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ORIGINAL ARTICLE

PERCEPTION OF STUDENTS AND TEACHERS ON THE USE OF SIMULATION IN IMAGING

Percepción de estudiantes y docentes en el uso de simulación en imagenología

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ABSTRACT

Introduction: Simulation is used to teach and practice radiographic image acquisition through the use of an ideal model or phantom that reproduces the ideal intraoral characteristics of a patient. It utilizes real X-ray equipment, allowing for standardized and repeatable practice. This study aims to understand the perception of learning periapical radiographic image acquisition with a phantom among teachers and students who took imaging courses between 2020 and 2022 at the Universidad Andrés Bello, Viña del Mar campus, Chile.

Material and Methods: An observational, descriptive, quantitative study with a convenience sample of 201 students and 3 teachers. The Barsuk questionnaire was applied to measure learning perception, with 7 questions rated on a 5-point Likert scale, plus a dichotomous question leading to an open-ended question. Data were analyzed with SPSS statistical software, and measures of central tendency, Chi-square, and Z-test ($p<0.05$) were observed.

Results: Students had a positive perception ($p<0.05$) regarding useful feedback, the mandatory nature of the phantom practice, and that this experience improves their preparation. The realism of the phantom obtained the lowest mean (2= Disagree). Teachers expressed a positive perception (median= 5) in all statements except for the realism of the phantom (median= 2).

Conclusions: Both students and teachers perceive the use of phantoms for radiographic image acquisition practice positively; therefore, its use is suggested for teaching imaging in dentistry.

Keywords: *Simulation Training; Dental Models; Radiography, Dental education; Students, dental; Perception.*

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RESUMEN

Introducción: La simulación es utilizada para enseñar y practicar la toma radiográfica mediante el uso de un modelo ideal o fantoma que reproduce las características intraorales ideales de un paciente. Utiliza un equipo de rayos X real, posibilitando que el ejercicio sea estandarizado y repetible. Este estudio tiene como objetivo conocer la percepción del aprendizaje de la toma radiográfica periapical con fantoma en docentes y estudiantes que cursaron imagenología entre los años 2020-2022, en la Universidad Andrés Bello sede Viña del Mar, Chile.

Material y métodos: Estudio observacional, descriptivo, cuantitativo con una muestra por conveniencia de 201 estudiantes y 3 docentes. Se aplicó el cuestionario de Barsuk para medir la percepción del aprendizaje, con 7 preguntas valoradas con la escala Likert de 5 puntos, más una pregunta dicotómica que llevaba a una pregunta abierta. Los datos se analizaron con el software estadístico SPSS y se observó medidas de tendencia central, Chi cuadrado y prueba Z (p<0.05).

Resultados: Los estudiantes tuvieron una percepción positiva (p<0.05) respecto a la retroalimentación útil, la obligatoriedad del práctico con fantoma y que esta experiencia mejora su preparación. El realismo del fantoma obtuvo la media más baja (2= En desacuerdo). Los docentes manifestaron una percepción positiva (mediana= 5) en todas las aseveraciones excepto en el realismo del fantoma (mediana= 2).

Conclusiones: Tanto estudiantes como docentes perciben de forma positiva el uso de fantomas para la práctica de toma radiográfica, por lo que se sugiere su uso para la enseñanza de Imagenología en odontología.

Palabras clave: *Entrenamiento simulado; Modelos dentales; Radiografía; Educación en odontología; Estudiantes de odontología; Percepción.*

INTRODUCTION

Education can be understood as a process that continuously evolves alongside technological advances and requires ongoing evaluation to ensure meaningful student learning. However, traditional evaluation tools do not always provide an accurate reflection of actual learning, as results may be influenced by various factors, including physical or emotional health at the time of assessment, the quality and/or amount of rest before evaluations, the opportunity to clarify doubts, or misinterpretation of instructions due to self-imposed pressure to achieve high grades.[1]

For these reasons, understanding students' self-perceptions of learning plays a central role in improving the quality of teaching. By considering students' personal learning experiences, educators could better identify which of the implemented methodologies were most effective in their instruction.[2]

