



(RESEARCH ARTICLE)



Effectiveness of Distance Learning and Clinical Training in Undergraduate Oral and Maxillofacial Radiology Education

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Abstract

Background. Although distance learning became widespread due to the pandemic, it continues to find its place in various fields. On the other hand clinical education is an indispensable part of dentistry. This study aims to evaluate the effectiveness of distance learning and clinical training specifically in undergraduate oral and maxillofacial radiology education.

Methods. Students in four groups: those who received only distance theoretical education (Group 1), those who received distance theoretical education plus clinical training (Group 2), those who received only face-to-face theoretical education (Group 3), and those who received face-to-face theoretical education plus clinical education (Group 4) answered 10 theoretical and 10 clinical questions of oral and maxillofacial radiology.

Results. Group 4 was the most successful in whole types of questions followed by the groups 2, 3 and 1 in varying statistical significance. There were no significant difference between groups in theoretical based questions unlike clinical based questions and overall results. Clinical training does not just affect clinical knowledge but reinforces theoretical knowledge as well.

Conclusion. Distance education should take place partially and supplemental in oral and maxillofacial education regarding its advantages. Clinical training is indispensable for education in dentistry and oral and maxillofacial radiology.

Keywords: Oral and Maxillofacial Radiology; Education; Distance Education; Clinical Training; Dentistry Education; Distance Learning

1. Introduction

The first cases related to the subsequent global pandemic were reported in Wuhan, China, in late 2019 [1]. The new coronavirus, named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), spread rapidly throughout China and was subsequently reported in numerous other countries [2, 3]. The rapid increase in cases worldwide meant the disease gained global significance, prompting the World Health Organization (WHO) to declare it a pandemic on 11 March 2020 [4]. Transmission of the disease through respiratory droplets and close contact has put large populations at risk of infection [5].

The rapid spread of the SARS-CoV-2 virus and its emergence as a serious global public health threat has led many countries to implement social distancing policies, mobility restrictions, quarantine measures and other comprehensive protective measures [6]. These measures have led to the suspension of face-to-face educational activities and a rapid

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transition to distance learning, paving the way for the development of numerous online tools and new teaching methods [7]. The pandemic has initiated a process of remote education on an unprecedented scale in modern educational history [8]. To ensure the safety of all students, including medical and dental students, they have been required to self-isolate at home [9].

Distance education refers to a learning process in which students and instructors are not in the same place at the same time [10]. Although it is perceived as a new field of application, this model has its origins in the era of teaching by correspondence and has become widespread through radio and television. Today, with the development of high-speed internet and video technologies, it has evolved into interactive online learning environments. This educational method can be implemented synchronously or asynchronously, interactively or unilaterally, and continues to be used by many institutions, even after the pandemic, to enable students to access academic staff and information in different institutions, cities and countries [11].

The traditional lecture method, long adopted in medical and dental education, effectively conveys comprehensive basic information in a short period of time [12]. However, this method has certain limitations when it comes to assessing students' learning and comprehension levels, and its effectiveness decreases significantly as participants' levels of interest and attention decline [13].

The emergence of these limitations has led to fundamental changes in teaching methods at all levels of education, including medical and dental education [14]. The proliferation of computer technologies and high-speed internet access has led many major universities around the world to offer various online teaching opportunities, such as distance learning, web-based learning, closed-loop online education systems and educational videos [15]. While traditional medical and dental education requires the mentor and student to be in the same physical environment, this education can now be conducted remotely and digitally archived for future use. Evidence currently suggests that students tend to prefer innovative, technology-supported educational approaches to traditional teaching methods [16, 17].

E-learning facilitates students' access to the most up-to-date information and enables the more effective use of evidence-based dental practices [18]. Although face-to-face continuing education remains the most common and preferred method, the flexibility and accessibility offered by distance learning in terms of time and place contribute to the increasing preference for this method in the field of dentistry [19].

The scope and level of education in oral and maxillofacial radiology (OMFR) is clearly defined in accordance with international standards. The education guidelines published by the International Association of Dentomaxillofacial Radiology (IADMFR) emphasise that undergraduate-level radiology education should be competency-based. This should cover not only imaging skills, but also clinical decision-making, radiographic interpretation, radiation safety and legal responsibilities. These standards necessitate a comprehensive approach to both theoretical and practical training, equipping students with the ability to conduct safe and precise radiological evaluations [20]. Consequently, an important area of research has emerged: the extent to which the remote and hybrid education models implemented during the pandemic meet the competencies defined in these international standards.

