

Dental students' perceptions and educational impact of preclinical interactive videos compared and in combination with live demonstrations

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Keywords: dental education, interactive videos, live demonstrations, preclinical training.

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ABSTRACT

OBJECTIVE: To study the utility of simulation videos with embedded quiz items compared and in combination with live hands-on demonstrations of dental procedures.

METHODS: Thirty-three videos with embedded items were developed to help students understand the procedures they had to practice in the simulation laboratory. Videos were uploaded to the university LMS platform for students to watch and complete the embedded items as many times as they liked. All seventy-six students from 2021 and seventy-three from 2022 Integrated Dentistry III courses were invited to participate in the study. Practical (OSCE) and theoretical (MCQ) exam grades of the 2021 academic year, when interactive videos replaced live demonstrations, were collected and compared to those of the previous years (2017-2020) when only live demonstrations were performed, as were those from the 2022 academic year, when videos were complemented with hands-on live demonstrations. At the end of each year, a perception questionnaire was voluntarily completed by the students.

RESULTS: Assessment grades were significantly higher in the 2021 academic year when interactive videos were incorporated versus the 2017-2020 period when only live demonstrations were performed. However, the combination of interactive videos with live demonstrations performed during 2022 showed the highest exam grades. Seventy-nine percent of students answered the questionnaire, highly valued the utility of the interactive videos and liked the embedded items. Overall, they stated that they learned from the videos.

CONCLUSIONS: Interactive videos of preclinical procedures with embedded items combined with live demonstrations can significantly enhance students' learning and are valued by students.

Keywords: dental education, interactive videos, live demonstrations, preclinical training.

INTRODUCTION

The use of instructional videos to demonstrate particular procedures in education for health professionals has increased steadily during the past decade, influencing teaching and learning.¹ The use of instructional videos is becoming an integral component of formal blended dental education,² complementing the transfer of knowledge in teaching psychomotor skills.³

Provided that they are well designed with precise instructions on the procedures, reliable and peer-reviewed,^{3, 4} educational videos are considered valuable resources as teaching aids, especially in comprehending concepts.⁵ They can offer students a useful means of learning and a flexible resource to review content at their own pace and according to their individual learning needs.⁶⁻⁹ Furthermore, videos have been utilized to standardize the delivery of information across tutors¹⁰ and calibrate examiners on the use of rating scales.¹¹ Videos can also help ensure the consistency of messaging and content when multiple learning sessions are required in large classes.³

However, the use of multimedia learning presents both opportunities and challenges.¹² Among the opportunities, several studies^{1, 2, 13-15} have reported that instructional videos promote cognitive engagement, enhance students' learning, and facilitate their active and analytical thinking, as well as skill development. Videos capture students' attention and engage them in hands-on learning by communicating facts and demonstrating procedures.³

Furthermore, it has been noted¹⁶ that videos allow the visualization of practical procedures from different camera perspectives, unlike when students crowd around an instructor,¹⁴ and that videos save time by reducing tutors' workload and fatigue. Additionally, instructional videos offer flexibility to both instructors and students, as they are accessible from anywhere and at any time, allowing students to permanently refer back to them and renew their knowledge repeatedly.^{2, 10}

Among the challenges, developing quality videos requires substantial effort,¹⁷ which costs time and money. Students may not be able to access the videos officially recommended by their school's curriculum, and they may have difficulty judging a video's content quality, accuracy, and applicability or may use videos without closely checking the source; most available online videos are produced by nonacademic publishers without peer-reviewed information.^{4, 18} A solution to this has been the creation of videos for students' specific needs by their teachers.^{1, 7}

Enhancing video demonstrations with subtitles of the presenter's dialog, text bullet points and summary text pages was found to improve undergraduate students' ability to retain theoretical knowledge but not practical performance.¹⁹ A study using an enhanced video with images and picture-in-picture videos to instruct undergraduate students on practical examination skills concluded that watching the video was highly recommended by the students.²⁰

In-video quizzes or quiz questions embedded directly within the video to increase the interactivity of its content and support formative assessment have been minimally explored in the literature despite the positive results of using quizzes as a formative assessment technique.²¹⁻²⁵ Thus, this quasiexperimental investigation aimed to study the impact on second-year dental students' acquisition of knowledge, practical skills, and perceptions of the utility of a series of instructional simulation videos with embedded quiz items designed to improve students' learning and engagement compared and in combination with live hands-on demonstrations before each simulation session.

