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Title:
An educational intervention bridging the theory-practice gap in dental students

'It is not a cooking recipe'

University of BRISTOL

An educational intervention bridging the theory-practice gap in dental students: **'It is not a cooking recipe'**

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Abstract

This research designed, implemented, and investigated an educational intervention to address the reported gap between theory and practice in dental education and the accompanying difficulties in developing early-year dental students' reflective skills. The intervention was developed following Design-Based Research principles considering a three-phase model, which included two cycles (i.e., Pilot and Main study) of intervention design, implementation, and evaluation. Under a socio-constructivism approach, reflective practice provides the bridge between theory and practice and places value on social interactions during the teaching and learning process.

The intervention was implemented with third year dental students during their preclinical practices. It consisted of a virtual environment on OneNote where students shared their experiences in the Clinical Skills Laboratory by uploading photographs, comments, and reflections.

A pilot study was conducted in 2017 (N=13 students), and the main study in 2018 (N=56 students, 7 tutors) at the Dental School of a traditional university in Chile. The pilot study evaluated the design's feasibility, showing that students worked with their mobile phones, taking photographs, commenting, and reflecting about them without interfering with their regular practices. The preliminary results highlighted the influence of assessment culture in the development of the intervention and considered the incorporation of contributions from tutors in a virtual environment. Tutors subsequently participated in the main study and showed similar levels of participation as their groups of students. The participation of students online was varied; even within a group, students varied in their uploads of photos, comments and reflections shared on OneNote. An incremented contribution online was observed concerning the proximity to the practical summative assessment. The Reflective Thinking Questionnaire (Kember et al., 2000) showed students engage primarily with Understanding and Reflection, suggesting students were orientated to learning (Understanding) in order to apply it later in their practices (Reflecting). Additionally, students reported the development of varied skills as a consequence of reflective practice. Those skills were: improved memory, critical thinking, self-assessment, communication, and the management of time and emotions.

With the intervention, students and tutors agreed that students move from the mechanical repetition of procedures and knowledge to integrating and understanding their actions. Still, most importantly, when reflective practice is incorporated into their preclinical training, students develop the skills that may benefit their transition to future clinical scenarios, thus bridging the theory and practice gap.

Dedication

To my grandmother Rosa Amelia López Campos

in loving memory

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Author’s Declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the *University's Regulations* and *Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

September 18th,2021

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List of Abbreviations

ACHEO	Association for Dental Education in Chile (In Spanish: Asociación Chilena de Enseñanza de la Odontología):
ADEA	American Dental Education Association
ADEE	Association for Dental Education in Europe
AMEE	Association for Medical Education in Europe
APM	Association of Professors of Medicine
CNA	National Commission on Accreditation (in Spanish: Comisión Nacional de Acreditación)
CPD	Continuous Professional Development
CR	Critical Reflection
CRUCH	Council of Chancellors of Chilean Universities (in Spanish: Consejo Nacional de Rectores)
CSL	Clinical Skills laboratory
DBR	Design-Based Research
DMIP-IV	Dental Material and Integrated Preclinical IV
FQ	Final Questionnaire
FT	Final Task
GDC	General Dental Council
HA	Habitual Action
HPE	Health Professions Education
ICT	Information and Communication Technologies
Los	Learning Outcomes
MMCS	Mixed Methods Case Study
OSCE	Objective Structured Clinical Examination
PFM	Porcelain Fused to Metal
PL	Peer Learning
PSU	University Entry Test (in Spanish: Prueba de Selección Universitaria)
R	Reflection
RQ	Research Question
RTQ	Reflective Thinking Questionnaire
SCT	Transferable Credit System
SoE	School of Education
U	Understanding
ZPD	Zones of Proximal Development

Chapter 1 Introduction

This doctoral thesis is about a research project conducted in the field of Health Professions Education (HPE), which examined the design and impact of an intervention seeking to improve learning processes and experiences of dental students. The novelty of this research lies in the use of technological tools available (e.g., open-source applications, online resources, mobile devices, and their cameras) to create a shared learning environment that promoted reflection among third year dental students. Additionally, this project aimed to develop pedagogies that might contribute to knowledge in the field and inform future educational practices.

The following sections introduce the research problem, a brief overview of the context in the field of HPE, specifically in the area of Dental Education, and a general, academic and personal rationale for the present study. The chapter will then move to briefly describe the intervention, participants, and the context of this research. Finally, the research questions are presented, followed by a general outline of each section of the thesis.

1.1 The research problem

Transferring knowledge into practice is one of the most crucial issues for students of any degree, independent of the nature of the discipline they are learning (Smith & Trede, 2013). Research has demonstrated this issue in the education of many disciplines, including medical undergraduates (McConnell & Eva, 2012; Weller, 2004), graduate teaching assistants in engineering (Zhu et al., 2013), preservice teachers (Tilson et al., 2017), nursing students (Houghton et al., 2012), and undergraduate dental students (Kobus, 2011; Serrano et al., 2018). However, transfer of clinical skills and knowledge to real scenarios is not a straightforward process with difficulties in connecting knowledge students have acquired through training with subsequent working life as a clinical practitioner (Abdalla & Shorbagi, 2018; Ashley et al., 2006; Fugill, 2005; Lee & Sim, 2020; McConnell & Eva, 2012).

It could be said that for dentistry, one of the significant challenges for undergraduates is the application of theoretical knowledge to the subsequent provision of the best possible treatment for their patients (Ringsted et al., 2011). Furthermore, traditionally the undergraduate dental programmes have been divided into preclinical and clinical stages (discussed further in 1.2.1), an artificial split common in other HPE (e.g., medicine (Ryan

et al., 2020), nursing (Madhavanprabhakaran et al., 2015)). This division, alongside teaching contributions at each stage from various professionals with different backgrounds and qualifications (Gallagher, 2004; Serrano et al., 2018; Swanwick, 2019), has reinforced the belief that teaching scientific principles should precede the development of skills within which those principles are applied (Schön, 1983). Consequently, a dissonance between learning outcomes (i.e., clinical skills) and the demonstrated learning (i.e., pre-clinical exercises) has been described in dental education (Chutinan et al., 2021), meaning that the application of these scientific principles into practice is not a straightforward process. This belief is well established in the community of health professions educators, and the idea of 'theory-practice gap' is widely understood (Abdalla & Shorbagi, 2018; Chutinan et al., 2021; Gallagher, 2004; Landers, 2000; Scully, 2011). Therefore, it is not surprising that many researchers have attempted to develop innovations to promote learning in and from practical situations, aiming to bridge that gap. Examples include the use of clinical skills laboratories (R. Morgan, 2006), simulations (Weller, 2004), use of threshold concepts (Kobus, 2011), and case-based activities (Chutinan et al., 2021).

Additionally, in dentistry, there is a growing body of literature that recognises the difficulties in the transition from preclinical practice to real clinical scenarios for dental students seeking to treat real patients for the first time (Botelho et al., 2018; Chutinan et al., 2021; Kobus, 2011; Serrano et al., 2018; Weller, 2004). Through training to become professionals, all dental trainees will face different educational strategies aiming to ease the transition from pre-clinical to clinical practice (Kobus, 2011). However, there is no clear definition of the theory behind these educational strategies (Higgins et al., 2020).

In the context of this research, reflection will be understood as a metacognitive skill that allows students to make meaning of their experiences by providing greater understandings of the self and the situation, permitting application of those understandings in future scenarios (see 2.4). There is consensus that reflection plays an important part in the dental profession, as well as the development of the capacity of reflective practice during dental training. Having the ability to reflect might help narrow the theory-practice gap by gaining a deeper understanding of what is learnt and linking it with future practice (Ashley et al., 2006; Davies et al., 2015; Gallagher, 2004; Kanthan & Senger, 2011; Koole, Fine, et al., 2016; Lewis & Jack, 2018; Ryder et al., 2008; Scully, 2011). Therefore, the strategies that could help students develop such skills should be central to their teaching and learning process with the aim of narrowing the gap between theory

and practice (Koole, Christiaens, et al., 2016; Lewis & Jack, 2018). In fact, one study has demonstrated the capacity of dental students to engage with reflective practice is increased as students' progress through the academic curriculum (Tricio et al., 2015). However, empirical research on using reflective practice enhancing the learning experience in dental education is scant (Bush & Bissell, 2008; Koole et al., 2013; Lewis & Jack, 2018; Rostami & Khadjooi, 2010)

A traditional technological object that has been used in dental training for decades is the phantom head (see 3.3). In addition, the constant development of the Internet and the Information and Communication Technologies (ICT) allows the emergence of online platforms and applications that have been influencing different aspects of our daily life, including dental education. In fact, the high level of technological engagement of the 21st-century health professions' students has been described by the literature, and the traditional training based on activities on the phantom head has been complemented with different educational initiatives with the emergent technologies (Jin & Bridges, 2014; Khatoon et al., 2013). However, many of those educational practices lack explicit support of learning theories that justify their application and latter help to explain their performance (Lacasse et al., 2019).