The changes in teaching methods that were introduced due to the pandemic also present an opportunity to compare the components of distance and face-to-face education and to objectively examine educational outcomes.

This study aims to draw conclusions on how online and face-to-face learning components and clinical education can be balanced in OMFR education today by comparing the performance and subjective evaluations of student groups exposed to different educational models. The objective is to examine the impact of delivering theoretical oral and maxillofacial radiology courses online in dental schools and reinforcing the theoretical topics covered in clinical practice on students' radiological competence.

2. Material and methods

Two hundred students who had received radiology training through various teaching methods took part in the study after signing an informed consent form.

The students were divided into four groups of 50. The first group consisted of students who had completed their radiology theory courses exclusively through distance learning. The second group comprised students who had completed their theory courses through distance learning and also received clinical training. The third group consisted of students who had completed their radiology theory courses in person. The fourth group comprised students who had completed their radiology theory courses in person and also received clinical training (Figure 1). The distance learning

method used at the faculty involves Microsoft Teams and takes place during class hours. It is conducted synchronously and allows students to contribute by asking questions.

A total of 20 multiple-choice questions were administered to students, consisting of 10 focusing on theoretical knowledge of OMFR (e.g. radiation physics, radiation safety, radiological imaging methods and radioanatomy) and 10 related to clinical practice (e.g. radio-opaque, radiolucent and mixed lesions; radiographic reflections of systemic diseases). Their responses were evaluated based on their educational background to assess the effectiveness of the oral and maxillofacial radiology education they received.

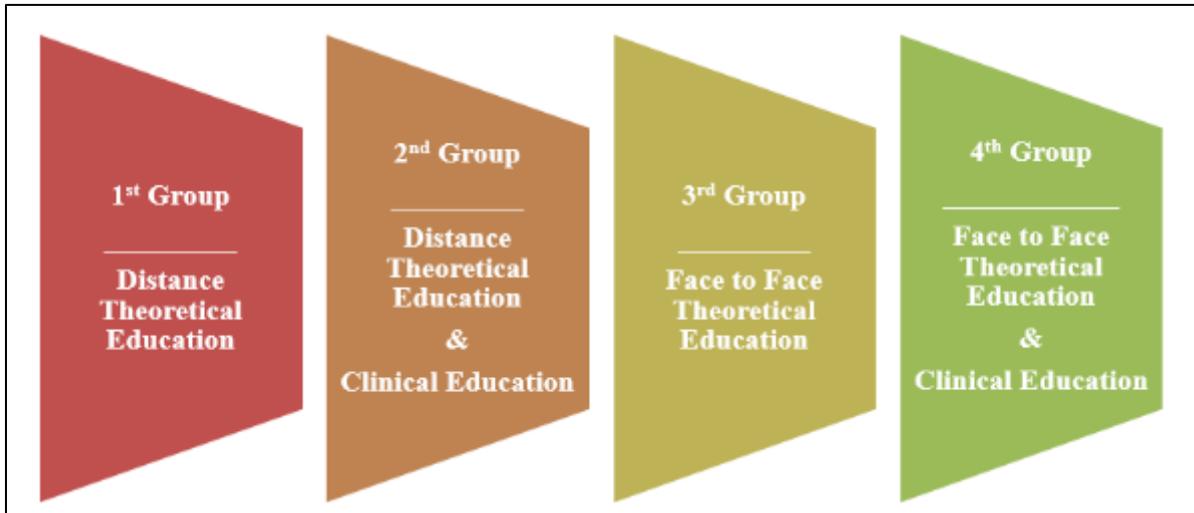


Figure 1 Defining student groups

2.1. Statistical Analysis

The study used IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA), to evaluate descriptive statistics. ANOVA was then used to assess the overall difference between training models, and the Bonferroni test was used to evaluate differences between groups according to questions. An independent t-test was applied at a 95% confidence interval to compare distance learning with face-to-face education models and theoretical education with theoretical + clinical education, creating two groups.

3. Results

Figure 2 shows the results of the student groups for the different questions.

The fourth group achieved the highest success rate, with an average of 6.00 correct answers to the first ten theory-based questions. The second, first and third groups achieved averages of 5.92, 5.90 and 5.90 respectively (Table 1). According to the results of the ANOVA test, there is no statistically significant difference between the groups ($p=0.988$) (Table 2).