MATERIALS AND METHODS

Ethics approval

The University of the Andes Scientific Ethical Committee reviewed and gave the study its full approval (reference number CEC202021).

Producing the instructional videos

A total of thirty-three videos were developed for all the simulation procedures that second-year dental students had to perform for the first time during their training in an integrated dentistry course (preclinical training). Staff members developed the video scripts and performed the procedures, which were professionally recorded and edited. Video themes included all procedures the students had to perform during each session. Among others, these procedures included the creation of alginate and silicone impressions, mixing and pouring dental stone, rubber dam isolation, typodont cavity preparation, liner application, various types of cement mixing, and composite filling.

Following Dong and Goh's⁶ tips, the videos were developed considering the learning outcomes of the course and were between three and six minutes long to avoid cognitive overload.²⁶ The videos demonstrated the procedure and included on-screen text, close-ups, picture-in-picture videos (screen captures of an example video in Figure 1), and various degrees of interactivity using the Canvas Studio® (Instructure Inc., Salt Lake City, Utah, USA) interface. The interactive elements consisted of formative assessment items with multiple-choice, true or false, and multiple answers with required responses that were embedded in the videos (Figure 1); immediate feedback was provided for each question.

Experiencing the videos and live demonstrations

All produced interactive videos were uploaded to the Canvas® university learning management system as part of the Integrated Dentistry course III so that the students could watch them as often as they liked; these videos were used instead of the previously utilized handouts detailing every step of each procedure they had to perform during each simulation session. During the 2021 academic year, videos replaced live demonstrations that were given before each practical session, as they had been in previous years (Figure 2). Therefore, it was compulsory for the students to watch the corresponding video before they could download the written material from Canvas® needed for the

practical lab session. In this manner, we could ensure that all students viewed the videos of the procedures they performed before the simulated session. At the beginning of each simulation lab session, videos were projected on screens in the room for the students to watch them again and make any enquiries; if needed, additional guidance was provided by an instructor. Subsequently, the videos were continuously projected during the entire practical session.

During the 2022 academic year, interactive videos were complemented with live demonstrations. Similar to the previous year (2021), students had to watch the corresponding video to download the material for the practical lab session. The videos were projected at the beginning of each simulation session before the instructors performed live demonstrations of the same procedures shown in the videos for the students to perform afterward. As before, the students had the opportunity to ask questions to clarify concepts or procedures, and videos were constantly projected during the session.

Perception questionnaire

Based on previous studies,^{3, 15, 19, 27} a draft questionnaire containing quantitative Likert-style and open-ended questions was developed to assess dental students' perceptions of the utility of the developed instructional videos and the combination of these with live demonstrations. The draft questionnaire was presented to all six instructors of the same Integrated Dentistry III course after they watched four of the newly developed videos that they created. The intention here was to ask these tutors to review and provide feedback on the wording and content of the draft questionnaire to ensure that it sampled all the relevant and pertinent information and that it appeared appropriate for the intended purpose. After an agreed version of the questionnaire was reached with the tutors, ten final-year students were asked to complete the questionnaire after watching four of the created videos. The same procedure to complete the survey was repeated two weeks later, and the results were compared, resulting in a Cohen's Kappa intrarater reliability score of 0.89. The final version of the questionnaire was designed to assess the students' perceptions of the videos and their combination with live demonstrations. It included fifteen Likert-style items for the 2021 group and seven teen Likert-style items for the 2022 group (two more questions to assess the combination of videos and live demonstrations), coupled with two open-ended questions for the students to comment about the aspects they found most and least useful regarding the videos.

Participants and data collection

All seventy-six students from 2021 and seventy-three from 2022 Integrated Dentistry III courses were invited to participate in the study.

To assess the impact of both interventions, the grades from the Integrated Dentistry III course for the 2021 group of students, where only interactive videos were used before every practical session, and those from the 2022 group of students, where interactive videos were combined with live demonstrations, were collected for comparison. Furthermore, historic grades from previous academic years (2017 to 2020) in the same Integrated Dentistry III course, during which only live demonstrations were provided before each simulation lab procedure, were also collected for evaluation and comparison. Live demonstrations were always delivered by the same group of tutors in all groups. During 2021, all interactive videos and live demonstrations were delivered during the second semester due to the COVID-19 pandemic.