In summary, the present research project considers the design and implementation of a technology-mediated educational intervention aimed at promoting dental students' reflective practice. The intervention will take place before the students face the period of academic transition from preclinical to clinical practices with the aim to facilitate the connection between theory and practice and seeking to make the transition to clinical work as seamless as possible. Additionally, it considers the use of technology-mediated tools and skills that might be used in their future professionals' practices, such as the use of online applications for mobile devices (i.e., smartphones and tablets) and photographs to support reflection in an online collaborative learning environment.

Having presented the research problem and outlined how this present research aims to tackle it, the next section will provide the rationale for conducting the research, first at the academic level and later at a personal level.

1.2 Rationale

1.2.1 Academic Rationale

In general, before becoming a professional in any discipline, students must develop the knowledge, skills, values, and aptitudes in a professional environment. According to the institution where this research was carried out, students must demonstrate that they are "capable of confronting problems autonomously and independently with flexibility"' in real practice (Document, dirección de docencia,2011, p.4). The same idea is highlighted as the purpose of programmes in HPE (Ladyshewsky, 2002) where graduates must join the workforce in a challenging environment. Consequently, following the period of training and practising under supervision, they will face different scenarios. Those scenarios might differ from what they learnt at the educational establishment and may not have an obvious solution (Sandars, 2009). Kember et al. (2001) refer to these scenarios as "the nature of professional practice" defining them as the daily activities of professionals (p. 4). Consequently, future professionals must learn to deal with problems that are unpredictable or ill-structured (Kember et al., 2001; Schön, 1983).

Adult learners learn from experience with reflection, which is considered the debriefing part of any experience (Boud et al., 1985; de Bruin et al., 2019; Mezirow, 1991; Moon, 2004; Schön, 1983). Reflection facilitates learning through constructing and deconstructing the experience and developing strategies for future encounters with similar situations (de Bruin et al., 2019; Pearson & Smith, 1985). The capacity to reflect is related to the solution of ill-structured problems that may present a challenge for students and is developed at different stages within different people (Boud et al., 1985). According to Kember et al.(2001), an indication that the students have reached the understandings that enable them to cope with situations featuring uncertain information is the ability to produce reflective judgements. Therefore, the current research sees reflection as the bridge to link the gap between theory and practice experienced by dental students. Still, it is crucial to actively encourage opportunities to practise reflection during all elements of a programme, including the theoretical and practical aspects of it.

The issue of reflection in the field of medical education has been addressed by numerous studies. One example is for nursing, where studies show reflection as an essential part of professional development which helps future nurses to make sense of their practice (Bagay, 2012; Bulman et al., 2012; Burton, 2000; Pai, 2016; B. Williams, 2001). By contrast, in dental education, there are only a few studies that have investigated

student reflection, and this is highlighted by the lack of guidelines in the literature for students and clinicians in the development of the ability to reflect (Koole, Christiaens, et al., 2016). Therefore, the present study seeks to fill this gap by implementing an intervention in third year dental students that fosters reflection through the use of photographs.

Different approaches have been used to assess reflection in general, with most published studies based on self-reported questionnaires (Carr & Johnson, 2013; Kember et al., 2000). Content analysis or coding of reflective journals have also been used as research methods (Kember et al., 1999; Wald et al., 2012). Other studies have combined discussions or groups of conversations about a task designed to promote reflective practice (Davies et al., 2015). However, most studies have focused on assessing student's reflections instead of focusing on how the described students' reflective qualities can be used to enhance their learning experience.

It is also important to mention how the curricula in dental education have evolved from being completely compartmentalised and orientated to learning in different disciplines and units to being organised into more integrated structures within and across disciplines (Ceriotti Toassi et al., 2012; Howard et al., 2009). This integration tries to reduce the impact of the division between theoretical concepts and practice described above. Thus, if the curriculum is integrated, the experiences need to integrate what the students learn in the different units considered within the curriculum and help them demonstrate that they have achieved the competencies needed to treat patients safely.

The use of technology is an opportunity for the tutor to create learning strategies that may facilitate the integration by promoting a deeper understanding of the studied concepts (Howard et al., 2009; Mattheos et al., 2008). Consequently, different studies elucidate the strategies that allow getting the most out of the technology (Issenberg et al., 2005; Jin & Bridges, 2014; Rajab & Baqain, 2005). Different roles have been attributed to technology within different learning strategies. In a systematic review, Jin and Bridges (2014) recognised eight roles: (1) Access to and structuring information, (2) Curriculum platform, (3) Communication media, (4) Thinking tools, (5) Rich context for learning, (6) Collaboration spaces, (7) A perspective toolkit, (8) Scaffolding. These roles could be expected when the technical support, infrastructure and resources are used in conjunction with educational strategies. Thus, even the incorporation of a state-of-the-art simulator in dental training needs appropriate pedagogies to support such innovation

(Dutã et al., 2011). In other words, a poorly developed curriculum will not improve only with the inclusion of technology. Hence, a re-thinking of the educational aspects of the curriculum is needed.

Thus far, the evidence from other fields has suggested that promoting reflective practice in dental students might contribute to closing the gap between theory and practice and to the development of reflective skills needed for future dentists. Additionally, the potential of technological advances provides a space to develop an educational intervention that can be useful for the purpose of incorporating reflection in the dental curriculum. With this in mind, the next section addresses the rationale at a personal level underpinning the development of this research.

1.2.2 Personal Rationale

The motivation for the field of dental education started years ago when the researcher was an undergraduate student at a traditional Chilean university from 2007 to 2012. She started wondering about the strategies her teachers used to teach her. At that time, personal smartphones were an early and expensive device; and even digital cameras were not accessible for students. She remembers studying from her handwritten notes and photocopies from old transcriptions produced by former dental students. At the dental school, there is the tradition of having mentors (fairy Godmothers), who are former students who pass all their notes, drawings, photocopies, etc., to the new students. These documents served as a map to start navigating the different content included in each of the units embedded in the dental curriculum.

Amongst the remarkable documents inherited by the researcher from her mentor, apart from her beautiful drawings and summaries, were the digital copies of some transcriptions. The starting point to create these transcriptions was the notes of a student, which took contemporaneous notes based on his abilities to use his personal computer to write the lessons while the teacher talks.

As technologies progressed and the internet was more accessible for students, notetaking was transformed into something more collaborative. Students developed their skills for recording, capturing, and transcribing the slides shared by the teachers. In a cohort of nearly 80 students, turns were taken to transcribe the sessions recorded with a voice recorder. This means that the maximum a student would transcribe would be two classes each term. The researcher's cohort ended with a colourful book, full of images and

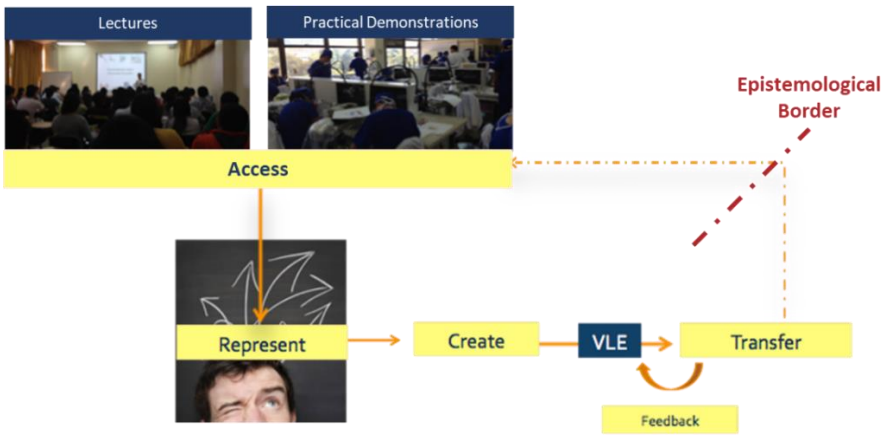
transcriptions of each of the units they had. It was a joint effort, and they felt proud of it. Everything was accessible online for all the students, any time, wherever they wanted.