In the second set of 10 case-based questions, Group 4 achieved the highest success rate again, with an average of 8.02 correct answers. Groups 2, 3 and 1 achieved averages of 6.52, 5.00 and 3.40 respectively (see Table 1). According to the results of the ANOVA test, there is a statistically significant difference between the groups ($p=0.000$) (Table 2).

When all 20 questions were evaluated, Group 4 performed the best with an average score of 14.02. Groups 2, 3 and 1 ranked with respective average scores of 12.44, 10.88 and 9.30 (see Table 1). According to the results of the ANOVA test, there is a statistically significant difference between the groups ($p=0.000$) (Table 2).

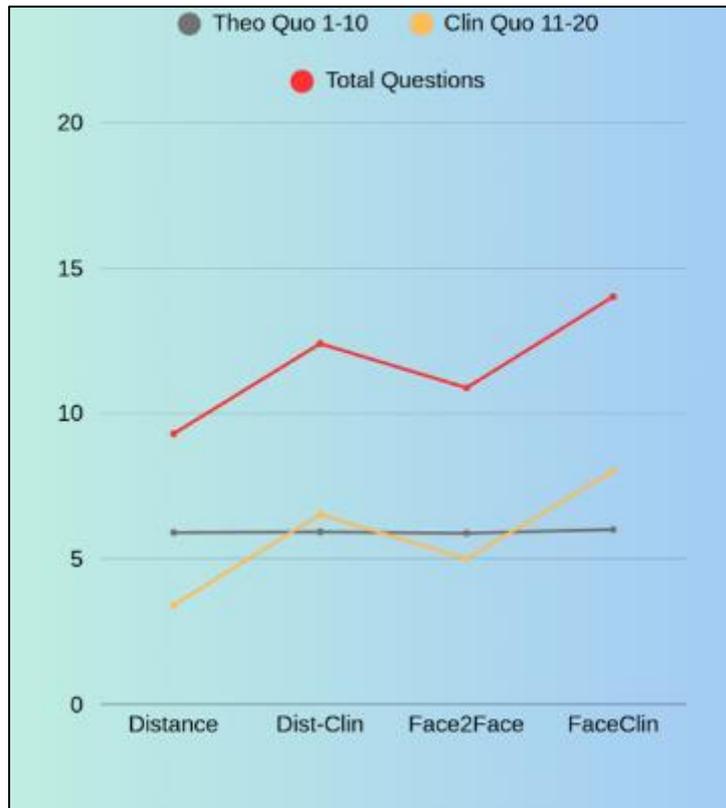


Figure 2 Graphical presentation of the answers of students with different educational background

Table 1 Average points of students with different background of radiological education

		N	Mean	Std. Deviation	Minimum	Maximum
1-10 Questions	1st Group	50	5.90	1.53	3.00	8.00
	2nd Group	50	5.92	2.17	2.00	9.00
	3rd Group	50	5.90	1.56	2.00	8.00
	4th Group	50	6.00	1.75	2.00	10.00
	Total	200	5.93	1.76	2.00	10.00
11-20 Questions	1st Group	50	3.40	1.21	2.00	5.00
	2nd Group	50	6.52	1.55	2.00	9.00
	3rd Group	50	5.00	2.14	1.00	10.00
	4th Group	50	8.02	1.52	2.00	10.00
	Total	200	5.74	2.37	1.00	10.00
Total Questions	1st Group	50	9.30	2.31	5.00	13.00
	2nd Group	50	12.44	2.96	6.00	17.00
	3rd Group	50	10.88	3.03	5.00	16.00
	4th Group	50	14.02	2.66	10.00	19.00
	Total	200	11.66	3.25	5.00	19.00

Table 2 ANOVA test results.

ANOVA						
		Sum of Squares	df	Mean Square	F	p Value*
1-10 Questions	Between Groups	0.415	3	0.138	0.044	0.988
	Within Groups	615.460	196	3.140		
	Total	615.875	199			
11-20 Questions	Between Groups	591.495	3	197.165	73.265	0.000*
	Within Groups	527.460	196	2.691		
	Total	1119.955	199			
Total Questions	Between Groups	617.800	3	205.933	27.142	0.000*
	Within Groups	1487.080	196	7.587		
	Total	2104.880	199			

*p<0.05 – Statistical significance

The Bonferroni test was used to evaluate the differences between the groups. While no significant differences were found in response to the first 10 questions, statistically significant differences of varying levels were found when all groups responded to the second 10 questions and all questions (Table 3).

