and treatment planning, AI showcases its versatility. AI can automatically detect and categorize dental restorations on panoramic radiographs, assisting in identifying dental and maxillofacial abnormalities such as periodontal diseases, and root caries (Chen et al., 2020; Abbasi et al., 2021).

While it's improbable for AI to supplant doctors, it's widely acknowledged as a dependable resource for clinical decision-making. Medical and dental students, who represent the future generation of healthcare providers, are candidates to incorporate this technology into their professional practice (Özbek Güven et al., 2024). AI research and technological advancements in dentistry are presently concentrated in the preclinical phases. Nonetheless, these innovations are projected to have extensive applications soon, contingent upon overarching trends. This highlights an increasing demand for educational initiatives concerning this subject within the dental school curriculum (Schwendicke et al., 2020). AI technology is poised to, and is already, impacting the education sector, as evidenced by its role during the COVID-19 pandemic. Its goal is to offer personalized learning through interactive educational experiences. Nevertheless, numerous educational institutions encounter hurdles in effectively integrating AI into their teaching methods due to insufficient training among educators, the expense of AI software, and ethical dilemmas (Roganović et al., 2023).

Adaptation to artificial intelligence-related changes is inevitable for students. Therefore, it's imperative to evaluate dental students' preparedness for artificial intelligence technologies and their integration into dental practice and gauge their apprehension levels. Hence, the present study aims to assess the perception and attitudes of undergraduate dental students towards artificial intelligence.

Materials and Methods
This study was conducted using Google Forms and the link was sent via e-mails or WhatsApp groups to all dental students at Cyprus International University in May 2023.

In total, 105 students willingly took part in this study and they completed it themselves. Students were prompted to send any inquiries via email and were directed to mark and fill out their responses individually.
A survey comprising 21 questions was undertaken. A self-administered multiple-choice questionnaire, adapted from a previously tested questionnaire utilized in similar research endeavors, was employed for data collection (Oh et al., 2019; Kim et al., 2019; Yüzbaşıoğlu, 2021; Jeong et al., 2023).

The survey included a total of 21 questions. 5 questions focused on gathering basic demographic information, such as gender, age, academic year, AI knowledge self-assessment, dental news sources, and experience in AI development. The remaining 16 questions pertained to AI-related topics and were categorized as follows: attitudes towards AI (5 questions), confidence in AI (3 questions), predictions for AI applications in dentistry (3 questions), and prospects for AI applications (5 questions).

Results
Table 1 illustrates the distribution of the answers of dental students. In general, students stated that they have little knowledge about AI (71.4%), and usually get the latest medical and dental news and information through the Internet (65.7%). Also, most of the students (58.1%) are moderately interested in AI which is widely used in everyday life. Reduction of misdiagnosis rates (43.6%) and fast and objective (34.7%) are the most selected advantages of AI. It is somewhat inflexible to apply to individual patients (25.5%) and difficult to apply to controversial issues (26.6%) choices are the most selected one for the disadvantages of AI. Answers to the question "Do you think the diagnostic ability of AI is superior to that of experienced dental professionals?" showed that most of the participants neither agree nor disagree (54.5%). 43,6% of the participants were strongly agree that AI-related lectures should be included in the regular curriculum for dental hygiene. More than half of the participants (57%) stated that they trust the dentist's judgment if the dentist's judgment and the AI's judgment are different. Furthermore, nearly half of the participants neither agree nor disagree about AI replacing their jobs.

Table 1. Distribution of the answers given by dental students to the survey questions

Gender	Female	56	53.3
	Male	49	46.7
Grade of student	1st year	26	24,8
	2nd year	24	22,9
	3rd year	36	34.3
	4th year	10	9,3
	5th year	19	8,6
How much do you know about AI	High (very much, to some extent)	12	11,4
	Medium (average)	18	17,1
	Low (little, not at all)	75	71,4
Where do you usually get the latest medical and dental news and information?	Schools or academic societies	23	22
	Internet	69	65,7
	Newspaper	1	1
	Books or papers	7	6,7
	Friends	5	4,8
Have you ever been involved in the development of AI?	Yes, I have	19	18,1
	No, I have no	86	81,9
	Very much, to some extent	31	29,5