When the researcher became a lecturer in March 2013, she did not expect her students to make transcriptions of her lectures. She remembers herself as a student being desperate to take pictures of slides and taking quick notes from what the tutors added. Therefore, as a lecturer, she recalls herself preparing the session and drawing and scanning plenty of images to explain some concepts to her students.

Later as technology advanced at an amazingly fast pace, the researcher became immersed in a constant search for tools that would support her work as a teacher. She undertook research in this area with a Master's degree in Computing Education and Knowledge Management between 2013 and 2016. She started learning the theory behind her beliefs and designing interventions that will contribute to the work in the field.

Together with colleagues, she authored a model of Knowledge Management in the context of dental preclinical practices (Careaga et al., 2014), which was applied to a virtual learning environment (see Figure 1). It included a previous model presented by Careaga and Avendaño (2006). It studied error as a source of learning instead of punishment in a system where assessment is focused on results rather than the process. The results of this research contributed to the interest of the researcher in creating a collaborative learning environment where students share with their groups all their experiences, not only their errors and have the space to comment and reflect on them.

Figure 1
Knowledge Management Model applied to Dental Preclinical Practices



Note. VLE=Virtual Learning Environment
Model used in researcher master's thesis including the epistemological border suggested by Careaga and Barnes in 2015 see in Pino and Careaga (2018)
Yellow squares represent each of the components of the model.

The model presented in Figure 1, represents the traditional 'accesses' to the information provided in lectures and practical demonstrations, with the addition of Virtual Learning Environment (VLE), where the transfer of knowledge was possible. With the information presented, students then 'represented' what they need to accomplish on their minds. This is followed by students conducting a simulated treatment in a phantom head and recording their experience to share it later ('create'). When the students can transfer their knowledge, they cross the epistemological border (Figure 1, red dotted line), i.e., they become active actors in the production of their knowledge, demonstrating and sharing their understandings.

1.3 Research outline

Within this research, a cooking recipe analogy will be used to consider an approach to learning which seeks to collect a series of ingredients and follow the directions to produce a tasty dish. However, if one expects to prepare dinner, it is not only the plate that will charm our guests; there are plenty of other aspects that are only achievable with the experience and reflection, socialising with our guests, and learning from past experiences. So, this dissertation is an invitation to see future patients as the dentist's guests and the treatment, the most delicious plate they have ever tasted. This analogy has been used before in dental education to highlight the fact that

> it would be quite difficult to master the skills of a great chef from only reading a recipe book. Preparing meals in concert with the head chef allows the two-way observation, feedback, and unspoken communication so important to learning procedural skills like sports, martial arts, and cooking. (Horst et al., 2009, p. 930)

Following the same idea, the dentist is not just following the recipe; they integrate all aspects to treat a patient as expected from a professional. For this research, this idea of integration is promoted by means of an educational intervention, which incorporates the action of reflection prompted by photographs taken by the students during their practices. Therefore, the action of reflection is thought of as a bridge between the learning the student does during their preclinical practices and their subsequent clinical treatments of their patients. The intervention is a product of this study, as well as understandings gained from its design, application, and performance into dental educational practices.

Literature has suggested that the inclusion of reflection in dental education could help bridge the gap between theory and practice. Additionally, technology offers a possibility to develop new and creative approaches (e.g. digital storytelling) to motivate and engage students in reflective learning (Sandars et al., 2008). Therefore, this research made use of photographs (seen in 3.5) with pedagogical function in promoting students' reflection. Photographs are widely used in dentistry for different purposes (e.g., documentation, communication to the laboratory, education), but this research also included them because they can be used as material to creatively trigger reflection (Lewis & Jack, 2018; Sandars et al., 2008). Thus, during the students' practices, they were encouraged to take photographs at their discretion of the procedures they were undertaking and comment and reflect upon them while sharing their experiences with their peers. This provided a wide range of backgrounds and perspectives about a determined procedure studied within the Clinical Skills Laboratory (CSL).

As outlined above, an educational intervention that incorporates reflection (see 5.2) was designed and implemented in a selected pre-clinical unit of the dental programme in a Chilean university. The intervention involved third year dental students' practices using free applications supported in mobile devices for their learning. In this preclinical unit, students' training simulates the work to be undertaken in real practice, including the different procedures used to teach them how to perform some treatments, which are highly standardised. However, their future patients will vary, and students must develop the capacity to deal with this inter-patient variability in the presentation of clinical situations and response to treatments and deliver the best possible solution. Thus, the incorporation of reflection during preclinical practice is an opportunity to develop such skills and facilitate the process in which students develop into practitioners in a safe educational environment without damaging patients.

The potential benefit of reflective practice has been acknowledged (see 2.4.3) and included into the design of this educational intervention. The use of diverse methods for data collection, e.g., focus groups with tutors and students, observation of practices at the clinical skills laboratory, collection of students and tutors' contributions, were intended to obtain a more profound understanding of the design, implementation, and enactment of the outlined educational intervention.

This research sought to investigate three main questions (RQ) following a pragmatic approach. It studies an educational intervention using photographs of studied procedures

at CSL taken by dental students with their mobile devices to encourage reflection; and secondly, the impact of such interventions in developing professional knowledge and skills in future dentists. For this purpose, Design-based research was the selected methodology to design and study the intervention. Multiple sources and methods were integrated to comprehensively answer the research questions seeking to understand teaching and learning as an activity constructed through social interactions (see 2.3).

The research questions are as follows:

RQ1: How does Design Based-Research inform the design and enactment of the educational intervention?

RQ2: What are the students' experiences and perceptions about the impact of the educational intervention on the teaching and learning processes?

RQ3: What are the experiences and perceptions of the tutors about the impact of the educational intervention/ reflective practice on the teaching and learning process?

1.4 The organisation of the thesis

The thesis is comprised of ten chapters, articulating the context, theoretical underpinnings, methodology, results, discussion, and conclusions. **Chapter 1** introduces the reader to the research problem and provides the rationale for conducting the research on an academic and personal level. It also presents the research questions and outlines the structure of the thesis to guide the reader through the different sections. **Chapter 2** explores learning and teaching in health professions education, including the theories to understand how students learn and how teachers teach. Consequently, it provides a review of the teaching and learning theories that supports this piece of research. **Chapter 3** reviews learning and teaching in dental education, exploring its evolution alongside the history of dentistry. Moreover, this chapter addresses issues related to the dental curriculum. This is followed by pedagogical trends in dental education.

Chapter 4 describes the research aims, objectives, and sets out the research questions. After this, an explanation of the methodological approach employed in this study is introduced. Next, a section of the methods used for data collection and data analysis is presented. Finally, this chapter addresses the ethical considerations, such as the anonymity of participants and issues of power relationships.

Chapter 5 presents the context where the educational intervention was designed. It describes the details of the Chilean Dental curriculum, the university, its undergraduate dental programme, and the intervened unit, thereby explaining the context within which the intervention was developed. This is followed by the prototype of the intervention and its implementation and results from the pilot study. The concluding part of this chapter includes the reflections made by the researcher. It outlines the decisions taken to conduct the main study, which is discussed further in the following chapters.

The findings of the main study are presented in the following three chapters, presenting the evidence that supports the answers to the research questions. **Chapter 6** focuses on the first research question, which is concerned with how Design-Based Research informs the design and enactment of the educational intervention. **Chapter 7** presents the results on the second research question, which addresses the experience of students regarding the teaching and learning process because of the intervention. **Chapter 8** is concerned with the findings of the third research question, which is aimed at gathering data about tutors' experiences and perceptions of the impact of the educational intervention in the learning and teaching process.

Finally, **Chapter 9** includes the discussion of this piece of research. It begins with an overview of key findings, followed by a discussion of the data presented to answer the research questions. This is followed by **Chapter 10**, in which the study contributions, strengths and limitations of the study are discussed. Additionally, this final chapter presents recommendations based on the results obtained and points out several possibilities for future research.

