

Students' perspective of the teaching-learning process of oral radiology before and during the COVID-19 pandemic

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ABSTRACT

The SARS-Cov-2 (COVID-19) pandemic changed the educational structure of dentistry courses and highlighted the importance of online tools. Understanding students' perception regarding these changes is essential to establishing future teaching-learning strategies to accommodate students' needs in higher education. The aim of this study was to assess students' perceptions of the Oral Radiology teaching-learning process before and during the COVID-19 pandemic. The sample consisted of students ($n = 111$) of the 2nd, 4th and 6th semesters of the dentistry course, who answered a questionnaire with 21 items: A) Students' demographic data (5 questions); B) Students' teaching-learning experiences during the pre-pandemic period (8 questions); and C) Students' teaching-learning experiences during the post-pandemic period (8 questions). Stuart-Maxwell tests revealed statistically significant differences between students' opinions before and during the pandemic when they were asked about the structure of the Oral Radiology module ($p = 0.008$); their previous experience with e-learning and teaching ($p < 0.001$); their thoughts about the importance of e-learning in Oral Radiology ($p < 0.05$); and the time they spent online for academic purposes ($p < 0.05$). Students seem to prefer on-campus activities (before COVID-19), but the pandemic increased their awareness of the importance of e-learning, the time they spent on online studies, and their knowledge of online educational tools.

Keywords: COVID-19 - dentistry - education - radiology - students.

Perspectiva dos alunos sobre o processo de ensino-aprendizagem em radiologia odontológica antes e durante a pandemia de COVID-19

RESUMO

A pandemia de SARS-Cov-2 (COVID-19) mudou a estrutura educacional dos cursos de odontologia e destacou a importância das ferramentas online. Compreender a percepção dos alunos sobre as mudanças vivenciadas é essencial para estabelecer futuras estratégias de ensino-aprendizagem e acomodar as necessidades dos alunos no ensino superior. Este estudo teve como objetivo avaliar a percepção dos alunos sobre o processo de ensino-aprendizagem de Radiologia Odontológica antes e durante a pandemia de COVID-19. A amostra foi composta por alunos ($n = 111$) do 2^o, 4^o e 6^o semestres do curso de odontologia que responderam a um questionário com 21 itens: A) Dados demográficos dos alunos (5 questões); B) Experiências de ensino-aprendizagem dos alunos no período pré-pandemia (8 questões); e C) Experiências de ensino-aprendizagem dos alunos no período pós-pandemia (8 questões). Os testes de Stuart-Maxwell revelaram diferenças estatisticamente significativas entre as opiniões dos alunos antes e durante as pandemias quando questionados sobre a estrutura do módulo de Radiologia Odontológica ($p = 0,008$); sua experiência anterior com ensino a distância ($p < 0,001$); seus pensamentos relacionados à importância da Radiologia Odontológica via e-learning ($p < 0,05$); e o tempo gasto online para fins acadêmicos ($p < 0,05$). Os alunos parecem preferir atividades no campus (antes do COVID-19), mas as pandemias aumentaram sua conscientização sobre a importância do e-learning, seu tempo dedicado aos estudos online e sua familiarização com ferramentas educacionais online.

Palavras-chave: COVID-19 - odontologia - educação - radiologia - alunos.

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INTRODUCTION

Two years have passed since the onset of widespread infection by SARS-Cov-2 (COVID-19) worldwide¹. In most countries, the teaching-learning process switched from a face-to-face relationship to a mainly virtual environment². While some authors report general acceptance of online-based dental education², others report higher rates of dissatisfied students³. Given the practical nature of dental education, authors suggest the need for continuous research of students' perceptions regarding the current transitions in the teaching-learning process during COVID-19 times⁴. To achieve a more comprehensive perspective of students' perception, however, research should be country-specific, especially because of the global differences in the curricula and educational approaches. In 2021, a study across 34 European countries highlighted dental students' concerns regarding clinical experience and the skills needed to become dentists³. In the same year, a study on 779 Brazilian dentistry undergraduates corroborated students' dissatisfaction with the transition between traditional education and e-learning⁵.