To compare the effectiveness of face-to-face and distance learning, the results of Groups 3 and 4 were compared with those of Groups 1 and 2. To compare the effects of theoretical education alone with theoretical and clinical education combined, the results of Groups 1 and 3 were compared with those of Groups 2 and 4.

On average, students who received face-to-face education scored 5.94 on the first 10 questions and 6.51 on the second 10 questions, while those who received distance education scored 5.90 and 4.96 respectively. According to the independent t-test results, the differences in the first set of questions were not statistically significant (p = 0.904), whereas the differences in the second set of questions and across the full set of 20 questions were statistically significant (p = 0.000) (Table 4).

Students who received only theoretical training scored an average of 5.89 for the first 10 questions and 7.27 for the second 10 questions, while those who received both theoretical and clinical training scored an average of 5.94 for the first 10 questions and 4.20 for the second 10 questions. According to the results of the independent t-test, the differences in the first set of questions were not statistically significant (p = 0.779), whereas the differences in the second set of questions and in the total set of 20 questions were statistically significant (p = 0.000) (Table 5).

Table 3 Bonferroni test results inter-groups

Post-Hoc Tests		(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p Value*
1-10 Questions	Bonferroni	1st Group	2nd Group	-0.02	0.35	1.000
			3rd Group	0.02	0.35	1.000
			4th Group	-0.10	0.35	1.000
		2nd Group	1st Group	0.02	0.35	1.000
			3rd Group	0.04	0.35	1.000
			4th Group	-0.08	0.35	1.000
		3rd Group	1st Group	-0.02	0.35	1.000
			2nd Group	-0.04	0.35	1.000
			4th Group	-0.12	0.35	1.000

		4th Group	1st Group	0.10	0.35	1.000
			2nd Group	0.08	0.35	1.000
			3rd Group	0.12	0.35	1.000
11-20 Questions	Bonferroni	1st Group	2nd Group	-3.12*	0.33	0.000*
			3rd Group	-1.60*	0.33	0.000*
			4th Group	-4.62*	0.33	0.000*
		2nd Group	1st Group	3.12*	0.33	0.000*
			3rd Group	1.52*	0.33	0.000*
			4th Group	-1.50*	0.33	0.000*
		3rd Group	1st Group	1.60*	0.33	0.000*
			2nd Group	-1.52*	0.33	0.000*
			4th Group	-3.02*	0.33	0.000*
		4th Group	1st Group	4.62*	0.33	0.000*
			2nd Group	1.50*	0.33	0.000*
			3rd Group	3.02*	0.33	0.000*
Total Questions	Bonferroni	1st Group	2nd Group	-3.14*	0.55	0.000*
			3rd Group	-1.58*	0.55	0.027*
			4th Group	-4.72*	0.55	0.000*
		2nd Group	1st Group	3.14*	0.55	0.000*
			3rd Group	1.56*	0.55	0.031*
			4th Group	-1.58*	0.55	0.027*
		3rd Group	1st Group	1.58*	0.55	0.027*
			2nd Group	-1.56*	0.55	0.031*
			4th Group	-3.14*	0.55	0.000*
		4th Group	1st Group	4.72*	0.55	0.000*
			2nd Group	1.58*	0.55	0.027*
			3rd Group	3.14*	0.55	0.000*

*p<0.05 - Statistical significance

Table 4 Independent t test results between students with distance education and face to face education background

Face To Face vs Distance Learning						p Value*
	Group	N	Mean	Std. Dev.	Std. Error	
QuoTheo	3 & 4	100	5.94	1.65	0.17	0.904
	1 & 2	100	5.91	1.87	0.19	
QuoClin	3 & 4	100	6.51	2.39	0.24	0.001*
	1 & 2	100	4.96	2.09	0.21	
QuoTotal	3 & 4	100	12.45	3.25	0.32	0.001*
	1 & 2	100	10.87	3.08	0.31	

*p<0.05 - Statistical significance

Table 5 Independent t test results between students with only theoretical education and theoretical and clinical education background

Theoretical vs Theoretical + Clinical Education						p Value*
	Group	N	Mean	Std. Deviation	Std. Error Mean	
QuoTheo	2 & 4	100	5.96	1.96	0.20	0.779
	1 & 3	100	5.89	1.54	0.15	
QuoClin	2 & 4	100	7.27	1.70	0.17	0.000*
	1 & 3	100	4.20	1.91	0.19	
QuoTotal	2 & 4	100	13,23	2.91	0.29	0.000*
	1 & 3	100	10.09	2.79	0.28	

*p<0.05 – Statistical significance

4. Discussion

4.1. Discussion of the methodology

Distance education is a technology-dependent process that advances and updates in parallel with technological developments. Even when evaluating studies on distance education from the 2010s, it can be seen that the sharing of one-way materials or recordings is commonplace, and the applicability of synchronous distance education in universities is limited [21].