Chapter 2 Learning and Teaching in Health Sciences

This chapter considers the theories behind teaching and learning that have guided the development of this research. Firstly, it presents the relevant background to intervention decisions. Following this, it analyses the subsequent design and study of its implementation and performance. Specifications about Health Professions Education (HPE) and particularly about Dental Education are important, as they facilitate a better understanding of how this research was developed. Therefore, it is necessary to highlight beforehand that none of the theories operates alone and that there are variegated factors that influence their selection, such as curriculum design, the objectives of the course, the state of development of the students, and the abilities and characteristics of teachers, among others (Torre et al., 2006). Consequently, it is undoubtedly important to understand the theories which underpin health professions education in order to use them appropriately (de Bruin et al., 2019; Kaufman, 2019; Shaker, 2018; D. Taylor & Hamdy, 2013; Torre et al., 2006; Young et al., 2014).

2.1 How do students learn? An overview of Learning Theories

Lecturers and professors in health education are, in most cases, health care professionals who have become teachers (Serrano et al., 2018; Swanwick, 2019). In this respect, it is important to highlight that their pedagogical practices have been transferred from generations of academics according to what worked for them in practice, and are rooted in positivistic approaches due to the adoption of the theories and methods often used in medicine and which are close to natural science (Swanwick, 2019). In more recent times, due to the increasing influence of best evidence practice in Health Sciences Education, understanding the way that students learn is a central focus within a learner-centred environment (de Bruin et al., 2019).

Thus, different theories provide an understanding of how students learn and, therefore, how teachers can best approach learning activities, designing, and using them in relation to the available tools and to students' capabilities and needs. This is important in this particular research to build an understanding of the development of an intervention which aims to enhance educational practices. Theory provides a lens to see the curriculum and practices in situ and detect which aspects could be improved.

Historically, the education model in the field of health professions was dominated by an apprenticeship model, where an apprentice, through the observation and imitation of

the craft, absorbed and developed the established skills of their mentor, as traditionally in medicine (Gourevitch, 2000). Additionally, different factors (i.e., technological development, influences from other disciplines) have been influencing the traditional ways of teaching and learning in higher education (Kolb, 2015) and health professions education (de Bruin et al., 2019), where a teacher-centred top-down educational model had held sway in the field for centuries. In more recent times, the development of new training standards for accreditation processes, the evolution of care systems to a more multidisciplinary approach, the importance given to continuous professional development, and the integration of evidence-based practices, among others, have each raised interest in and awareness of learning theories in medical education (Torre et al., 2006). However, Swanwick (2019) questions whether Medical Education is a discipline per se or an "idiosyncratic collection of concepts appropriated from other educational fields and perfused with a technical rationality borne out of the dominance of bioscience within medicine" (p.3).

In this sense, the same author mentions that there are dominant assumptions in the field. It is not only a 'magpie' of ideas randomly juxtaposed from different places, but rather an emergent field with significant further contributions to the broader educational literature.

Before referring to any individual Learning Theories, it is important to acknowledge, as mentioned by other authors (i.e., Taylor and Hamdy (2013), Kaufman (2019), Rostami and Khadjooi (2010), Young et al. (2014), that often different theories overlap and could be used as complementary and contrasting explanations when studying the same phenomena. In this way, considering the same scenario, many authors have attempted to summarise the theories of learning in medical education. For example, Lacasse et al. (2019) review the literature trying to map out the conceptual frameworks in health professions education from 2011 to 2016 finding that they are generally grouped by discipline or field of activity. However, they highlight that independent of the learning theory used to explain an educational phenomenon, it is important to know about it in order to use it productively to enhance students' learning experiences.

In this vein, Taylor and Hamdy (2013), authored the Association for Medical Education in Europe (AMEE[1]) guide entitled: 'Adult learning theories: implications for learning and

[1] Worldwide organization, currently conceived as being the International Association for Medical Education part of the World Federation for Medical Education - https://amee.org

teaching in medical education: AMEE Guide No.83'. In this guide, learning theories are outlined and grouped into the following four categories: i) **Instrumental learning theories**, referring to learning that focuses on experience as a source of learning; ii) **Humanistic theories:** grouping theories promoting individual development and highlighting students' capacity for self-actualisation; iii) **Transformative learning theories:** theories which are based on reflection as a way of changing beliefs and assumptions, and finally iv) **Social theories of learning:** those which consider the context and communities, stranding from the base sustaining that learning and thinking are social activities that are structured by the characteristics of the environment. Additionally, they highlight that any theoretical model aiming to explain adult learning should include motivation and reflection.

Traditional models of teaching and learning were centred on the vertical transference of knowledge from the teacher to the students, rather than considering it as an activity centred on learners (Bonk & Cunningham, 1998). In this sense, the aspects highlighted by Taylor and Hamdy (2013) on the AMEE guide form part of a more considerable contribution towards more learner-centred education. Despite all these separate classifications, the authors acknowledge that there is much overlap between them. For this reason, they propose a multi-theory model of adult learning. From the model, it is possible to highlight the integration of different theories which determine how students face a learning task which causes dissonance activating a reflective process, which according to the model, is the starting point in adult learning processes.

Similarly, the Association of Professors of Medicine (APM) in the United States (Torre et al., 2006) classify Learning Theories applicable to Health Professions Education. They suggest that the strength is knowing the theories that could serve as a useful background with which to analyse the decisions taken by educators depending on their specific outcomes. They considered five distinct orientations to put together learning theories, including **i) behaviourist**, **ii) cognitivist**, **iii) humanist**, **iv) social learning**, and **v) constructivist** orientations to learning, based on previous studies of adult learning.

Behaviourist theories look for a change in behaviour using different techniques as a reward, for feedback, and as reinforcement (Torre et al., 2006). Theories under this classification were found useful for explaining some of the issues affecting competency development and demonstrating technical and psychomotor skills. (Rostami & Khadjooi, 2010). However, it could be argued that this body of theory does not take sufficient account of the transferability of the skills developed. Unfortunately, the situations that

future professionals will face may differ from the ones in which the skill was trained and possibly leave the student without the tools to properly deal with them (Rostami & Khadjooi, 2010; Torre et al., 2006).

Cognitivist theories focus on the development of the internal skills of students as insight, information processing, perception, and memory. In other words, they seek to understand the thinking processes behind learning (Shaker, 2018). Cognitivism has been associated with acquiring theoretical knowledge but is rarely related to acquiring the motor skills needed in most health professions (Shaker, 2018). Nonetheless, when it is associated with motor skills training, it considers rigid task execution and aims to reduce the cognitive load by building intrinsic understandings of the studied processes (Spruit et al., 2014). However, if one only considers cognitivist theories in an isolated sense, it will not thoroughly explain how students apply what they learn in this rigid task execution environment to the variability of clinical scenarios.

Humanist theories focus on students' personal growth; they are orientated toward the development of self-directed learning, responsibility, creativity, curiosity and interest in the arts (Rostami & Khadjooi, 2010). There is a growing body of literature that internalises the first principle: self-directed learning, which indicates the importance afforded in Health Professions Education to the development of the student as an independent learner, not only during their training period but also as an intrinsic characteristic of them as professionals (Dornan et al., 2005).

Social learning theories consider learning as a social process, which occurs in relation to the environment and to people, and is mediated by individual interactions (Torre et al., 2006). Learning is not simply seen as an individual activity but more as a collective endeavour (Mann, 2011).

Constructivist theories relate to making sense collectively or socially of experiences, providing an active role to the learners in constructing their own knowledge (Mann & MacLeod, 2015; Torre et al., 2006). Further discussion of this will be presented in 2.3, as an exercise of reflective practice included within this research, which is informed by a social constructivist lens.

Although these theories have been broadly discussed in the literature, there were other attempts to show a comprehensive view of how adults learn. For example,

Andragogy, is suggested as the best set of principles or assumptions to guide adult learning in practice (Merriam et al., 2006).

2.2 Andragogy

Higher education involves teaching adults. In this regard, Andragogy is well suited to trying to understand how adult learner learns. Knowles (1980, p. 43) defines andragogy as 'the art and science of helping adults learn'. The term emerged in contrast with pedagogy which focuses on the teaching and learning of children (Merriam et al., 2006).

It could be suggested, then, that the main contribution of Knowles is shifting the focus from teaching to the emphasis on learning. The main principles that emanate from his work could be summarised in four key assumptions about how adults learn in contrast to children, and can be reviewed in relation to the learner, their experience, readiness to learn and the orientation towards learning. Thus,

> 1. Their self-concept moves from one being a dependent personality towards being a self-directed human being.
> 2. They accumulate a growing reservoir of experience that becomes an increasingly rich resource for learning.
> 3. Their readiness to learn becomes oriented increasingly to the developmental task of their social roles, and
> 4. Their time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly, their orientation toward learning shifts from one of subject-centeredness to one of performance-centeredness.(Knowles, 1980, pp. 44–45)

Those principles have been applied in the health professions education, suggesting the characteristics which need to be considered when designing teaching activities (Reed et al., 2014). Therefore, the challenge is to connect those assumptions with the wider understandings of the learning process which explain how future health professionals learn.