The theoretical component of dental training is generally complemented by simulation strategies, which have evolved from the use of extracted teeth to the development of artificial teeth, and eventually to simulators or phantoms. These simulators have advanced so rapidly and now feature artificial teeth arranged in dental arches,

joints that mimic mouth opening and closing, water drainage systems, and head position.[3] These innovations aim to create a more realistic context for dental diagnosis and treatment.[2] Consequently, the acquisition of knowledge through simulation has become the foundation of an active learning methodology that promotes, improves, and validates students' progress through structured activities designed to represent real or potential clinical situations.[4] These experiences facilitate the development or refinement of knowledge, skills, and attitudes, combining theoretical and practical components of dental education.[1,5]

Most dental procedures performed on patients are irreversible, so it is extremely important for students to feel confident when assuming the responsibility of patient care. Preclinical practice is therefore a key component of dental training, as it offers students the opportunity to make mistakes and learn from them, without posing any risk to patients or themselves.[6]

Simulation in dentistry began with the introduction of the head phantom in 1894,[3] and has since evolved rapidly. Today there is a wide variety of dental simulators,[2,7] culminating in the development of virtual simulation systems. One of these systems is the IDEAL educational platform (IoT-based dental education and learning),[5,8] which facilitates student practice without relying on traditional radiographic equipment. The use of simulation offers several advantages and some disadvantages.

Among its advantages are the acquisition of theoretical knowledge and clinical skills through repeatable and reversible preclinical training, which makes learning more flexible.[9] It also enables objective evaluation and feedback from the instructor by recording the training process.

Additionally, it is highly relevant to clinical practice because it mimics reallife clinical situations. Nevertheless, its disadvantages include insufficient three-dimensional display, low image resolution, lack of support for intraoral procedures and bimanual coordination, and limited tissue realism, which restricts the development to basic skills only. Therefore, these aspects should be improved and further studied to assess its true effectiveness in the educational field.[2]

However, in the field of oral radiology, there is currently no evidence to determine whether it is a truly useful strategy based on the perception of students and faculty at national universities. Obtaining such information could refine the strategy of using phantoms for radiograph training, with the aim of improving the teaching process of imaging techniques to dental students. This study aimed to explore the perceptions of dental students and Faculty at Universidad Andrés Bello, Viña del Mar, Chile, regarding the learning process of taking periapical radiographs using a phantom. Participants included those involved in imaging courses between 2020 and 2022.

MATERIALS AND METHODS

This observational, descriptive, and quantitative study involved a sample of 267 students who took the imaging course between 2020 and 2022, along with 3 instructors who taught the course at Universidad Andrés Bello, Viña del Mar, Chile. The trainees participated in preclinical simulation sessions to learn the periapical retroalveolar intraoral technique.

A Manfrotto® X-ray phantom set with a tripod and a Nissin® phantom was used, which included an adult phantom head, a standard rubber mask, an XRY1001-UL-SP-Z arch, a finger, and a phantom stand.

Regarding the student sample, sample size was determined through a statistical calculation adjusted for a finite population, considering a 5% margin of error and a 95% confidence level. This resulted in a minimum required population of 159 students, based on Cronbach's alpha reliability. This sample size was considered sufficient to obtain statistically significant results and to draw valid conclusions about student perceptions. All three course instructors were included in the study.

The inclusion criteria consisted of students who took the imaging course, offered in the third year of the dental program, between 2020 and 2022, as well as the instructors who taught the course. The exclusion criterion was refusal to provide informed consent. A convenience sample of 201 students and three instructors was used.

Informed consent and the Barsuk questionnaire were administered to each student and instructor in a self-administered format. This questionnaire has been validated in Spanish studies, which have demonstrated its reliability and validity in Spanish-speaking samples.[6,11] This questionnaire was adapted to assess the perception of learning in relation to the practice of periapical retroalveolar radiography using a phantom.
To ensure its relevance within the specific context of teaching periapical radiography, it was reviewed by two dentistry professors with over 10 years of teaching experience.