The situation of Brazilian dental education in COVID-19 times is particularly relevant because in 2020, the country was ranked second amongst the countries with the highest numbers of confirmed cases⁶. Moreover, Brazil has nearly 370,000 dentists⁷ (estimated as 17% of the dentists in the world) and at least 374 dental schools offering 47,192 admission places⁸ for students. The effects of COVID-19 on the educational process of Brazilian undergraduate dentistry students could eventually lead to potential harm of great magnitude given the number of professionals entering the market every year.

In specific fields of dentistry, computer-based classes are essential. Such is the case of Oral Radiology – a field that requires constant updates and training with state-of-the-art technology. Hence, students of Oral Radiology may accept transitions to e-learning more easily. A systematic literature review⁹ found out that e-learning strategies used in the teaching-learning process of Oral Radiology seem to be as effective as other traditional approaches, such as lecture-based learning. Strategies used to bring online dentistry lessons closer to reality include case-based learning, problem-based learning, and research-based learning^{2,10}. For image interpretation (an essential component of Oral Radiology), the available online

tools could enable proper teaching and even enhance students' interaction with image analysis. On the other hand, practical training in radiographic techniques for image acquisition could be negatively impacted after the switch to the online environment¹¹. In these cases, demonstrative instructions followed by laboratory practice with a restricted number of students (per group), and the use of facilities dedicated to oral radiology, including phantom heads, would be beneficial when teaching returns to being part online and part face-to-face¹². Striving for the best conditions for students' educational development, however, depends on the available pedagogical solutions. Understanding the perspective of undergraduate dentistry students regarding the ever-changing educational scenarios experienced during the COVID-19 pandemics is fundamental to establishing more effective strategies for the teaching-learning interface in Oral Radiology. The aim of this study was to assess the perspective of students regarding the teaching-learning process of Oral Radiology before and during the pandemic.

MATERIAL AND METHODS

Study design and ethical aspects

This was an observational, survey-based, cross-sectional study with prospective data collection. It was approved by the Institutional Committee of Ethics in Research (protocol 42072720.9.0000.5374). The Declaration of Helsinki (DoH) 2013 was followed to ensure ethical standards in this medical research. EQUATOR (Enhancing the Quality and Transparency of Health Research) guidelines were followed and the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist¹³ for cross-sectional studies was used.

Sample and participants

The sample consisted of undergraduate dentistry students from a private institution in the southeast region of Brazil. The inclusion criteria for sample selection consisted of male and female students enrolled in the undergraduate course who had successfully concluded at least one semester of the discipline of Oral Radiology during the COVID-19 pandemic, age above 18 years. The exclusion criteria were students transferred from other institutions during the COVID-19 pandemic; students with a gap in their studies during the pandemic; and students

who failed the Oral Radiology course because of insufficient attendance rate.

Sample size calculation considered the total population of students ($n = 171$) enrolled at the undergraduate level (especially because the structure of the Oral Radiology discipline in the selected private institution is divided into the 1st, 2nd and 3rd semesters), with 95% confidence level and 5.53% confidence interval. Hence, the target sample size for the present study was estimated as 111 students.

Variables and measures

A self-administered questionnaire was tailored for the present survey. Following the scientific literature, the questionnaire was designed as closely as possible to the recommendations established for survey research¹⁴. The questionnaire consisted of 21 questions divided into three groups: A) General information about the students' demographic data (5 questions); B) Specific questions related to the students' teaching-learning experiences in the pre-pandemic period (8 questions); and C) Specific questions related to the students' teaching-learning experiences in the post-pandemic period (8 questions). Question structure was dichotomous (the question about whether they had had contact with e-learning tools before the pandemic) or multiple-choice (students should select a single answer). Questions in sections B and C were mirrored for the period pre- and trans-pandemic. This approach enabled the questions to be answered by the same students – so they could report on experiences regarding the Oral Radiology teaching-learning process at two different times (before/pre and during/trans pandemic) – creating a dependent association between answers (dependent variables between sections B and C) (Table 1). Because institutional activities were returning to face-to-face during the pandemic period, the questionnaire was provided on-campus and separately to students of the second, fourth, and sixth semesters of the undergraduate course. The main researcher supervised the application of the questionnaire in class. All the students were adults (age >18 years old) and expressed their consent to participate in the study within a signed informed consent applied before the questionnaire.