By drawing on the concept of Andragogy, Badyal and Singh (2017) argue that there are similarities between how formal schooling students and medical students do not have control over how or what they learn and how in both you find students who are not equally internally motivated. Therefore, it was concluded that Andragogy is better

considered as a concept rather than as a theory itself (Badyal & Singh, 2017; Taylor & Hamdy, 2013), which describes in better details the characteristics of adult learning rather than understandings of adult learning itself (Merriam et al., 2006). Additionally, Knowles (1980) highlighted that andragogical and pedagogical principles are not polar opposite ideas, and thus the principles could be applied in a complementary manner depending on the particular circumstances.

In summary, whilst there are many theories available to draw upon, none of them will entirely explain how future professionals learn in an isolated and reductionist fashion. The common thread between them though is the possibility of providing multiple strategies for educators to nourish provision and analysis (Mann & MacLeod, 2015). Thus, for example, theorists who exclude the capacity for self-direction from their view of human potentialities restrict their research to the external sources of influence (Bandura, 1977). Similarly, theories which focus on acquiring motor skills under rigid task execution (Spruit et al., 2014) limit the transferability of the skills developed (Rostami & Khadjooi, 2010; Torre et al., 2006). Therefore, the educator's role is to look for the 'resources in which each learner can flourish' (D. Taylor & Hamdy, 2013, p. e1561). On account of this, this research embraces the recommendations from AMEE about how different theories enlighten educational practices. Consequently, it follows an eclectic multi-theory approach in order to provide a richer more nuanced analysis of the plural factors which play a role.

What follows is an analysis of the theories which aim to contribute to the closure of the gap between theory and practice and which reduce the difficulties students have when transitioning from preclinical to clinical practices.

2.3 Social Constructivism

The research described in this thesis was conceived mainly from a social constructivist standpoint, where teaching and learning make us think of learning as a social activity embedded within classroom interactions (Watson, 2001). Consequently, we do not learn in isolation (Andrews, 2012). Therefore, learning is conceived as a dialogical activity possible within a sociocultural context. Furthermore, the instruction, is centred on the student, and incorporates tools and structures to promote the development of students' cognition as well as to incorporate strategies of communication and remembering, and also creating a community of practice (Bonk & Cunningham, 1998).

Constructivism can be understood from different approaches emanating from different disciplines, such as psychology and philosophy. As a general view:

> It is a learning or meaning making theory. It suggests that individuals create their own new understandings, based upon the interaction of what they already know and believe, and the phenomena or ideas with which they come into contact (Richardson, 1997, p. 3).

Constructivist principles include an acceptance by teachers of student autonomy and their initiative, an awareness of how students question and analyse ideas and concepts, who are problem finders rather than problem solvers, who are free to play with and explore ideas and gain new information, and furthermore, through a discourse with the teacher or colleagues facilitates being able to go through the meaning making process (Brooks & Brooks, 1999). There is a recognition of the Zones of Proximal Development (ZPD), which are "the distance between actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adults guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

Assuming that "social interaction is central to the development of new patterns of thoughts and strategic behaviours" (Bonk & Cunningham, 1998, p. 36).

2.4 Reflection

2.4.1 Definition

The importance of reflection and reflective practice are frequently noted in the literature. Indeed, reflective capacity is regarded by many as being an essential characteristic for professional competence (Mann et al., 2009, p. 595). The most influential work on the topic of reflection was produced by Dewey (1933), with his book entitled '*How we think?*', followed by Habermas (1971) with '*Knowledge and Human Interests*'. The latter treats epistemological issues in the sociology of knowledge. Therefore, most of the definitions of reflection include elements of what Dewey (1933) defines as a reflective thought as an "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it , and the further conclusions to which it tends" (p. 7).

Additionally, these definitions incorporate elements from the transformative dimensions of learning exposure elaborated by Habermas, where an experience is reinterpreted, thus gaining a new meaning and perspective (Mezirow, 1991), and reflected upon in order to understand the process which is underlying the generation of knowledge (Moon, 2000). In this regard, Mezirow (1991) defines reflection as "the process of critically assessing content, process, or premise(s) of our efforts to interpret and give meaning to an experience" (p. 104).

Content and process reflection care about what and how a person perceives, thinks, feels, or acts in the way that she or he does. However, premise reflection also require a critical review of presuppositions which are internally assimilated, and according to that, can transform our meaning framework (Mezirow, 1991).

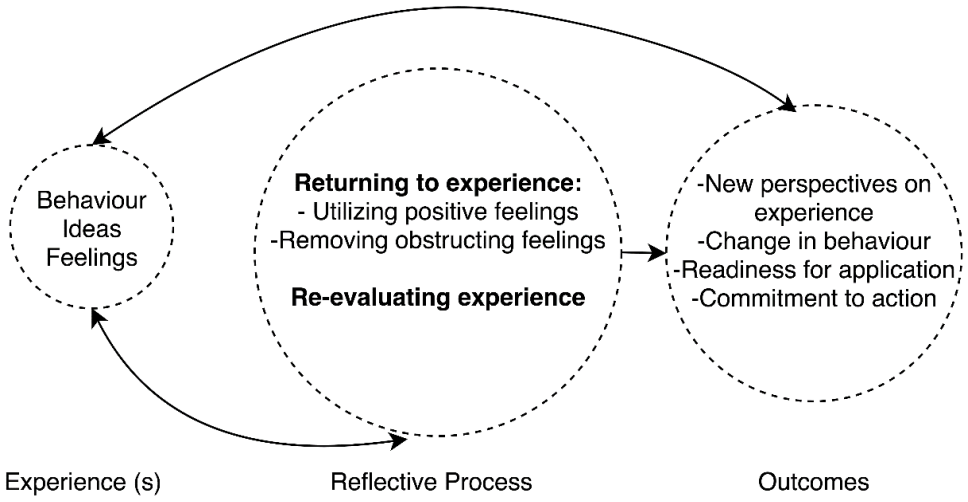
A technical rationality model has dominated academic scenarios since the industrial revolution. It provides a hierarchical separation between research and practice, and the curricula in schools of professional learning thus focus on relevant basic and applied sciences and the skills needed to become a competent practitioner according to this paradigm of thought. A secondary importance is given to skills development, and problem solving displaces the importance of problem setting. Therefore, the work of Schön (1983) is notable in presenting the transition between technical rationality and an epistemology of practice as the critical view of practitioners from different disciplines, emphasising the connection of thinking and doing, and complementing the practical competencies in divergent situations that have been missed in the model of technical rationality. Schön considered two elements of reflective practice: firstly reflection-in-action and secondly reflection-on-action, with a failure to recognise the importance of reflection-before-action (Moon, 2000).

Other countermodels emerged to explain the complexities of the reflective practice, understanding it as "an important human activity in which people recapture their experience, think about it, mull it over and evaluate it" (Boud et al., 1985, p. 19).

The model presented in Figure 2 incorporates and integrates the most significant aspects of reflection (i.e., experience, reflecting process and outcomes). In this model, Boud et al. (1985) emphasise that to enhance the learning process a link between the learning experiences and reflective activities is needed. Additionally, they mentioned that a model for learners and teachers would be useful to support and encourage the reflective processes of the learners. Their model considers three interconnected stages. First, the

experience, which includes behaviour, ideas, and feelings. This is followed by a reflective process, where the learner returns to the experience aiming to re-evaluate it. As a consequence of this process, it is anticipated that the learner will gain a new perspective of the experience, duly adapt their behaviour, and get ready to apply or act upon what they have learnt.

Figure 2
The reflection processes in context



Note. Source: adapted from Boud et al. (1985, p. 36).

Reflection is a desirable skill for future professionals (Jonas-Dwyer et al., 2013), especially for those who need to learn from their practices (Kember et al., 2001). Likewise, in dentistry, a mature professional is someone who can perform as an expert and has obtained the ability to gain learning from his or her daily practice and can make independent judgments.

A definition from Sandars (2009) could be used as a starting point for analysing reflection. It considers reflection as "a deliberate process used to develop an understanding or making sense of a situation so that future actions can be informed" (p.687).