Each questionnaire consisted of seven questions rated on a Likert scale from 1 to 5, where 1 indicated "Completely disagree" and 5 indicated "Completely agree." It also included two additional questions: one dichotomous question and one open-ended (Appendix 1).

Data Analysis: The data obtained from the questionnaire were collected using Google Forms and organized into two separate databases in Microsoft 365 Excel software (version 2309, Microsoft Corp., Washington DC, USA): one for student responses and the other for instructor responses.

Statistical analyses and graphs for both databases were conducted using IBM® SPPS® Sta-tistics (version 27.0, IBM, New York, USA). The internal consistency of the questionnaire was assessed using Cronbach's Alpha reliability test. Responses on the Likert scale were categorized as follows: scores of 4 or higher were considered satisfactory, indicating a positive perception of the evaluated dimension, while scores below 4 were considered unsatisfactory, indicating a negative perception.

Responses were analyzed using descriptive statistics, frequency distribution, and measures of central tendency. The Chi-square test was used to examine the relationship of the year in which the course was taken with the perceived significance of phantom use. Additionally, a hypothesis test for proportions or Z test was also applied to assess the percentage of perceived approval for each question. Results were considered statistically significant at $p<0.05$.

The final open-ended question of the questionnaire was analyzed quantitatively by organizing the data into the main categories and recording the frequencies in which they appear.

This study was approved by the Research and Ethics Committee of the Faculty of Dentistry, Universidad Andres Bello, Viña del Mar. The study followed the STROBE guidelines for reporting observational research.

RESULTS

Three instructors and 201 students who took the Imaging course in the Dentistry program between 2020 and 2022 at Universidad Andres Bello, Viña del Mar, participated in the present study. The student questionnaire included items measuring perceptions of skill, feedback, realism, confidence, and training, yielding a Cronbach's Alpha of 0.83 for students; the corresponding scale produced a Cronbach's Alpha of 0.55 for instructors.

Students: The results of the student learning perception questionnaire are presented in Table 1.

Question 6, "Practical workshops using a phantom to simulate dental patient care should be a mandatory component of oral radiology teaching," received the highest approval rating (71.6%) and a mean of 3.82.

Questions 4 and 5, which address the realism of the phantom, and the confidence gained through the practical exercise of taking periapical retroalveolar radiographs received the lowest approval rating, with less than 50%. The remaining questions received approval ratings above 50%, with a mean of 3.11 and a median of 4.

Regarding the results of the dichotomous question (Yes/No), which assessed whether the X-ray phantom practice significantly impacted learning, these findings are detailed in Table 2. A total of 54.2% of students indicated that the phantom practice did not make a significant difference in their learning experience.

Table 1.
Results of the student learning perception questionnaire.

Questions for students	N	Mean	Median	Mode	% of Approval
1. Practicing on phantoms improves my skills in taking periapical radiographs.	201	3.26	4	4	53.2
2. I received useful educational feedback during the practical session(s).	201	3.51	4	4	62.7
3. Practicing radiographic techniques on the phantom allows for making mistakes that could occur in a real clinical setting.	201	3.26	4	4	53.2
4. The phantom used in the radiographic workshop realistically simulates or represents the procedure.	201	2.69	2	2	31.4
5. Practicing radiographic techniques on the phantom reinforces my confidence in my clinical skills.	201	3.11	3	4	43.2
6. Practical workshops using phantoms to simulate dental patient care should be a mandatory component in Oral Radiology education.	201	3.82	4	4	71.6
7. Practicing radiographic techniques with phantoms helps me prepare for performing the clinical procedure more effectively than relying solely on clinical experience.	201	3.44	4	4	56.2

Table 2.
Learning perception results for students based on a dichotomous question.

		Year 2020 (%)	2021 (%)	2022 (%)	Total (%)
Based on your experience during the course, did the practice of taking X-rays on a phantom make a significant difference?	**No**	52 (59.8)	43 (51.8)	14 (45.2)	109 (54.2)
	Yes	35 (40.2)	40 (48.2)	17 (55.8)	92 (45.8)
Total		**87**	**83**	**31**	**201**

Table 3.
Hypothesis test: proportion of students' perception of learning.