Data synthesis and analysis

Data were explored by means of descriptive statistics within absolute (n) and relative (%) frequencies. The

descriptive approach was specifically pertinent to questions inherent to section A (General information about the participant demographic data). For the subsequent sections, comparisons between answers were performed between dependent groups of students. This means that students in the 4th and 6th semesters answered questions about their experiences with the teaching-learning process in Oral Radiology before and during the pandemic, while students in the 2nd semester only answered questions related to their experiences during the pandemic. In order to compare the experiences before and during the pandemic within each group of students (per semester), marginal homogeneity tests were applied (Stuart-Maxwell test). Statistical significance was set at 5% with a confidence interval of 95%.

RESULTS

General information about the students' demographic data (Questionnaire section A) showed that the questionnaire was answered by 31 (27.92%) male and 80 (72.08%) female students. Forty students (14 males and 26 females) were in the 2nd semester, while 42 (11 males and 31 females) and 29 (6 males and 23 females) were in the 4th and 6th semesters, respectively. Most of the students were 18 to 20 years old (75.67%), followed by students aged 21 to 24 years (21.62%), or over 25 years (2.71%). Most students did not know their internet speed at home (41.44%). Of the students that did know, most (25.22%) reported a speed between 110 and 150 Mb/s. Regarding the devices used to access e-learning content, notebooks (58.55%) and smartphones (27.02%) were the most prevalent. Desktops were only reported by students in older age categories (Table 2).

When asked about the quality of Oral Radiology teaching, most students of both the 4th and 6th semesters rated it as moderate or good before and during the pandemic. When students were asked about their performance in the Oral Radiology module, they tended to rate it as moderate or good. Particularly for students in the 6th semester, there was a predominance of "good" ratings (>41%) both before and during the pandemic. Students in the 4th semester considered the structure of the Oral Radiology module to be good before the pandemic, but moderate during the pandemic. Most students in the 6th semester rated the module structure as moderate at both times, and students that rated the module as good and very good (>24%) maintained their opinion. Nearly 80% of the

Table 1. Self-administered questionnaire provided to undergraduate students in the 2nd, 4th, and 6th semesters of the dentistry course, regarding their perspective of the Oral Radiology teaching-learning process before and after the COVID-19 pandemic.