Furthermore, all 76 students from the 2021 Integrated Dentistry III course were invited to complete the final version of the pen-and-paper questionnaire voluntarily and anonymously during the last session of the course, which included thirty-three interactive videos but not live demonstrations. Similarly, all seventy-three students from the 2022 Integrated Dentistry III course, which included the same thirty-three interactive videos and live demonstrations at the beginning of the practical sessions, were also invited to complete the same questionnaire voluntarily and anonymously. In both groups, the questionnaire was administered to the students to evaluate the utility of the interactive videos that they had watched during the course in combination with live demonstrations or not.

Additionally, the number of video visits per student and the grades students obtained in the practical (OSCE) and theoretical final exam (MCQ) results were obtained from the LMS software (Canvas®).

Data analysis

A t-test was used to compare the final exam results (OSCE & MCQ) from the 2021 and 2022 groups with those from the previous academic periods (2017 to 2020). The Likert-style responses from the questionnaires were studied to determine the students' perceptions of the videos by comparing both groups of respondents. The number of times videos were watched by the students and the students' grades from the final exams were also descriptively studied and compared using t-tests and ANOVA.

The data were organized into Microsoft Excel spreadsheets (Microsoft Excel, Microsoft Inc., Washington, USA) and statistically processed using the Statistical Package for Social Sciences Windows® version 27 (SPSS IBM Inc., USA). The same researcher grouped all open-ended comments from the questionnaires.

RESULTS

The average final practical (OSCE) and theoretical exam (MCQ) grades of students from the 2021 group (interactive videos only) were 78.5% and 71.1%, respectively. In 2022 (interactive videos and live demonstrations), these were 80.2% and 72.0%, respectively. The practical exams had a significant difference ($p = 0.008$), while the theoretical exams did not ($p = 0.606$). The differences between these grades and those from the previous academic years (2017 to 2020, live demonstration only) were significantly different ($p < 0.001$) (Table 1).

A total of one hundred and eighteen students answered the questionnaire (79% female, 21% male, mean age 20.1 SD 0.97), fifty-nine (78%) students from the 2021 group and fifty-nine (81%) from the 2022 group.

Videos were seen an average of 1.7 times per student in 2021 and 1.2 times in 2022. As shown in Table 2, the students gave the highest positive answers when they were asked whether interactive videos had a clear goal (100%), their content was of good quality (average of 98%), they provided useful information for their preclinical training (average of 95%) and, overall, they learned from the videos (average of 97%).

Regarding the items embedded in the videos, most students (an average of 93%) stated that these items helped them better understand the theoretical and practical aspects of the activity they had to perform in the simulation lab. Furthermore, an average of 83% of both groups of students disagreed with the statement declaring that the embedded items were not useful.

The students' written comments about the aspects they found most and least useful about the videos can be found in Table 3. Among the positive features, they highlighted that the videos were kept on the platform to be watched any time, that the videos were made by their tutors and showed the same materials used in the simulation lab and were different from the videos found on YouTube®, and that the embedded items helped reinforce theoretical concepts. On the other hand, the students expressed some drawbacks of the videos, including that they could leave them with more questions, they were sometimes too fast and had short captions, they had questions that were not always useful, and they could not be downloaded.

DISCUSSION

The current study examined the impact on second-year dental students' acquisition of knowledge, practical skills, and perceptions of the utility of thirty-three instructional simulation videos with embedded quiz items designed to improve the students' learning and engagement compared and in combination with live demonstrations before each simulation session.

An important finding of the present study is that the combination of interactive videos and live demonstrations of simulation procedures was shown to be the best option to increase the students' grades on both the practical and theoretical exams. This is probably because the current generation of learners prefers instant answers through search engines and videos over traditional reading assignments²⁸, as students had to do before the implementation of interactive videos; as mentioned above, when live demonstrations were performed, the students had to read the material related to the simulation session they were about to perform. In contrast, the students in this study arrived in the lab session with previous knowledge received in the form they most preferred: videos that challenged them with interactive items, which could have increased their motivation. As mentioned by Walinski et al.,²⁸ how the message is delivered is as important as the message itself.