Question number of students	Total	Perception by perception	Frequency between perceptions	Frequency limit of the proportion (95%)	Lower limit of the proportion (95%)	Upper	*p*-value
1	201	Negative	94	0.468	0.399	0.537	0.3586
		Positive	107	0.532	0.463	0.601	
2	201	Negative	75	0.373	0.306	0.440	0.0004*
		Positive	126	0.627	0.560	0.694	
3	201	Negative	94	0.468	0.399	0.537	0.3586
		Positive	107	0.532	0.463	0.601	
4	201	Negative	138	0.687	0.622	0.751	0.0000*
		Positive	63	0.313	0.249	0.378	
5	201	Negative	114	0.567	0.499	0.636	0.0574
		Positive	87	0.433	0.364	0.501	
6	201	Negative	57	0.284	0.716	0.221	0.0000*
		Positive	144	0.654	0.346	0.779	
7	201	Negative	88	0.438	0.369	0.506	0.0792
		Positive	113	0.562	0.494	0.631	

Table 4.
Analysis of students' response by category to the open-ended question.

		Category of responses	Number of students	%
No	How could it be improved?	Practice with patient - among peers	56	51.38
		More practical sessions	28	25.69
		Most realistic phantom	16	14.68
		Feedback	3	2.75
		Others	6	5.50
Yes	How did it help you?	Angulation and positioning	29	31.52
		Improved confidence and skill	24	26.09
		Apply theory	16	17.39
		Others	23	25.00

Table 5.
Results of the learning perception questionnaire for instructors.

Questions for the instructor	N	Median	Mode
1. Practicing on a phantom improves students' skills in taking periapical radiographs.	3	5	5
2. As an instructor, you consider that you provided useful educational feedback during the practical session(s).	3	5	5
3. Practicing radiographic techniques with a phantom allows students to make mistakes that could occur in a real clinical setting.	3	5	5
4. In your clinical experience, you consider that the phantom used in the radiographic workshop realistically simulates or represents the procedure.	3	2	-
5. Practicing radiographic techniques on the phantom reinforces the students' confidence, improving their clinical skills.	3	5	5
6. Practical workshops using a phantom to simulate dental patient care should be a mandatory component in oral radiology education.	3	5	5
7. Practicing radiographic techniques with a phantom helps students prepare to perform the clinical procedure more effectively than relying solely on exclusive clinical experience.	3	5	5

The responses were analyzed by academic year to determine whether the health context influenced students' perceptions. The trend leaned toward the "No" response, with the highest percentage (59.8%) recorded in 2020, when the course was taught virtually, and the lowest percentage (45.20%) in 2022, when the course was delivered completely in person.

However, there was no statistically significant difference based on the year in which the course was taken ($p>0.05$). Table 3 presents the results of the hypothesis testing on the proportion of responses to the questionnaire administered to students.

The analyses showed no statistically significant difference ($p>0.05$) between positive (Likert scale 4-5) and negative responses (Likert scale 1-3) for questions 1, 3, and 5. These questions addressed the following areas: improvement of periapical radiographic skills, opportunity for error in a controlled environment, and enhancement of clinical confidence. Regarding the feedback provided by ins-tructors during practical activities with the phantom (Question 2), 126 students found it useful, which was statistically significant ($p<0.05$). In contrast, for Question 4, 138 students indicated that the phantom used in the workshops did not realistically simulate the radiographic procedure. This difference was also statistically significant ($p<0.05$), but in the opposite direction, as the majority stated that the procedure was not faithful to reallife conditions.

Regarding the mandatory use of the phantom in Oral Radiology teaching (Question 6), 144 students stated that it should be a mandatory component of the curriculum, a result that was likewise statistically significant ($p<0.05$).

Finally, in Question 7, although 113 students expressed a positive perception that practicing with the phantom improves their ability

to perform clinical procedures, the difference between proportions was not statistically significant.