Are you interested in AI that is widely used in everyday life?	Moderately	61	58,1
	Rarely, not at all	13	12,4
How do you mainly learn about AI?	Schools or academic societies	15	14,3
	Internet	73	69,5
	Newspapers	5	4,8
	Books or papers	2	1,9
	Friends	10	9,5
What is the biggest advantage of AI when applied to dentistry?	Fast and objective	35	34,7
	Integration of vast amount of data	26	25,7
	Reduction of misdiagnosis rates	44	43,6
	No spatial or temporal constraints	6	5,9
	No emotional exhaustion or physical limitations	23	22,8
What is the biggest disadvantage of AI when applied to dentistry?	Decreased ability to consider or empathize with the patient's feelings	20	19,6
	Developed by experts with little clinical experience	11	10,7
	Difficult to apply to controversial issues	24	13,7
	It is difficult to handle unexpected situations other than stored information	21	20,6
	It is somewhat inflexible to apply to individual patients	26	25,5
Do you think AI-related lectures should be included in the regular curriculum for dental hygiene?	Strongly agree, agree	44	43,6
	Neither agree nor disagree	42	41,6
	Disagree, strongly disagree	15	14,9
Do you think the diagnostic ability of AI is superior to that of experienced dental professionals?	Strongly agree, agree	20	20,2
	Neither agree nor disagree	54	54,5
	Disagree, strongly disagree	25	25,2
Which would you trust more if the dentist's judgment and the AI's judgment are different?	AI's judgment	12	12
	Dentist's judgment	57	57
	Leave it to the patient's choice	6	6
	Opinions of other AI programs	5	5
	Opinions of other experts	20	20
Who do you think is liable for misdiagnosis by AI?	Company that developed AI	31	31
	Dentist in charge	30	30
	Patient who followed AI's judgment	22	22
	Other	17	17
Which roles do you think AI will play in dental healthcare?	AI will not be helpful for dental healthcare	20	19
	AI will serve as a guide in rare cases	43	41
	AI will provide data on evidence-based dental approaches in clinical practice	43	41
	AI will be used as a device to compensate for the limitations of human intellectual abilities (neglected by dentists)	42	40
	AI will be used as a reference for each treatment	32	30,5
	AI will completely replace dentists' judgment	12	11,4
Which field of dentistry do you think will benefit most from AI?	Diagnosis	41	39
	Treatment decision	34	32,4

	Direct treatment (including surgery)	28	26,7
	Research and development of drugs and materials	44	42
	Dental care support in medically vulnerable areas	35	33,3
	Development and improvement of social insurance	18	17,1
Which type of dental healthcare facility will AI be commercialized in first?	Public primary care institutions such as public healthcare centers	25	25,8
	Primary care institutions such as private clinics	33	34
	Specialized clinics (orthodontics, aesthetic prosthetics, joint dental clinic, etc.)	25	25,8
	University hospitals	14	14,4
Do you expect the application of AI to be useful in dentistry?	Strongly agree, agree	47	47
	Neither agree nor disagree	43	43
	Disagree, strongly disagree	10	10
When do you expect the commercialization of AI in dentistry to take place within the next few years?	0 to 3 years	24	23,8
	4–7 years	7	6,9
	8–11 years	6	5,94
	12–15 years	40	39,6
	16 years or over	24	23,8
Do you think AI will be further improved in the future to reduce misdiagnosis rates?	Strongly agree, agree	47	47,5
	Neither agree nor disagree	37	37,4
	Disagree, strongly disagree	15	15,2
How often do you expect AI to be used once applied in dentistry?	It will be used in all practices, will be used in most practices	29	29
	It will be used in about half the time	43	43
	It will only be used when absolutely necessary, seldom used	28	28
Do you think AI can replace your job?	Strongly agree, agree	21	20,6
	Neither agree nor disagree	48	47,1
	Disagree, strongly disagree	33	32,4

Answers to the questions were compared according to gender and a significant difference was observed in the question of how much you know about AI. Male students showed that they have significantly more knowledge about AI than female students. ($p < 0.05$) (Table 2)

Table 2. Comparison of the answers given by dental students to the survey questions in terms of gender

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
How much do you know about AI	Equal variances assumed	.177	.675	-3.668	102	.000	-.3601	.0982	-.5548	-.1654
	Equal variances			-3.618	91.963	.000	-.3601	.0995	-.5578	-.1624