Furthermore, the final exam grades of students in the 2021 academic year who received video instruction only on what they had to perform in their simulation lab practical sessions were significantly higher (Table 1) than those of students who received the same instruction but used only live demonstrations during the 2017 to 2020 period (exams had a similar difficulty index). These results show that interactive videos can help students improve not only their practical skills for procedures they have to perform for the first time but also their knowledge as assessed by written, objective tests. Notwithstanding, as in the present study, Gorucu-Coskuner et al.²⁹ reported that most students preferred the combination of live demonstrations with videos for clinical orthodontics.

Similar to the current study, Abd-Shukor et al.¹⁹ reported that videos enhanced with subtitles of the presenter's dialog, text bullet points and summary text pages improved the students' knowledge retention. However, in contrast to the present results, this study also reported that students' practical skills were minimally affected. Furthermore, a study by Thilakumara et al.¹⁵ suggested that noninteractive procedural videos were as good as live demonstrations in teaching about the arrangement of artificial teeth, but the students considered videos to be a better teaching tool; in the

present study, the students who were presented with interactive videos in 2021 showed a significant grade increase compared to those who were presented with only live demonstrations delivered in previous years (2017-2020). In line with this, Schlafer et al.¹⁶ reported that prerecorded video demonstration of a class IV restoration might represent a promising teaching format as an alternative to live hands-on demonstrations in undergraduate dental education.

However, the results of the present study are different from those reported by Patel et al.,⁵ who found that video demonstrations of class I amalgams and of class I amalgams and composite restorations did not improve the first-year students' performance on selected operative procedures in a preclinical environment, even though the students positively evaluated the videos. It is important to note that the authors did not report any interactivity in the videos.

The fact that 97% of the participating students in both groups expressed that they learned from the interactive videos with embedded items shows the acceptability of these interactive teaching tools and represents a promising instructional format that has not been widely explored. There are five possible reasons for these positive perceptions. First, as highlighted by students' comments (Table 3), the videos were recorded by their own tutors and were tailored to the students' needs. A qualitative study by Botelho et al.² also reported that students perceived videos to be an important and vital learning tool regarding on-demand access and for particular needs that were not possible to meet from textbooks or lectures. Second, the videos were considered by both groups to have a clear goal, as they reflected the learning outcomes of the course and to be of good quality and visually appealing, which might have contributed to their acceptability. In this regard, orthodontic students in the Alqahtani et al.³⁰ study found procedural videos to be clear and easy to understand. Third, the video content was highly valued as being consistent with the information delivered in lectures and lab step-by-step practical guides; this might have acted as a retrieval practice study strategy.³¹ Fourth, the videos helped the students increase their confidence to perform the procedures they had to practice in the simulation lab, which might have contributed to their motivation.³² Fifth, the embedded items were highly valued, which might have helped the students better understand the theoretical and practical aspects of the simulation lab activity, which was corroborated by the higher exam grades obtained by those students in the 2021 academic year than those obtained by students in the previous years, where only live demonstrations were given.

Among the most valuable aspects of the interactive videos, the students highlighted that they had subtitle texts, which allowed a large amount of content to be taught in a short period of time, as the subtitles provided step-by-step procedures with details that were easy to follow and that clarified what needed to be done in the simulation lab. Another important aspect of the videos is that they were considered to be not very long, and according to Dias de Silva et al.,⁴ shorter videos show better user retention levels.

Questions with immediate feedback were also emphasized by students as useful, as they helped reinforce the application of theory to practice. This is important, as it has been described that interactive videos with embedded active elements ensure student engagement and participation and help students pay full attention to the content of the video;³³ one of the themes that emerged from the present study was as follows: "Have interactions that make us focus on all details". A similar finding was already reported by Schlafer¹⁶ in that didactic elements such as questions in videos stimulate reflection. Furthermore, Abd-Shukor et al.¹⁹ reported that adding text to instructional videos enhances students' ability to improve their theoretical knowledge by recalling and transferring that information.

In contrast, the students also reported the least useful aspects of the videos, including that some embedded questions were not that useful, while others reported that they would have liked more inserted items. Another important reported issue was that students had to complete all embedded questions to watch the video for a second time and that some procedures required better zoom-in on specific steps.