A) Student's general information and demographic data		
A.1) What is your registered sex?	<input type="checkbox"/> Male <input type="checkbox"/> Female	<input type="checkbox"/> Other <input type="checkbox"/> Prefer not to say
B.2) How old are you?	<input type="checkbox"/> 18-20 <input type="checkbox"/> 21-24	<input type="checkbox"/> 25-30 <input type="checkbox"/> >30
B.3) In what academic year are you enrolled?	<input type="checkbox"/> 1 st <input type="checkbox"/> 2 nd	<input type="checkbox"/> 3 rd <input type="checkbox"/> 4 th
B.4) What is your internet speed at home?	<input type="checkbox"/> 10-50Mb <input type="checkbox"/> 60-100Mb	<input type="checkbox"/> 110-150Mb <input type="checkbox"/> >150Mb
B.5) What is your main device for e-learning?	<input type="checkbox"/> Desktop computer <input type="checkbox"/> Notebook	<input type="checkbox"/> Smartphone <input type="checkbox"/> Tablet
B) Students' teaching-learning experiences during the pre-pandemic period		
B.1) How do you rate the quality of Oral Radiology teaching before the pandemic?	<input type="checkbox"/> Very bad <input type="checkbox"/> Bad <input type="checkbox"/> Moderate <input type="checkbox"/> Good <input type="checkbox"/> Very good	
B.2) How do you rate your performance in Oral Radiology before the pandemic?	<input type="checkbox"/> Very bad <input type="checkbox"/> Bad <input type="checkbox"/> Moderate <input type="checkbox"/> Good <input type="checkbox"/> Very good	
B.3) How do you rate the structure of the Oral Radiology module before the pandemic?	<input type="checkbox"/> Very bad <input type="checkbox"/> Bad <input type="checkbox"/> Moderate <input type="checkbox"/> Good <input type="checkbox"/> Very good	
B.4) Had you experienced e-learning teaching before the pandemic?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
B.5) What were your thoughts related to Oral Radiology via e-learning before the pandemic?	<input type="checkbox"/> Not important <input type="checkbox"/> Of little importance <input type="checkbox"/> Moderate <input type="checkbox"/> Important <input type="checkbox"/> Very important	
B.6) How much time a day did you use to spend on the computer for non-academic purposes?	<input type="checkbox"/> <1h <input type="checkbox"/> 1-3h <input type="checkbox"/> 4-6h <input type="checkbox"/> 7-10h <input type="checkbox"/> >10h	
B.7) How much time a day did you use to spend on the computer for academic purposes?	<input type="checkbox"/> <1h <input type="checkbox"/> 1-3h <input type="checkbox"/> 4-6h <input type="checkbox"/> 7-10h <input type="checkbox"/> >10h	
B.8) How do you rate the assessment system of the Oral Radiology module before the pandemic?	<input type="checkbox"/> Inefficient <input type="checkbox"/> Of little efficiency <input type="checkbox"/> Moderate <input type="checkbox"/> Efficient <input type="checkbox"/> Very efficient	
C) Students' teaching-learning experiences during the trans-pandemic period		
C.1) How do you rate the quality of Oral Radiology teaching before the pandemic?	<input type="checkbox"/> Very bad <input type="checkbox"/> Bad <input type="checkbox"/> Moderate <input type="checkbox"/> Good <input type="checkbox"/> Very good	
C.2) How do you rate your performance in Oral Radiology before the pandemic?	<input type="checkbox"/> Very bad <input type="checkbox"/> Bad <input type="checkbox"/> Moderate <input type="checkbox"/> Good <input type="checkbox"/> Very good	
C.3) How do you rate the structure of the Oral Radiology module before the pandemic?	<input type="checkbox"/> Very bad <input type="checkbox"/> Bad <input type="checkbox"/> Moderate <input type="checkbox"/> Good <input type="checkbox"/> Very good	
C.4) Had you experienced e-learning teaching before the pandemic?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
C.5) What were your thoughts related to Oral Radiology via e-learning before the pandemic?	<input type="checkbox"/> Not important <input type="checkbox"/> Of little importance <input type="checkbox"/> Moderate <input type="checkbox"/> Important <input type="checkbox"/> Very important	
C.6) How much time a day did you use to spend on the computer for non-academic purposes?	<input type="checkbox"/> <1h <input type="checkbox"/> 1-3h <input type="checkbox"/> 4-6h <input type="checkbox"/> 7-10h <input type="checkbox"/> >10h	
C.7) How much time a day did you use to spend on the computer for academic purposes?	<input type="checkbox"/> <1h <input type="checkbox"/> 1-3h <input type="checkbox"/> 4-6h <input type="checkbox"/> 7-10h <input type="checkbox"/> >10h	
C.8) How do you rate the assessment system of the Oral Radiology module before the pandemic?	<input type="checkbox"/> Inefficient <input type="checkbox"/> Of little efficiency <input type="checkbox"/> Moderate <input type="checkbox"/> Efficient <input type="checkbox"/> Very efficient	

students in the 4th and 6th semesters had not had any contact with e-learning tools before the pandemic, becoming more familiar with them during the pandemic (Table 3).

Table 2. Descriptive assessment of the general information about the students' demographic data (questionnaire section A)

Students' personal data	2 nd semester		4 th semester		6 th semester	
	N	%	N	%	N	%
Age (years)						
18-20	37	93%	34	81%	13	45%
21-24	3	8%	7	17%	14	48%
25-30	0	0%	0	0%	1	3%
>30	0	0%	1	2%	1	3%
Internet speed (Mb/s)						
10-50	1	3%	0	0%	0	0%
60-100	7	18%	3	7%	4	14%
110-150	11	28%	12	29%	5	17%
>150	9	23%	6	15%	6	21%
I do not know	12	30%	20	49%	14	48%
Device for e-learning						
Desktop	-	-	3	7%	1	3%
Notebook	18	46%	24	57%	23	79%
Smartphone	13	33%	13	31%	4	14%
Tablet	8	21%	2	5%	1	3%

N: absolute frequency; %: relative frequency; Mb/s: megabytes per second.