Self-regulated and lifelong learning have reflection as an essential aspect, and it is also required to develop both a therapeutic relationship and professional expertise (Sandars, 2009, p. 695).

Thus far, within this research reflection is understood as a metacognitive skill of thinking, taking an outcome into consideration; not just think-to-think (Boud et al., 1985).

It is something that is planned to put the ideas we already know in order and to reorganise them. Therefore, with a clear objective in mind, a person will reflect on something that is uncertain or ill-structured. It creates a better understanding of oneself and the situation, impacting on lifelong learning. It helps students to focus on what they need to learn and to integrate learning from different sources (A. Grant et al., 2006; Moon, 2000; Sandars, 2009). Reflection is conceived as an epistemology of practice (Schön, 1983), meaning that it is a way of being, seeing and understanding practices as a place where knowledge emerges. Thus, practice becomes an uncertain, unstable, unique and value-conflicted situation where practitioners "as inquirers of their own practice, engage their reflective capacities to question assumptions, (re)frame situations, examine their practices, test potential moves in the midst of practice, and consider possible ways forward" (Ng et al., 2015, p. 464). This is complemented with a broad conceptualisation of reflection as a social activity within the educational context. Knowledge emerges from social interactions (see 2.3) and reflection is embedded within the social and systemic forces which shape individual assumptions and experiences (Ng et al., 2015; Warman, 2020). Understanding reflection as a social activity therefore valued social interactions within an educational environment which meant a better understanding of the self and others and the situations which prepared individuals for further encounters with similar scenarios. It is the recognition that knowledge from interactions and the collaboration of individuals frames the understanding of how individuals make sense of their experience and navigate the plural uncertainties of practice.

2.4.2 Categorisation of Reflection

After defining reflection, we will now go on to consider to what extent a person reflects. According to King & Kitchener (1994), it depends on the assumptions a person has about knowledge and how a special situation can be ill-structured or messy and demand reflective judgment for its solution. They described seven sets of sequentially developed assumptions, or patterns of responding to ill-structured problems. These must guide the actions of teachers to make sense of their students' experiences through understanding that those epistemological assumptions inherently affect their reasoning (King & Kitchener, 1994). The model is well summarised by Kember et al.:

Pre-Reflective

1. Knowledge is absolute.

2. Knowledge is absolute but not always immediately available. It can be obtained from authority figures or directly observed.

3. Knowledge is absolute in most cases but temporarily uncertain in others.

Quasi-reflective

4. Knowledge is uncertain as there is always an element of ambiguity in evidence.

5. Knowledge is personal since individuals have to interpret the evidence.

Reflective

6. Knowledge about ill-structured problems is constructed by evaluating evidence and the opinions of others.

7. Knowledge of ill-structured problems is constructed from inquiry which leads to reasonable solutions based upon evidence currently available

(Kember et al., 2001, p. 12)

According to Moon's review on reflection, the depth of reflection a person achieves is related to the learning process and may prove to be the difference between a surface or deeper approach to learning. With this in mind, a superficial approach to reflection involves a person who mainly memorises facts. In contrast to a deeper approach where there is an attempt to understand their meaning in relation to previous knowledge (Moon, 2004). Thus, profound reflection is related to a review of the manner in which a person uses their frames of reference to make sense of a given experience, it implies a metacognitive stance and an understanding of how knowledge is constructed. On the other hand, a superficial reflection has no significant difference with mere description (Kember et al., 2001; Mezirow, 1991; Moon, 2000).

In the same context, Mezirow (Mezirow, 1991) offers a framework that incorporates various levels and types of reflection, differentiating reflective action from non-reflective action. Non-reflective action includes three kinds of action (i.e., habitual action, thoughtful action, and introspection). Those non-reflective actions could be understood as follows:

i. **Habitual action**, such as riding a bike or driving a car, are the actions which require effort, practice, and concern over it, but later becomes performed mechanically or automatically without focal awareness.

ii. **Thoughtful action** uses previous knowledge to plan the next moves, without altering meaning schemes or perspectives. A good example is provided by Kember

et al., the 'book learning', when a student tries to make sense of a concept in a book without considering his or her previous knowledge (Kember et al., 2001, p. 18).

iii. **Introspection** is the recognition or self-awareness of one's own feelings and thoughts.

On the other hand, reflective action includes a checking back of actions, to understand the ideas, values, and consequences, behind them. It involves reflection and a critique of **what** (content reflection), **how** (process reflection), and **why** (premise reflection) we perceive, think, judge, feel, and act the way we do (Mezirow, 1991, pp. 106–111)

2.4.3 Reflection in teaching and learning

Adult learners, then, learn from experience through reflective practice (Boud et al., 1985; de Bruin et al., 2019; Mezirow, 1991; Moon, 2004; Schön, 1983). Learning occurs through constructing and deconstructing the experience and developing strategies for future encounters with similar situations (de Bruin et al., 2019; Pearson & Smith, 1985). This issue has been addressed by numerous studies showing that reflection may be useful if considered in a teaching and learning context. It was reported that reflection facilitates students understandings and recognition of their learning needs (A. Grant et al., 2006); enables students to get the most from feedback received from tutors (Forsythe & Johnson, 2016); helps professionals make sense of their practice by increasing the impact of the learning experiences (Orsmond et al., 2002; Strauss et al., 2003); eases students development of better motor skills as they develop their abilities to reflect on their performance (Ste-Marie et al., 2013); helps students to develop a therapeutic relationship with patients. All of those characteristics suggest that reflection may help students to develop their professional practice (Ahmed, 2018; Sandars, 2009).

To help understand student reflection, the literature suggests educators ask students to recall a **significant clinical experience**, known as an analysis of a critical incident (e.g., Baernstein and Fryer-Edwards (2003), Alphonso (2007), Rostami and Khadjooi (2010)), and **promote reflective writing by using portfolios** (e.g., Dasgupta and Charon (2004), Wald and Reis (2010), Koole et al.(2013) Tonni et al. (2016)), among the most common published initiatives. Additionally, after graduation, students are involved in continuing professional development, requiring reflective practice to demonstrate they are competent as professionals (Tran et al., 2014).

Despite evidence showing that reflection facilitates learning in many different Health Professions Educations (Ahmed, 2018; Foley et al., 2015) there is paucity of published literature relating to dental students' reflective practices. Additionally, the lack of guidelines for health professions' students and clinicians to develop and teach the ability to reflect (Koole, Christiaens, et al., 2016). In the same way, Wulf et al. (2010) suggest that reflective practice could be controversial, it posits:

> Does one really want to become reflective in the midst of taking a critical incision with a scalpel, disrupting smooth motor control? Or would it be best to reflect before and after cutting action on whether conditions have been optimised or on assessing the consequences? (p. 82).

However, besides this point being considered controversial, they found that four factors related to reflective practice enhance the learning processes of motor skills: observational practice, the focus of attention, feedback, and self-controlled practice, highlighting that "training in the medical field is not to facilitate performance during practice, but to enhance the learning and transferability of clinical skills" (p.76).

Additionally, the literature highlighted that tutors need to promote and assist students' reflection in order that they acquire deep knowledge (Ahmed, 2018). However, empirical research on using those reflective capabilities enhancing the learning experience in dental education is scant (Bush & Bissell, 2008; Lewis & Jack, 2018; Rostami & Khadjooi, 2010).

It is noteworthy that a commonly described problem in the literature is the lack of engagement with reflection for undergraduate students, probably due to reflection being considered an informative process; students are focused on summative assessment rather than reflective activities, and are not taught content about reflection within the curriculum; together with a lack of staff to provide feedback on reflective product (Ahmed, 2018).

2.4.4 Assessing Reflection

The literature describes different approaches to assessing reflection (Ahmed, 2018; Ghanizadeh & Jahedizadeh, 2017; J. C. Williams et al., 2019) Most of these are based on self-reported questionnaires (Carr & Johnson, 2013; Kember et al., 2000), while others are based on content analysis or the coding of reflective journals (Kember et al., 1999; Wald

et al., 2012), along with groups of discussions about a task which is designed to promote reflective practice (Davies et al., 2015).