Various studies in the literature have investigated the importance of different methods used in medical and dental education, such as distance learning, face-to-face learning and theoretical and clinical education. However, studies specifically related to dental radiology education are relatively rare [12–14, 16, 17, 19].

Some studies in the literature have compared distance and face-to-face learning, focusing on student satisfaction as a key parameter. Students' responses are determined by their positive and negative experiences of these methods [22, 23].

In addition, studies that assess student performance provide more objective data [12, 24]. In the present study, the effectiveness of the methods was evaluated objectively by considering the performance of student groups who underwent different stages and teaching methods in terms of their success in answering questions that focused on theoretical and clinical knowledge.

4.2. Discussion of the results

The data pertaining to the study can be examined in terms of general findings related to pre-graduation education in OMFR, the effectiveness of face-to-face and distance education, and the evaluation of theoretical and theoretical plus clinical education effectiveness.

In the study, students were divided into four groups: those who received only distance theoretical education (Group 1), those who received distance theoretical education plus clinical education (Group 2), those who received only face-to-face theoretical education (Group 3), and those who received face-to-face theoretical education plus clinical education (Group 4). When evaluating the students' answers to theoretical and clinically weighted questions, Group 4 was the most successful group in terms of both theoretical and clinical weighting, followed by Groups 2, 3, and 1. Groups 1 and 3 achieved the same average score on the theory-focused questions, and while there was no statistically significant difference between the groups on the theory-focused questions, the difference in the clinical-focused questions and the overall results was found to be statistically significant.

The fact that the averages of the second group are generally higher than those of the third group highlights the importance of clinical training.

In paired group tests evaluating face-to-face and distance learning activities, face-to-face learning produced better results than distance learning in all theoretical and clinically focused questions. While the difference was statistically

insignificant in the theoretical questions, it was statistically significant in the clinically focused questions and the overall results.

Although lessons are conducted in a synchronous and interactive manner in the exact lecture time, experience has shown that students' contribution to lessons and their willingness to ask questions is lower in distance learning than in face-to-face education. This is also reflected in the findings of the present study.

To evaluate the effectiveness of clinical training, student groups who had only received theoretical dental radiology training were compared with those who had completed clinical training in addition to theoretical training, taking into account the students' educational stage. Of the paired groups, those who had received clinical training performed better on both theoretical and clinical focused questions, although this difference was higher for theory-focused questions than for face-to-face versus distance education comparisons. However, it was statistically significant for both types of questions.

Clinical training has been found to reinforce theoretical education, leading to more successful answers to both clinically- and theoretically focused questions.

5. Conclusion

Distance learning is an educational method that has gained prominence during the pandemic, with its various problems and solutions evolving, and becoming partially or completely permanent in many areas.

In the education of dentistry and OMFR, face-to-face learning has generally been found to be more effective than distance learning.

Nevertheless, the identical results between the groups that received only theoretical distance education or face-to-face theoretical education on theoretical questions demonstrates that distance learning should be used partially and as a supplement in dental and dental radiology education. This is especially true when considering the opportunity for students to interact with academics from outside the institution, city, or country who possess high levels of knowledge and experience in the field.

Dentistry and OMFR are clinical sciences with strong theoretical foundations. In education, it is essential to reinforce this theoretical knowledge in the clinic alongside the theoretical foundation.

Compliance with ethical standards

Disclosure of conflict of interest

The authors have nothing to disclose.

Statement of ethical approval

The study was approved by the Trakya University Faculty of Medicine Non-Interventional Ethics Committee (decision number 2021-087).

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

- [1] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. *New England Journal of Medicine*. 2020 Mar 26; 382(13):1199–1207.
- [2] Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *New England Journal of Medicine*. 2020 Feb 20;382(8):727–733.
- [3] Gorbalenya AE, Baker SC, Baric RS, de Groot RJ, Drosten C, Gulyaeva AA, et al. The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nature Microbiology*. *Nature Research*; 2020. p. 536–544.