Regarding the final open-ended question: "Based on your experience during the course, did practicing with the X-rays on a phantom make a significant difference?" (dichotomous response), students who answered "Yes" were asked to elaborate or justify their choice by responding to the question: "How did it help you?" Their responses were then organized into three categories: angulation and posi-tioning, improved confidence and skill, and application of theoretical knowledge.

For students who answered "No," a separate follow-up question was included: "How could it be improved?" Their respective responses were organized into the following categories: practicing with peers or with real patients, more practical sessions, a more realistic phantom, and enhanced feedback.

Table 4 lists the number of student responses by category for each question. Based on the responses to the question "How could it be improved?", according to the students' perception, the category with the highest number of responses was "practicing with patients or among colleagues" with a total of 56 responses, followed by "having more practical sessions" with 28. Additionally, 16 students suggested that using a "more realistic phantom" would improve the experience, and 3 students believe it could be improved through more or better "feedback".

Among the positive responses in which students described how the periapical radiography phantom practice helped them, the most frequent theme was learning correct "angulation and positioning" cited by 29 students. A total of 24 students reported a notable increase in "confidence and skill," while 16 students stated that the phantom practice helped them "apply the theoretical knowledge" and gain better understanding of the content.

Faculty: Due to the small faculty sample size (n=3), a general descriptive analysis was conducted, and comparisons with student responses were made.

The results are presented in Table 5. Faculty members agreed that adequate feedback is provided and that the phantom practice is important for building confidence and preparing students for the actual radiographic procedures. However, they noted that the phantom does not realistically simulate the procedure. In addition, they reported being unfamiliar with alternative simulation methods and suggested improvements such as incorporating patient practice, clinical case discussions, and providing more time with the phantom.

DISCUSSION

Simulation-based education in the healthcare field can be defined as a strategy that replicates the behavior of a situation or process through a suitably analogous circumstance or device for educational or training purposes. It is classified by the level of realism as either low and high fidelity, depending on the dynamic and interactive nature of the model or scenario used.[12]

The phantom used to simulate periapical retroalveolar radiography represents a low-fidelity model. Although it replicates the anatomy of an ideal patient, its fixed structure restricts dynamic interaction with

the student, which reduces its pedagogical potential.

Despite the inherent limitations of phantom simulation, a study by Rowe *et al.*,[13] highlights that supervised practice with these models significantly improves student skills in crucial areas of radiology, including patient positioning, selection of exposure parameters, and image evaluation. Supervision by specialized professionals emerges as a key component for optimizing radiographic learning.

These findings support the results of the present study, in which 71.6% of students indicated that hands-on workshops with phantoms should be mandatory in oral radiology training. The assessment of learning perception is a common practice in healthcare education, aimed at continuously improving teaching quality. In the field of oral radiology, existing studies exhibit methodological heterogeneity and are influenced by the educational contexts of each country, which makes direct comparisons difficult.[1,-5,8,12,13,15,16]

However, the use of phantoms in practical workshops emerges as a common factor in healthcare training. A study by Villagrán *et al.*,[6] which assessed medical students' perceptions of medical-surgical workshops, used the same questionnaire applied by Barsuk *et al.*,[10] and adopted in the present study, underscoring the relevance of this tool for evaluating learning perceptions across different clinical simulation contexts. In that study, the statement "The phantom used in the workshop simulates or represents the procedure realistically" received the lowest median score, a 4. In contrast, the median score in the present study was 2.

This difference may be due to the varying nature of the procedures assessed, as each study evaluates different ones. In dentistry, a phantom used in radiology training would need more realistic features, such as spontaneous head and tongue movements, saliva production, and anatomical variations in the teeth and/or oral cavity to achieve a higher level of realism. Previous studies have explored the most effective strategies for clinical training in radiology.[4,9] England *et al.*,[14] concluded that simulation is widely accepted as a valuable learning opportunity even though it does not replace direct clinical experience with patients.