Table 3. Students' responses related to their experiences with the Oral Radiology teaching-learning process before and during COVID-19 pandemic (Part 1)

Teaching-learning process components	4 th semester				6 th semester			
	Before pandemic		During pandemic		Before pandemic		During pandemic	
	N	%	N	%	N	%	N	%
How do you rate the quality of Oral Radiology teaching?								
Very bad	1	2.4%	1	2.4%	0	0.0%	0	0.0%
Bad	4	9.5%	3	7.1%	1	3.4%	6	20.7%
Moderate	8	19.0%	18	42.9%	12	41.4%	10	34.5%
Good	21	50.0%	17	40.5%	12	41.4%	11	37.9%
Very good	8	19.0%	3	7.1%	4	13.8%	2	6.9%
How do you rate your performance in Oral Radiology?								
Very bad	0	0.0%	1	2.4%	0	0.0%	1	3.4%
Bad	4	9.5%	5	11.9%	2	6.9%	4	13.8%
Moderate	12	28.6%	17	40.5%	8	27.6%	9	31.0%
Good	23	54.8%	15	35.7%	14	48.3%	12	41.4%
Very good	3	7.1%	4	9.5%	5	17.2%	3	10.3%
How do you rate the structure of the Oral Radiology module?								
Very bad	1	2.4%	1	2.4%	4	13.8%	2	6.9%
Bad	3	7.1%	4	9.5%	7	24.1%	6	20.7%
Moderate	6	14.3%	18	42.9%	10	34.5%	13	44.8%
Good	28	66.7%	16	38.1%	7	24.1%	7	24.1%
Very good	4	9.5%	3	7.1%	1	3.4%	1	3.4%
Had you ever experienced e-learning?								
No	34	81.0%	3	7.1%	23	79.3%	0	0.0%
Yes	8	19.0%	39	92.9%	6	20.7%	29	100.0%

N: absolute frequency; %: relative frequency.

When asked about their opinion of e-learning for Oral Radiology, most students in the 4th and 6th semesters changed their opinion from moderate importance (before the pandemic) to important (during the pandemic), with a threefold increase in the importance of the module detected in both groups. The amount of time that students spent online for non-academic reasons remained the same before and during the pandemic. Most students (60-70%) reported a non-academic online time of 1-6 hours/day. In contrast, the time spent online for academic reasons was initially longer than for non-academic reasons, and increased during the pandemic. Among 4th semester students, those reporting online time from 7 to 10 hours doubled. Among students in the

6th semester, the number of students spending 7-10 hours online for academic reasons increased almost 5 times. Students' opinions regarding the assessment system of the module remained unchanged before and during the pandemic (Table 4).

Stuart-Maxwell tests revealed statistically significant differences between students' opinions before and during the pandemic when they were asked about the structure of the Oral Radiology module ($p = 0.008$, statistically significant for the students in the 4th semester only); their previous experience with e-learning ($p < 0.001$ for both groups of students); their thoughts related to the importance of online learning for Oral Radiology ($p < 0.001$ and $p = 0.03$ for students in the 4th and 6th semesters, respectively);

Table 4. Students' responses related to their experiences with the Oral Radiology teaching-learning process before and during COVID-19 pandemic (Part 2)