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
	not assumed									
Where do you usually get the latest medical and dental news and information?	Equal variances assumed	.683	.410	-.344	102	.731	-.0595	.1730	-.4027	.2836
	Equal variances not assumed			-.349	101.985	.728	-.0595	.1708	-.3983	.2792
Have you ever been involved in the development of AI?	Equal variances assumed	6.084	.015	-1.197	102	.234	-.0893	.0746	-.2373	.0587
	Equal variances not assumed			-1.216	101.658	.227	-.0893	.0734	-.2349	.0563
Are you interested in AI that is widely used in everyday life?	Equal variances assumed	4.460	.037	1.796	102	.075	.2202	.1226	-.0230	.4634
	Equal variances not assumed			1.785	96.507	.077	.2202	.1234	-.0247	.4652
How do you mainly learn about AI?	Equal variances assumed	24.157	.000	1.337	102	.184	.2738	.2048	-.1323	.6799
	Equal variances not assumed			1.405	80.896	.164	.2738	.1949	-.1140	.6616
What is the biggest advantage of AI when applied to dentistry?	Equal variances assumed	1.808	.182	-1.927	98	.057	-.4976	.2582	-10.100	.0148
	Equal variances not assumed			-1.907	90.465	.060	-.4976	.2609	-10.158	.0207
What is the biggest disadvantage of AI when applied to dentistry?	Equal variances assumed	.708	.402	.364	99	.717	.0942	.2588	-.4193	.6076
	Equal variances not assumed			.365	98.076	.716	.0942	.2580	-.4178	.6061
Do you think AI-related lectures should be included in the regular curriculum for dental hygiene?	Equal variances assumed	.023	.880	1.313	98	.192	.1876	.1429	-.0960	.4712
	Equal variances not assumed			1.321	97.286	.190	.1876	.1420	-.0943	.4695
Do you think the diagnostic ability of AI is superior to that of experienced dental professionals?	Equal variances assumed	.259	.612	-.400	96	.690	-.0552	.1381	-.3293	.2189
	Equal variances not assumed			-.397	91.780	.692	-.0552	.1389	-.3310	.2206

Which would you trust more if the dentist's judgment and the AI's judgment are different?	Equal variances assumed	2.869	.094	.146	97	.884	.0361	.2470	-.4541	.5263
	Equal variances not assumed			.149	95.636	.882	.0361	.2425	-.4453	.5175
Who do you think is liable for misdiagnosis by AI?	Equal variances assumed	.689	.408	.866	97	.388	.1874	.2164	-.2420	.6169
	Equal variances not assumed			.869	95.876	.387	.1874	.2158	-.2410	.6159
Which roles do you think AI will play in dental healthcare?	Equal variances assumed	2.065	.158	-1.021	41	.313	-.459	.449	-1.366	.448
	Equal variances not assumed			-1.027	39.853	.311	-.459	.447	-1.362	.445
Which field of dentistry do you think will benefit most from AI?	Equal variances assumed	.118	.733	1.241	36	.223	.539	.434	-.342	1.420
	Equal variances not assumed			1.238	35.189	.224	.539	.435	-.345	1.422
Which type of dental healthcare facility will AI be commercialized in first?	Equal variances assumed	2.492	.118	1.652	94	.102	.3399	.2057	-.0685	.7483
	Equal variances not assumed			1.661	93.849	.100	.3399	.2046	-.0663	.7461
Do you expect the application of AI to be useful in dentistry?	Equal variances assumed	.360	.550	.386	97	.700	.0517	.1339	-.2141	.3175
	Equal variances not assumed			.385	93.500	.701	.0517	.1344	-.2152	.3186
When do you expect the commercialization of AI in dentistry to take place within the next few years?	Equal variances assumed	.005	.943	.312	98	.755	.0692	.2217	-.3707	.5092
	Equal variances not assumed			.313	96.245	.755	.0692	.2212	-.3698	.5083
Do you think AI will be further improved in the future to reduce misdiagnosis rates?	Equal variances assumed	.092	.763	2.412	96	.018	.3462	.1435	.0613	.6311
	Equal variances not assumed			2.419	95.435	.017	.3462	.1431	.0621	.6302
How often do you expect AI to be	Equal variances assumed	.022	.884	.800	97	.426	.1222	.1529	-.1812	.4256

				.801	94.316	.425	.1222	.1526	-.1808	.4253
used once applied in dentistry?	Equal variances not assumed									
Do you think AI can replace your job?	Equal variances assumed	.383	.538	.954	99	.342	.1383	.1449	-.1492	.4259
	Equal variances not assumed			.954	95.559	.343	.1383	.1451	-.1496	.4263

A t-test was applied to all questions, and the results were interpreted as follows:

- ☐ **"How much do you know about AI?"**
  - **t-test**: The means are significantly different ($p < 0.05$).
- ☐ **"Where do you usually get the latest medical and dental news and information?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Have you ever been involved in the development of AI?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Are you interested in AI that is widely used in everyday life?"**
  - **t-test**: The means are not significantly different ($p > 0.05$), but it is close to the significance threshold ($p = 0.075$).
- ☐ **"How do you mainly learn about AI?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"What is the biggest advantage of AI when applied to dentistry?"**
  - **t-test**: The means are not significantly different ($p > 0.05$), but it is close to the significance threshold ($p = 0.057$).
- ☐ **"What is the biggest disadvantage of AI when applied to dentistry?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Do you think AI-related lectures should be included in the regular curriculum for dental hygiene?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Do you think the diagnostic ability of AI is superior to that of experienced dental professionals?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Which would you trust more if the dentist's judgment and the AI's judgment are different?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Who do you think is liable for misdiagnosis by AI?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Which roles do you think AI will play in dental healthcare?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Which field of dentistry do you think will benefit most from AI?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Which type of dental healthcare facility will AI be commercialized in first?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Do you expect the application of AI to be useful in dentistry?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"When do you expect the commercialization of AI in dentistry to take place within the next few years?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Do you think AI will be further improved in the future to reduce misdiagnosis rates?"**
  - **t-test**: The means are significantly different ($p < 0.05$).
- ☐ **"How often do you expect AI to be used once applied in dentistry?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).
- ☐ **"Do you think AI can replace your job?"**
  - **t-test**: The means are not significantly different ($p > 0.05$).

For most questions, the mean differences between the two groups are not statistically significant ($p > 0.05$). This indicates that there are no substantial differences in responses between the two groups for most of the questions. However, for some questions (e.g., "How much do you know about AI?" and "Do you think AI will be further

improved in the future to reduce misdiagnosis rates?"), there are significant differences between the groups, indicating notable differences in opinions or knowledge levels regarding these specific topics.

Discussion

Artificial intelligence allows for the development of smart machines. It has started to influence how diagnoses and treatments are conducted in healthcare. In dentistry, AI has significantly advanced in diagnosis, treatment planning, prognosis, identifying landmarks, and assessing risks (Thulasi et al., 2022; Fatima et al., 2022).

Artificial Intelligence is becoming more commonly used in medical and dental education, providing a wide range of advantages for both students and instructors. The incorporation of Artificial Intelligence into dental education has demonstrated promising outcomes by enhancing the learning process and elevating patient care. Dental students can utilize virtual simulations to practice intricate procedures like fillings and root canals, minimizing risks to actual patients (Dave & Patel, 2023).

This study represents the initial exploration of dental students' views on AI in North Cyprus. Findings reveal that most students are familiar with AI. The students anticipate a transformative impact of AI on dentistry in the future. Despite their enthusiasm for AI applications in dentistry, they neither agree nor disagree that AI will replace human dentists soon, which contrasts with findings from other studies (Jeong et al., 2023; Yüzbaşıoğlu, 2021).

The majority of participants showed interest in the different applications of AI in daily activities. While only 22% of the participants stated schools/academic societies as getting the latest medical and dental information, but nearly more than half of the participants (65,7%) used the internet to access AI-related information. Our results in terms of getting knowledge from school and academic societies showed a lower percentage when compared with the studies of Jeong et al. and Yüzbaşıoğlu et al. (Jeong et al., 2023; Yüzbaşıoğlu, 2021).

Many participants (44%) stated that AI-related lectures should be included in the regular curriculum for dental hygiene. In a study conducted by Kim et al. (Kim et al., 2019), radiological technologists similarly expressed a significant desire for AI-related courses in universities to prepare for future advancements.

11.4% of the participants stated that they have a high knowledge of AI. This percentage is lower than the results of Yüzbaşıoğlu (Yüzbaşıoğlu, 2021) (15.4%) and higher than the results of Oh et al. (Oh et al., 2019) (6%). This average rate might indicate the present condition of AI, which is now a familiar presence in everyday life thanks to the swift advancements in AI technology.

Only 20% of the participants think the diagnostic ability of AI is superior to that of experienced dental professionals. This resembles the results of Jeong et al. (Jeong et al., 2023). On the other hand, other previous studies (Yüzbaşıoğlu, 2021; Kim et al., 2019) reported higher confidence in AI's diagnostic and judgment abilities. Participants observed that they received more information from social media than from academic sources. Interestingly, highly educated students were the least apprehensive about this emerging technology. This indicates a significant opportunity to educate undergraduate students about the foundational concepts of AI (Uzuner et al., 2010). In North Cyprus, dental students are not receiving any formal academic instruction on AI.

There are several limitations to this study. The survey was conducted exclusively in only one university in North Cyprus, which means that different educational curricula and teaching methodologies in other countries could influence the results. Also, the sample size is relatively low.

Conclusion

In general, participants demonstrated diminished confidence in AI. It is seen that the dental education curriculum provided minimal information about AI and most of the students stated that AI-related lectures should be included in the regular curriculum for dental hygiene. Based on these findings, it is important to arrange lectures and seminars aimed at enhancing dental students' comprehension of AI.

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