However, in the present study, students perceived that the use of a phantom did not make a significant difference in their learning (54.2%). This perception may be attributed to the lack of realism in the phantom and the fact that it was evaluated as the only teaching strategy. Other studies that have compared strategies used in radiology teaching reported positive results.

For instance, Sapkaroski *et al.*,[15] who examined student perceptions of conventional roleplaying, where students alternate between the roles of physician and patient while practicing with their peers, *versus* a virtual reality program designed to train radiographic positioning, concluded that there was no statistically significant difference in the educational effectiveness between the two approaches, with students expressing a generally positive perception of both. Evidence of a positive student perception of practical activities suggests the need to incorporate pedagogical strategies complementary to phantom practice in teaching radiographic imaging.

These strategies could enrich the learning experience by promoting deeper under-stan-ding and more effective application of theoretical knowledge in a simulated clinical setting. An important feature of simulation-based learning is the immediate feedback provided by instructors, which helps improve student performance.

This approach allows students to engage in active learning while fostering reflection and self-assessments. Kong *et al.*,[16] evaluated first-year radiology students' perceptions of instructor feedback in their study. Students expressed satisfaction with the feedback provided. Such feedback enables students to practice clinical skills and build confidence in a safe environment where they can learn from mistakes without compromising patient safety.[16]

This is reflected in the 82.3% of students who reported improved clinical skills after repeated practice with a phantom. This same trend was observed in the present stu-dy, where 62.7% of students indicated that the feedback received from the instructor was useful for their learning. Furthermore, 56.2% of students expressed a positive perception that practicing radiograph techniques with a phantom better prepares them for clinical procedures than clinical experience alone.

This aligns with the findings of Sapkaroski *et al.*,[15] whose perception study showed that students in the roleplaying group perceived significantly higher performance compared to those in the virtual reality simulation group. In the present study, 51.38% of students who indicated that the experience with the phantom was not significant agreed that it could be improved by practicing with real patients or with peers.

Furthermore, peer-assisted learning has also been shown to be beneficial. According to Elshami *et al.*,[17] students reported feeling more confident when working with peers, as it reduces the fear of being judged. For this reason, peer-assisted learning could be a valuable addition to the practical teaching of oral radiology.

Another advantage of peer practice is the improvement of problem-solving skills; it encourages discussion and reflection on course content. These are the same advantages that students perceived in the phantom-based practice, where the most frequently mentioned benefits included improved confidence, greater dexterity, and an enhanced ability to apply theoretical knowledge with deeper understanding. As in the study by Sapkaroski *et al.*,[15] students perceive that more and longer practical sessions are needed.

One limitation of this study was the small sample size of instructors, which should be expanded in future research. Additionally, the study focused solely on students' perceptions of learning outcomes from the practical activity of taking radiographs with a phantom, without comparing these perceptions to their academic performance. Future studies are encouraged to include such comparisons.

It is also possible that participants responded to the questionnaire in a way that portrayed themselves or the learning experience more positively, potentially introducing social desirability bias. Finally, it is important to note that perception-based measurements rely on self-reported data, which may be subject to limitations in accuracy and objectivity.

CONCLUSIONS

Both students and instructors expressed a positive perception of using phantoms for practicing radiographic examinations, supporting their continued use in dental imaging education. However, a commonly noted limitation was the lack of realism in the anatomy and function of the phantom, which was seen as a disadvantage of the practical exercise.

To address this, participants suggested supplementing phantom-based practice with radiographic examinations on peers or real patients. The feedback provided by instructors was highlighted as an essential component, significantly enhancing both the practical exercise of radiographic examination techniques and the under-standing of theoretical concepts.

CONFLICT OF INTERESTS

The authors declare that there are no conflicting interests.

ETHICS APPROVAL

The present study was approved by the Research and Ethics Committee of the Facultad de Odontología, Universidad Andres Bello, Viña del Mar, and informed consent was obtained from all participants.