As defined as a metacognitive skill, either writer or verbal assessment may decrease the validity of the assessment as they could be influenced by the questions that are asked or could be confounded with the introspective ability of the student assessed (Ahmed, 2018; Atkins & Murphy, 1993). However, in the case of written reflection, Moon (Moon, 2004) highlights that reflective learning involves reflective writing, the latter being the evaluated construct. Additionally, Moon remarks that the best way to evaluate if a student acquires the learning needed to progress in their programmes is to ask them to demonstrate the ability that they gain through such learning. The topic of assessing reflection will be discussed in further detail in the research design (see 4.4.4).

2.5 Peer Learning (PL)

The fact that students learn from others in the field of medical education is well known (Secomb, 2008) However, it has only been incorporated into formal activities relatively recently (Harden & Laidlaw, 2021). Commonly, people learn from each other in many contexts of daily life, mainly if they share an activity or background (Boud, 2001). In educational contexts, it has probably always taken place implicitly and vicariously (Topping, 2005). Informally, students learn while they are interacting with others. Furthermore, and close to the research area, Secomb (2008) conducted a systematic review of peer teaching and learning in clinical education and found that PL is a commonly used strategy. However, it lacks detailed definition and formal implementation. Additionally, students teaching one or more fellow students are largely underused within dental education (Cameron et al., 2015).

The potential benefits that peer learning could add to the students' learning and teaching may be influenced by the students' personal characteristics and might only benefit those who have innate abilities to both socialise and network. Therefore, providing this beneficial opportunity to all the students could require a detailed formalisation of such practices (Boud, 2001).

Topping (2005) proposes a definition for Peer Learning (PL) :

> the acquisition of knowledge and skill through active helping and supporting among status equal or matched companions. It involves people from similar social

> grouping who are not professional teachers helping each other to learn and learning themselves by so doing (p. 631).

Additionally, peer-assisted and self-directed teaching methods in undergraduate courses help students and teachers. For students, it helps them to become lifelong learners and to develop reflective practice and self-awareness (Candy et al., 1994), and to improve learning in the psychomotor and cognitive domains of clinical practice (Secomb, 2008). For teachers, it helps them to overcome the difficulties in understanding the approaches in the performance of beginner students' skills, and thus to give them appropriate feedback. Peers who are at the same cognitive stage could provide useful feedback (Walsh et al., 2011). The advantage is that the students, as they are in the same situation and position, experience similar challenges and can communicate in a relaxed environment through similar language (Cameron et al., 2015).

Other benefits of PL are described in the literature, for example, cognitive development, increases in self-confidence, autonomy, clinical reasoning, self-evaluation, collaboration with peers, learning opportunities and the development of transferable skills (Secomb, 2008; Topping, 2005), and finally, a few potential disadvantages, such as occasional incompatibility with others (Ibid). A more competent student may guide a less competent or knowledgeable one, and act as a model. This modelling element could contribute to enthusiasm, competence, and the possibility of success. In this context, students could have the modelling experience of a peer which could influence the self-monitoring, self-awareness, and self-regulation of their learning process, contributing to their development in their independent practice and thus keeping them motivated while performing the task (Topping, 2005).

In the context of this current research, the goal is that students simultaneously learn and contribute to each other's learning.

2.6 How do teachers teach?

This section echoes the understanding of how students learn (see 2.1), as those understandings support teachers' decisions. The historical model in Health Professions Education (HPE) embraces that people that have been students almost automatically have the ability to teach, and therefore, little or no training has been offered to those that assumed the role to teach (Steinert, 2019). In this way, there is a historical portrayal of a

teacher who is an expert in a determined area that allowed students to watch their work. In that case, the prevailing criticised concept of 'everyone teaches' (Simpson et al., 2007) would continue to be valid. However, the recognition of different theories that explain how people learn led to the scholarship and research of teaching and the role of educators in the field of HPE (Steinert, 2019; Torre et al., 2006).

It is noteworthy the lack of an underlying conceptual framework in the development, implementation and evaluation of many educational innovations in the field (Lacasse et al., 2019). Consequently, teachers are expected to use approaches that provide a solid and evidence-based background to their educational practices and possible innovations (Franks & Payakachat, 2020; Lacasse et al., 2019).

Learning theory works as a set of interconnected principles and ideas that provide possible explanations for certain phenomena in relation to educational processes (Badyal & Singh, 2017). Therefore, sometimes multiple theories are required to understand and design educational practices. Still, their importance may vary depending on the topic, the group of learners, or both, as they are interrelated, interconnected, and depend on characteristics of each educational environment (Kaufman, 2019; Lacasse et al., 2019; D. Taylor & Hamdy, 2013). Knowledge of these theories could help educators inform their decisions regarding their instructional strategies, learning objectives, and evaluation approaches (Kaufman, 2019; Mukhalalati & Taylor, 2019; Torre et al., 2006). As a result of this, educators will lead their students to the best learning experience based on their understanding of the teaching and learning processes involved.

The literature highlights the compromise from teachers and educators to reassess their practices and seeks innovations that could positively impact teaching and learning processes (Bartle & McGowan, 2021; Torre et al., 2006).

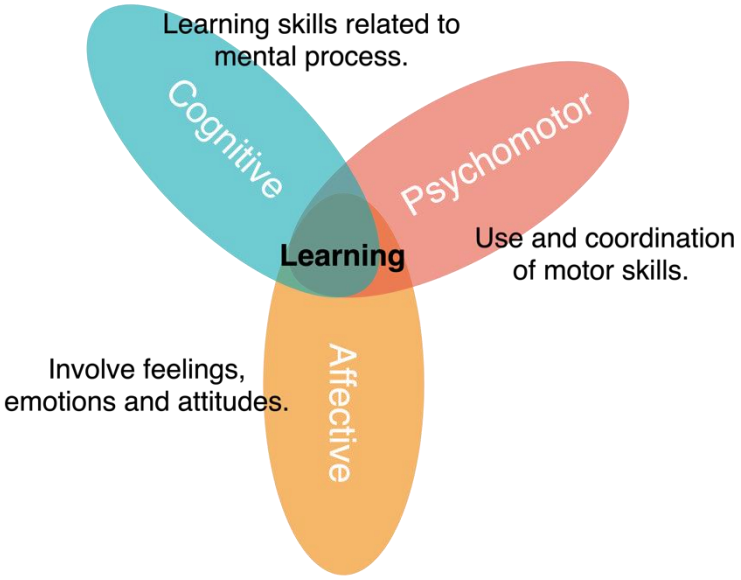
2.7 Understanding the guidelines in the field

Different approaches have been used to understand the complexities of promoting the effective development of students' skills , knowledge and attitudes in the field of Health Professions Education (Mann, 2011). Consequently, the International Association of Medical Education provides a guideline, AMEE Guide no.83 (D. Taylor & Hamdy, 2013) about how different theories are applied in medical education. In this document, the authors categorised different adult theories that came from different fields, e.g., psychological theories and pragmatic observations. They took a constructivist approach

and highlighted that learning should include the acquisition of three domains: cognitive, psychomotor, and affective, as displayed in Figure 3. **Cognitive** domain includes learning skills related to mental process; the **Psychomoto**r domain, the use and coordination of motor skills; and the **Affective** domain, feeling, emotions and attitudes. Therefore, when considering a theory of learning one should include all of the domains described above, as they are essential to performing as an independent professional (D. Taylor & Hamdy, 2013).

Figure 3

Representation of Learning domains related to Medical Education and general description of them

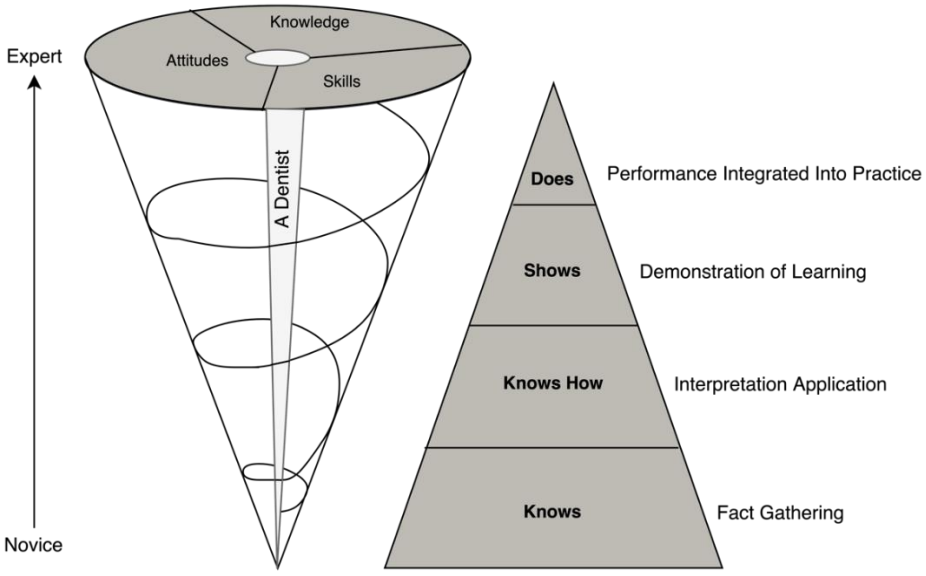


Note. Source: author Representation based on Hoque (2016)