Teaching-learning process components	4th semester				6th semester			
	Before pandemics		During pandemics		Before pandemics		During pandemics	
	N	%	N	%	N	%	N	%
What are your thoughts related to e-learning for Oral Radiology?								
Not important	5	11.9%	1	2.4%	3	10.3%	0	-
Of little importance	5	11.9%	4	9.5%	4	13.8%	1	3.4%
Moderate	20	47.6%	4	9.5%	14	48.3%	4	13.8%
Important	9	21.4%	27	64.3%	6	20.7%	17	58.6%
Very important	3	7.1%	6	14.3%	2	6.9%	7	24.1%
How much time a day did you use to spend on the computer for non-academic purposes?								
< 1 hours	6	14.3%	7	16.7%	9	31.0%	5	17.2%
1-3 hours	20	47.6%	14	33.3%	8	27.6%	9	31.0%
4-6 hours	12	28.6%	15	35.7%	11	37.9%	11	37.9%
7-10 hours	2	4.8%	5	11.9%	1	3.4%	4	13.8%
> 10 hours	2	4.8%	1	2.4%	0	0.0%	0	0.0%
How much time a day did you use to spend on the computer for academic purposes?								
< 1 hours	9	21.4%	1	2.4%	11	37.9%	2	6.9%
1-3 hours	17	40.5%	12	28.6%	6	20.7%	3	10.3%
4-6 hours	9	21.4%	15	35.7%	9	31.0%	10	34.5%
7-10 hours	6	14.3%	13	31.0%	3	10.3%	13	44.8%
> 10 hours	1	2.4%	1	2.4%	0	0.0%	1	3.4%
How do you rate the assessment system of the Oral Radiology module?								
Inefficient	1	2.4%	3	7.1%	1	3.4%	2	6.9%
Of little efficiency	14	33.3%	16	38.1%	3	10.3%	6	20.7%
Moderate	24	57.1%	22	52.4%	17	58.6%	17	58.6%
Good	3	7.1%	1	2.4%	8	27.6%	3	10.3%
Very good	0	0.0%	0	0.0%	0	0.0%	1	3.4%

N: absolute frequency; %: relative frequency.

Table 5. Comparison of students' responses related to their experiences with the Oral Radiology teaching-learning process before and during the COVID-19 pandemic

Comparison of pre- and trans-pandemic perspectives	4th semester		6th semester	
	Before pandemic	During pandemic	Before pandemic	During pandemic
How do you rate the quality of Oral Radiology teaching?				
Difference (<i>p</i>)		0.053		0.257
How do you rate your performance in Oral Radiology?				
Difference (<i>p</i>)		0.213		0.505
How do you rate the structure of the Oral Radiology module?				
Difference (<i>p</i>)		0.008		0.832
Had you ever experienced e-learning?				
Difference (<i>p</i>)		<0.001		<0.001
What are your thoughts related to Oral Radiology via e-learning?				
Difference (<i>p</i>)		<0.001		0.003
How much time a day did you use to spend on the computer for non-academic purposes?				
Difference (<i>p</i>)		0.188		0.185
How much time a day did you use to spend on the computer for academic purposes?				
Difference (<i>p</i>)		0.015		0.002
How do you rate the assessment system of the Oral Radiology module?				
Difference (<i>p</i>)		0.235		0.215

Stuart-Maxwell test (significance set at 0.05).

and the time they spent online for academic purposes ($p = 0.015$ and $p = 0.002$ for students in the 4th and 6th semesters, respectively) (Table 5).

DISCUSSION

Research on students' perception of learning experiences serves as a quality control measure to understand the effects of the teaching process in practice. COVID-19 changed the way lectures were given, creating the need for immersion in the online environment. The concern of educational institutions regarding the quality of learning-teaching experiences increased worldwide, especially because the measures adopted as teaching solutions to pandemics were understood as temporary¹⁵. Hence, it is the objective of scientific studies to investigate and possibly predict whether the online solutions will continue to be used in the long term, in a post-pandemic future. The present study assessed the perception of undergraduate students regarding the experience with the Oral Radiology teaching-learning process before and during the pandemic.

The preliminary outcomes of this study show that most students use notebooks during the online lectures, while others use tablets or smartphones. These (recent) technologies are compatible with the age of the sample (over 75% of the students were 18 to 20 years old). Older students reported the use of desktop personal computers. Recent studies mention all these technologies as being useful during online activities¹⁶. More importantly, the student must be able to interact with the lecturer and the instructor using audio and video tools. From desktop personal computers to tablets, the equipment reported by the students enables access to the available technology to participate in online activities. As ¼ of the students had internet speed at home of 110-150 Mb/s, and almost 41% had access to internet even though they did not know their internet speed, it can be estimated that home facilities for online learning were available. Thus, it is necessary to enquire into students' perceptions of the teaching component. Most of the ratings of the Oral Radiology teaching quality were moderate to good. The main difference was observed between students of the 4th and 6th