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AUTHORS' CONTRIBUTIONS

Macarena Rodríguez-Luengo: Conceptualization; writing; review and editing; supervisión.
Camila Carvajal-Barraza: Data curation: writing original draft.
Lía Torres-Real: Data curation; writing original draft.
Sven Niklander-Ebensperger: Writing; review and editing.
Juan José Valenzuela- Fuenzalida: Writing; review and editing.
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REFERENCES

1. Holmström A. Radiography Students' Learning of Plain X-Ray Examinations in Simulation Laboratory Exercises: An Ethnographic Research. J Med Imaging Radiat Sci. 2019;50(4):557-564. http://doi.org/10.1016/j.jmir.2019.07.005. Epub 2019 Nov 26. PMID: 31784204.
2. Li Y, Ye H, Ye F, Liu Y, Lv L, Zhang P, Zhang X, Zhou Y. The Current Situation and Future Prospects of Simulators in Dental Education. J Med Internet Res. 2021;23(4):e23635. http://doi.org/10.2196/23635. PMID: 33830059; PMCID: PMC8063092.
3. Plessas A. Computerized Virtual Reality Simulation in Preclinical Dentistry: Can a Computerized Simulator Replace the Conventional Phantom Heads and Human Instruction? Simul Healthc. 2017;12(5):332-338. http://doi.org/10.1097/SIH.0000000000000250. PMID: 28697057.
4. Abe S, Noguchi N, Matsuka Y, Shinohara C, Kimura T, Oka K, Okura K, Rodis OMM, Kawano F. Educational effects using a robot patient simulation system for development of clinical attitude. Eur J Dent Educ. 2018;22(3):e327-e336. http://doi.org/10.1111/eje.12298. Epub 2017 Nov 1. PMID: 29091328.
5. Desjarlais S. Opportunity to acquire technical skills of dental radiography utilizing virtual simulation. J Dent Educ. 2022 Jun;86 Suppl 1:839-840. http://doi.org/10.1002/jdd.12754. Epub 2021 Aug 4. PMID: 34331463.
6. Villagrán I, Tejos R, Chahuan J, Uslar T, Pizarro M, Varas J, Achurra P, Leiva I, Nazar C, Sirhan M, Uribe J, Ruz C, Villafranca C, Soza R, Solís N, Fuentes-López E, Padilla O, Corvetto M, Riquelme A. Percepción de estudiantes de pregrado de Medicina de talleres de simulación de procedimientos médico-quirúrgicos [Undergraduate student's perception of clinical simulation workshops: assessment of an instrument]. Rev Med Chil. 2018;146(6):786-795. http://doi.org/10.4067/s0034-98872018000600786. PMID: 30148911.
7. Steinberg AD, Bashook PG, Drummond J, Ashrafi S, Zefran M. Assessment of faculty perception of content validity of PerioSim, a haptic-3D virtual reality dental training simulator. J Dent Educ. 2007;71(12):1574-82. PMID: 18096883.
8. Kong A, Hodgson Y, Druva R. The role of simulation in developing clinical knowledge and increasing clinical confidence in first-year radiography students. Focus Health Prof Educ Multi-Prof J. 2015;16(3):29. http://doi.org/10.11157/fohpe.v16i3.83
9. McKenzie CT, Tilashalski K, Abou-Arraj R, Peterson DT, White ML. Students' Evaluations of Simulations in Dentistry: A Multiple Cohort Study at a U.S. Dental School. J Dent Educ. 2019 Oct;83(10):1142-1150. http://doi.org/10.21815/JDE.019.121. Epub 2019 Jun 24. PMID: 31235505
10. Barsuk JH, Cohen ER, Vozenilek JA, O'Connor LM, McGaghie WC, Wayne DB. Simulation-based education with mastery learning improves paracentesis skills. J Grad Med Educ. 2012 Mar;4(1):23-7. http://doi.org/10.4300/JGME-D-11-00161.1. PMID: 23451302; PMCID: PMC3312528.
11. Cerdán Gómez F, Diéguez Pérez M. Percepción de los estudiantes de cuarto curso del grado de Odontología de la Universidad Europea, del aprendizaje adquirido mediante el empleo de simuladores hápticos en las asignaturas de Odontopediatría. En: Simulación-OneHealth 2024. Congreso. https://simulacion-onehealth.org/ponencia/percepcion-de-los-estudiantes-de-cuarto-curso-del-grado-de-odontologia-de-la-universidad-europea-del-aprendizaje-adquirido-mediante-el-empleo-de-simuladores-hapticos-en-las-asignaturas-de-odontopedia/
12. Shiner N. Is there a role for simulation based education within conventional diagnostic radiography? A literature review. Radiography (Lond). 2018;24(3):262–71. http://doi.org/10.1016/j.radi.2018.01.006
13. Sapkaroski D, Mundy M, Dimmock MR. Virtual reality versus conventional clinical role-play for radiographic positioning training: A students' perception study. Radiography (Lond). 2020;26(1):57-62. http://doi.org/10.1016/j.radi.2019.08.001. Epub 2019 Sep 5. PMID: 31902456.
14. England A, Geers-van Gemeren S, Henner A, Kukkes T, Pronk-Larive D, Rainford L, McNulty JP. Clinical radiography education across Europe. Radiography (Lond). 2017 Sep;23 Suppl 1:S7-S15. http://doi.org/10.1016/j.radi.2017.05.011. Epub 2017 Jun 8. PMID: 28780956.