- [4] Roy D, Tripathy S, Kar SK, Sharma N, Verma SK, Kaushal V. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian J Psychiatr.* 2020 Jun 1;51-55.
- [5] Naser AY, Dahmash EZ, Al-Rousan R, Alwafi H, Alrawashdeh HM, Ghoul I, et al. Mental health status of the general population, healthcare professionals, and university students during 2019 coronavirus disease outbreak in Jordan: A cross-sectional study. *Brain Behav.* 2020 Aug 1;10(8).
- [6] Deb P, Furceri D, Ostry JD, Tawk N. The Economic Effects of COVID-19 Containment Measures. *Open Economies Review.* 2022 Feb 1;33(1).
- [7] Iyer P, Aziz K, Ojcius DM. Impact of COVID-19 on dental education in the United States. *J Dent Educ.* 2020 Jun 27;84(6):718–722.
- [8] Toprak ME, Tunç SK. COVID-19 pandemic and emergency remote education practices: Effects on dentistry students. *Niger J Clin Pract.* 2022 May 1;25(5):621–629.
- [9] Liu J, Zhu Q, Fan W, Makamure J, Zheng C, Wang J. Online Mental Health Survey in a Medical College in China During the COVID-19 Outbreak. *Front Psychiatry.* 2020 May 13;11.
- [10] Keegan D. The future of learning: From eLearning to mLearning OTHER MATERIALS COURSE CONTENT 2025 [Cited 2025 October 23] Available from: <http://www.fernuni-hagen.de/ZIFF/mlearn.htm>
- [11] Valentine, D. Distance Learning: Promises, Problems, and Possibilities. *Online Journal of Distance Learning Administration,* 2002 Nov; 5(3).
- [12] Soltanimehr E, Bahrapour E, Imani MM, Rahimi F, Almasi B, Moattari M. Effect of virtual versus traditional education on theoretical knowledge and reporting skills of dental students in radiographic interpretation of bony lesions of the jaw. *BMC Med Educ.* 2019 Jun 25;19(1).
- [13] Varghese SS, Ramesh A, Veeraiyan DN. Blended Module-Based Teaching in Biostatistics and Research Methodology: A Retrospective Study with Postgraduate Dental Students. *J Dent Educ.* 2019 Apr;83(4):445–450.
- [14] Kerecsen L, Pazdernik T. From mainframe to Web-based: 30 years of experience in computer-aided instruction of pharmacology. *Naunyn Schmiedebergs Arch Pharmacol.* 2002 Jul 1;366(1):83–89.
- [15] Hendricson WD, Panagakos F, Eisenberg E, McDonald J, Guest G, Jones P, et al. Electronic curriculum implementation at North American dental schools. *J Dent Educ.* 2004 Oct;68(10):1041–57.
- [16] Hendricson W, Eisenberg E, Guest G, Jones P, Johnson L, Panagakos F, et al. What do dental students think about mandatory laptop programs? *J Dent Educ.* 2006 May;70(5):480–99.
- [17] Meckfessel S, Stühmer C, Bormann KH, Kupka T, Behrends M, Matthies H, et al. Introduction of e-learning in dental radiology reveals significantly improved results in final examination. *Journal of Cranio-Maxillofacial Surgery.* 2011 Jan;39(1):40–8.
- [18] Browne L, Mehra S, Rattan R, Thomas G. Comparing lecture and e-learning as pedagogies for new and experienced professionals in dentistry. *Br Dent J.* 2004 Jul 24;197(2):95–7.
- [19] Cobb SC. Internet continuing education for health care professionals: An integrative review. *Journal of Continuing Education in the Health Professions.* 2004;24(3):171–80.
- [20] IADMFR Education Standards Committee Undergraduate dental education in dental and maxillofacial radiology. *Dentomaxillofacial Radiology.* 2007 Dec;36(8):443–50.
- [21] Özbay Ö. Dünyada ve Türkiye’de Uzaktan Eğitimin Güncel Durumu (The Current Status of Distance Education In The World And Turkey). *The Journal of International Educational Sciences.* (2015) 2. 376-394. 10.16991/INESJOURNAL.174.
- [22] Sarialioglu Gungor A, Sesen Uslu Y, Donmez N. Perceptions of dental students towards online education during the COVID-19 pandemic. *Eur Oral Res* 2021; 55(3): 124-132.
- [23] Kaysi F, Aydemir E. Assessment of interaction dimensions in distance education processes. *The Journal of Social Science /* 2017,11, 778-790.
- [24] Dervisbegovic, S., Laky, M., Tur, D. et al. Educational videos as a teaching approach to enhance dental students’ practical skills in preclinical courses. *BMC Med Educ* 2025 Oct; 25,1299. <https://doi.org/10.1186/s12909-025-07807-2>.