This study has some limitations that might affect the extensive use of interactive videos for teaching practical skills to dental students. Most likely, the most important limitation is the high cost of producing the videos themselves, as well as the fees from the LMS platform that supports the interactive videos. Another is the time tutors had to dedicate to writing the scripts and then performing the demonstrations. Furthermore, possible improvements to the interactive videos include making them available for download to be watched offline so that students can view videos for a second time without having to answer the embedded items and that they provide tips to help students understand better.

CONCLUSION

Professionally developed interactive videos with embedded items of preclinical procedures are well perceived by students, and when combined with live demonstrations, they are effective in helping second-year students achieve the best results on practical and theoretical assessments.

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

The data that support the findings of this study are available on request.

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Table 1. Average scores of the students' grade marks, standard deviation (SD), and difficulty index of the practical (OSCE) and theoretical (MCQ) exams in 2021 (students who watched interactive videos without live demonstrations of the practical session) and 2022 (students who watched interactive videos with live demonstrations of the practical session) groups.

Integrated Dentistry III						
Year and teaching method used	Practical exam (OSCE)			Theoretical exam (MCQ)		
	Average (%)	SD	Difficulty index	Average (%)	SD	Difficulty index
2017 Live demonstration without video	73.4	7.3	0.72	61.9	7.3	0.66
2018 Live demonstration without video	73.3	6.2	0.71	61.3	7.6	0.64
2019 Live demonstration without video	72.1	8.0	0.73	62.6	7.4	0.66
2020 Live demonstration without video	72.8	8.6	0.74	64.5	7.5	0.64
2021 Interactive videos without live demonstration	78.5	5.5	0.75	71.1	6.4	0.65
2022 Interactive videos with live demonstration	80.2	7.5	0.75	72.0	7.1	0.65

* p 0.110
 † p <0.001
 § p 0.008

* p 0.230
 † p <0.001
 § p 0.606

Table 2. Students' answers to the questionnaire by the percentage of total respondents and the statistical significance between students' answers in 2021 (students who watched interactive videos without live demonstrations of the practical session) and 2022 (students who watched interactive videos with live demonstrations of the practical session) groups.

Regarding the videos watched in Canvas®:							
Q	Statement	2021 Videos with interactivity (n. 59)			2022 Demonstrations and videos with interactivity (n. 59)		
		Agree	Neutral	Disagree	Agree	Neutral	Disagree
1	They had a clear goal	100%	0%	0%	100%	0%	0%
2	The content was of good quality	97%	3%	0%	100%	0%	0%
3	They were visually appealing	85%	12%	3%	95%	5%	0%
4	Its content was consistent with the lectures and lab step-by-step practical guides	92%	7%	1%	97%	2%	1%
5	They provided useful information for my preclinical training	97%	3%	0%	95%	5%	0%
6	They did not serve to understand the procedures that I must carry out in the simulation lab	2%	8%	90%	2%	0%	98%
7	They adequately showed the sequence of procedures that I must carry out in the simulation lab	88%	10%	2%	93%	5%	2%
8	They complemented the information delivered in lectures	90%	8%	2%	90%	8%	2%
9	They provided information that is irrelevant	3%	15%	82%	2%	5%	93%
10	They were very long in duration	3%	25%	72%	5%	19%	76%
11	They helped me to have more confidence to do the procedures that I have to carry out in the simulation lab	80%	17%	3%	83%	12%	5%
12	Overall, I learned from the videos	97%	3%	0%	98%	2%	0%
13	They had embedded items that helped me to better understand the theoretical aspects of the sim lab activity	89%	8%	3%	97%	3%	0%
14	They had embedded items that helped me to better understand practical aspects of the sim lab activity	89%	8%	3%	100%	0%	0%
15	They had embedded items which were not useful	10%	15%	75%	0%	10%	90%
16	The combination of live demonstrations with interactive videos	-	-	-	95%	5%	0%

	on Canvas is a good method to understand the theoretical aspects of the activity.						
17	The combination of live demonstrations with interactive videos on Canvas is a good method to understand the practical aspects of the activity.	-	-	-	98%	2%	0%

Table 3. Students' comments about the aspects they found most and least useful about the videos.