15. Sapkaroski D, Mundy M, Dimmock MR. Virtual reality versus conventional clinical role-play for radiographic positioning training: A students' perception study. Radiography (Lond). 2020;26(1):57-62. http://doi.org/10.1016/j.radi. 2019. 08.001. Epub 2019 Sep 5. PMID: 31902456
16. Kong A, Hodgson Y, Druva R. The role of simulation in developing clinical knowledge and increasing clinical confidence in first-year radiography students. Focus Health Prof Educ Multi-Prof J. 2015;16(3):29. http://doi.org/10.11157/fohpe.v16i3.83
17. Elshami W, Abuzaid M, Abdalla ME. Radiography students' perceptions of Peer assisted learning. Radiography (Lond). 2020 May;26(2):e109-e113. http://doi.org/10.1016/j.radi.2019.12.002. Epub 2019 Dec 19. PMID: 32052761.

Appendix I.

Questionnaire applied to students and instructors.

Questionnaire for students	Questionnaire for instructors
1. Practicing on phantoms improves my skills in taking periapical radiographs. 2. I received useful educational feedback during the practical session(s). 3. Practicing radiographic techniques on the phantom allows for making mistakes that could occur in a real clinical setting. 4. The phantom used in the radiographic workshop realistically simulates or represents the procedure. 5. Practicing radiographic techniques on the phantom reinforces my confidence in my clinical skills. 6. Practical workshops using phantoms to simulate dental patient care should be a mandatory component in Oral Radiology education. 7. Practicing radiographic techniques with phantoms helps me prepare for performing the clinical procedure more effectively than relying solely on clinical experience. 8. Based on your experience during the course, did the phantom X-ray practice make a significant difference? (Yes/No) 9-. R: Yes. How did it help you? 9-. R: No. How could it be improved?	1. Practicing on a phantom improves students' skills in taking periapical radiographs. 2. As an instructor, you consider that you provided useful educational feedback during the practical session(s). 3. Practicing radiographic techniques with a phantom allows students to make mistakes that could occur in a real clinical setting. 4. In your clinical experience, you consider that the phantom used in the radiographic workshop realistically simulates or represents the procedure. 5. Practicing radiographic techniques on the phantom reinforces the students' confidence, improving their clinical skills. 6. Practical workshops using a phantom to simulate dental patient care should be a mandatory component in oral radiology education. 7. Practicing radiographic techniques with a phantom helps students prepare to perform the clinical procedure more effectively than relying solely on exclusive clinical experience. 8. As an instructor, how do you think the learning of periapical radiographic techniques can be improved for students? 9. Are you familiar with any other imaging simulation methods apart from the use of a phantom? If so, please specify. (Yes/No) R: Yes, which one?