semesters. In the former, ratings were predominantly good before the pandemic and became moderate during it. In the latter, over 40% of the students rated the quality as good both before and during the pandemic. These differences may be explained by the previous academic experiences of senior students (6th semester) compared to students in earlier stages of the dentistry course. The senior students had already experienced practical activities on-campus when the pandemic began. In contrast, the 4th semester students were just beginning their clinical practice when they had to move to an online environment. This change may have interfered with the plans they had when they initially enrolled in the dentistry course. However, the educational structure worldwide is currently progressively moving back to “normal” and (following this rationale) students’ perception of Oral Radiology teaching may become more positive over time. Some authors¹⁵ report that students’ perception of the effectiveness of face-to-face classes can influence their desire to return (or not) to on-campus activities. Consequently, if pre-pandemic ratings of students of the 4th semester were predominantly “good”, a decrease to “moderate” is to be expected because the students certainly wish to return to on-campus activities. Secondly, these outcomes corroborate the quality of traditional (face-to-face) teaching of Oral Radiology at the institution considered for this study.

Despite the students’ interest in face-to-face activities interpreted between the lines of our outcomes, they seem to understand the importance of online teaching of Oral Radiology during the dentistry course. Their perception of the importance of online teaching increased up to three times during the pandemic ($p < 0.05$). The rationale behind this phenomenon may be explained in two ways: I) students’ own perception of the content of the module (which is relevant to supporting their studies during the dentistry course); and II) students’ desire to continue their studies without a gap in time during the pandemic (hence, online tools are important to enable continuous academic training). It must be noted that online teaching of Oral Radiology is not only important because of the pandemic period. In 2012, some authors¹⁷ demonstrated the significant role of blended teaching strategies as effective tools compared to traditional face-to-face (only) strategies. Blended teaching may figure as a strong approach in the post-pandemic period, especially because it can combine

the advantages of online and face-to-face activities (e.g., online theory and face-to-face practice). The literature¹⁸ advocates the possibility of fully implementing radiological content via e-learning methods and corroborates, once more, the importance of online teaching as part of an integrated training process in dentistry. More recently, a systematic literature review¹⁹ indicated that most studies on the use of e-learning in undergraduate dental radiology curricula may lead to an enhancement of the learning process. However, case-specific strategies must be designed considering the facilities available at the higher education institutions.

The reduced clinical experience emerging from the transition from the face-to-face to online structures is of major concern to Oral Radiology. Some authors²⁰ have suggested a broad variety of digital resources for teaching, such as Zoom, Blackboard, and Google applications. Others²¹ have suggested the implementation of online journal clubs and case discussions to trigger student engagement. The current technology available to students and instructors provides a scenario which is very different from the past²², in which professionals were not fully familiar with digital resources, and the access to online solutions in radiology was scarcer. The present study shows that students’ perception of the Oral Radiology teaching-learning process may change before and during the COVID-19 pandemic. Lessons learned during this period should be considered prior to strategic planning and preparation for the upcoming post-pandemic educational system – in which on-campus activities are returning.

Future research should be designed to assess student perception after the full return to face-to-face activities, and to understand potential changes in curricula as a result of the COVID-19 pandemic. Additionally, prospective research planning should take into account students’ individual needs regarding their professional skills developed (or underdeveloped) during the dentistry course, which might lead to an increase in specialized postgraduate training²³. Finally, sampling individuals from other semesters and additional higher education institutions (private and public) could improve the overview of students’ perceptions and lead to a more comprehensive strategy for managing the Oral Radiology teaching-learning process in challenging situations such as pandemics.

In conclusion, students’ perceptions of the Oral Radiology teaching-learning process during the

COVID-19 pandemic changed from the pre-pandemic to trans-pandemic periods. In general, students of the 2nd, 4th and 6th semesters had a predominantly positive perception of the Oral Radiology teaching-

learning process. The COVID-19 pandemic led to stronger student interaction with e-learning tools and increased students' perception of the importance of online education in times of social distancing.

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DECLARATION OF CONFLICTING INTERESTS

The authors declare no potential conflicts of interest regarding the research, authorship, and/or publication of this article

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