What were the <u>most useful</u> aspects of the videos?	What were the <u>least useful</u> aspects of the videos?
The videos have interactions that make us focus on all details	Sometimes, the procedure can't be seen so well
The videos are simple and short enough and provide slow step-by-step sequences	Some questions that are not useful
The videos are easy to follow and visually attractive	You are required to answer all questions again if you want to watch the video for a second time
The videos provide visual guidelines about what needs to be done in the lab	Sometimes a better zoom-in on specific steps is needed
The videos have questions that provide immediate feedback that can be seen as many times as you like	Some videos are too long
The videos have questions that ask you to reinforce theory and apply it to practice; the answers are not obvious	All questions should be at the end, not in between
The videos teach you a lot in a short period of time	The videos can't be downloaded to watch them without an internet connection
The final score is given at the end of the video	The videos could have more questions
The videos have subtitle texts with short explanations	The videos present the procedures as much easier than they truly are
The videos are neat, short, precise, and didactic	The videos do not show how long the procedure should take
The videos zoom in on important steps during the procedure	Sometimes, the videos are too fast
The videos are kept on the platform to watch them at any time	The videos have too few captions and could have more written explanations
The videos are made by our own tutors	Some details are missing
The videos show the same materials we use in the lab and not just any materials like on YouTube®	The videos do not give tips
The videos show exactly what we need to do in the lab	
The videos allow me to arrive to the practical session prepared	
The videos are much better than the written guides	

Figure 1. Images were taken from an interactive video about resin composite filling (A), picture-in-picture image of the procedure in the video (B), an embedded item in the same video (C), on-screen text reinforcing the content of the video (D).

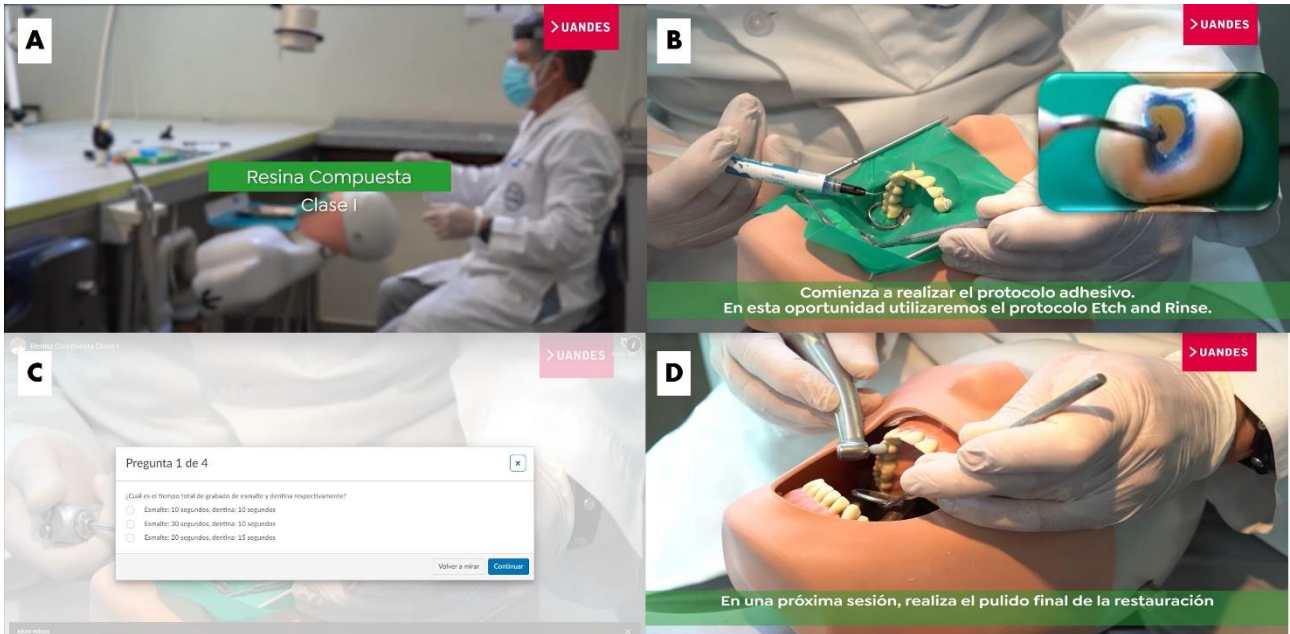


Figure 2. Timeline of the study protocol showing all different interventions per year.