It is noticeable that learning acquisition is developed by the learner through their progression and across educational programmes. These programmes include a series of learning objectives which are based on acquisition of the competencies required to become future professionals. Thus, the learner shows a progressive development of the cognitive, psychomotor, and affective domains while becoming a competent professional. The most famous taxonomy of learning domains was developed by Bloom et al. (1956) considering primarily the cognitive and affective domains. Bloom's Taxonomy and its different derivatives have been widely used to develop the objectives of different programmes. One such example in medical education was proposed by Miller (1990) who refers to the development of professional competence from a novice learner to an expert

level. The same idea of developmental processes could be exemplified by the concept of spiral curriculum presented by Harden and Stamper (1999) suggesting that each learning experience is based on an old one and each contributes to the development of the attitudes, skills and cognitive aspects required by a competent professional. The model is presented in Figure 4, parallel to Miller's pyramid (1990), including the development of a competent professional (e.g. dentist) through the educational process.

Figure 4
Development of the undergraduate Dental Student, from Novice to Expert



Note. Source: Author representation, based on the spiral curriculum from Harden and Stamper (1999) and Miller pyramid (1990)

From this taxonomy (Bloom et al., 1956) it is also possible to discern the methods associated with the acquisition of each domain, and how they contribute to student progression throughout the curriculum. Therefore, different methods of learning are aligned with the three different domains: cognitive, affective, and psychomotor. The traditional methods for the cognitive domain are reading, lectures, and problem-based learning. For the affective domain methods include experiential learning, reflection, and reflective journals. Clinical experiences, standardised patients, task trainers, models and supervised clinical experiences are learning methods associated with the psychomotor domain.

2.8 Summary of the chapter

This chapter proposes multiple theory approach to understanding teaching and learning in Health Professions Education. It considers the background influencing the selection of a socio-constructivist approach and also presents the theories embraced by the intervention design presented within this dissertation.

The background of lecturers and professors in health science education influences how teaching and learning have been developed as a hand-in-hand transmission of knowledge. However, the latest expansion of health education as a field also allows evidence-based practices and therefore, particular interests have been given standard guidelines for the area. Thus, this chapter reviews the concept of Andragogy, highlighting four key elements that distinguish adult learners. Adult learners are self-directed to learn; they use each experience as a resource for new learning. They oriented learning to their social roles and focused their learning experience on their performance.

In the previous chapter the recognition of a theory-practice gap and the difficulties of acquiring reflection skills were presented (see 1.1). Additionally, the transfer of clinical skills and knowledge to real scenarios of practices is never straightforward. Therefore, the exploration of how students learn (see 2.1) and how teachers teach (see 2.6) provides the background justifying the intervention designed, implemented and studied within this research. A cognitive, psychomotor, and affective domain of learning were described (see 2.7) and highlighted how each attempt to develop educational interventions should consider the integration of these three domains. Thus, reflection was sought as the bridge between theory and practice by allowing students to give meaning to their experiences and to prepare for future similar experiences. Therefore, with the intervention students are encouraged to develop their reflective skills and by doing so value their experiences as a source of learning. The integration of affective, psychomotor, and cognitive domains because of reflection is what was conceived as being the bridge to fulfil the gap between theory and practice and what is applied into the intervention design (see 4.4.1).

Thus, the constructivist understanding of knowledge has been set out, presenting learning as a social activity centred on students and embedded within classroom interactions. Thus, the reflective practice was placed at the centre of discussion as the connector between pre-clinical practices, clinical training, and independent professional practice. Consequently, reflection was defined as being a metacognitive skill that allows students to make sense of their experiences, go beyond the mechanical, procedural

repetition of tasks, or replicate observed practices. Additionally, special attention was given to peer learning to provide students with a broader background of experiences to reflect on.

These ideas will be complemented with those in Chapter 3, which will focus on dental education, the development of clinical skills, and the use of information and communication technologies.

Chapter 3 Exploring Dental Education

The purpose of this chapter is to explore how dentistry has traditionally been taught and how educational practices have evolved by incorporating new technologies and innovative approaches. Additionally, it highlights the importance of understanding how dentistry and its continuous improvements, including new equipment, the development of new materials, tools, and techniques, requires students who engage with the concept of lifelong learning. Consequently, dental education needs to provide sufficient experiences to their students to fulfill the requirements of safe and competent real-life practice. The review, then, follows with an analysis of how students develop clinical skills, describing traditional practices and modern practices enhanced by technology.

The chapter concludes with a review of practices aimed at achieving integration in dental education, exploring alternatives mediated by technology, paying special attention in the use of images and photographs as tools which are commonly used for dental practitioners and for dental education.

3.1 Dental Education: Brief time exploration

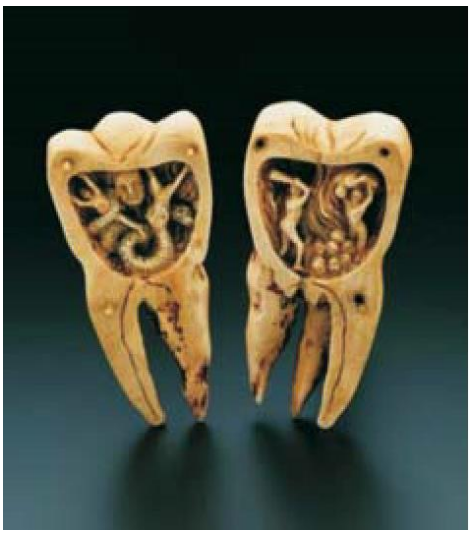
The history of dentistry and of dental education are interlinked. Technological and scientific advances influence both the practice of dentistry and the way it is taught. For this reason, a review of the history of dentistry offers many explanations of the ways in which dentistry has been practiced, and how this relates to the way it has been taught and learnt. Techniques, procedures, and materials are constantly under development, based on the advances of science and research. Therefore, dentistry is always changing and evolving as is dental education (Institute of Medicine (US) Committee on the Future of Dental Education, 1995). Thus, as new techniques and materials are developed, the practitioner needs to learn about them, so that they are capable of selecting the most appropriate items or approaches to delivering evidence-based practice for the benefit of their patients. Consequently, in some countries like the UK professionals must complete their continuous professional development (CPD) as part of the requirements for their continued registration as dentists[2] (General Dental Council, 2013). The same was found in a systematic review about the international requirements for CPD in the health

[2] The General Dental Council in UK regulates and provides the standards for CPD allowing legal registration of dental professionals. The up-to-date regulations for CPD are found in their webpage: Standards for the dental team (gdc-uk.org)

professions. CPD was reported as being mandatory for continuing registration in diverse countries as Australia, Canada, some states of United States, and being voluntary in others, e.g., Italy, France, Egypt (Tran et al., 2014). Additionally, there are other countries, such as Chile, with no clear regulations (Mariño et al., 2016).

Dentistry has coexisted with humans since we have existed, because we have teeth and tissues surrounding them, that when damaged can cause pain. Therefore, it is not surprising that during the period of antiquity humans considered supernatural powers to be a likely explanation for the cause of such diseases or pains and thus they developed beliefs that these should be assuaged through sacrifices and rituals (Hussain & Khan, 2014). The first known representation of causes of caries and periodontitis, amongst the most common diseases treated by modern dentists, was the myth of the *Tooth Worm* (see Figure 5). The myth was associated with the Sumerians around 5000 BC and presented in diverse cultures across the ages (Forrai, 2009; Gerabek, 1999; Hussain & Khan, 2014; Townend, 1944), and was not entirely ruled out until approximately the 18th century (Forrai, 2009). Therefore, any kind of instruments, materials or actions seeking to eliminate the maleficent evil causing pain was foreseeable, and it could be associated with magic (Gerabek, 1999). This suggests that the way to learn the practices was probably through the observation of these sorts of rituals. In fact, hand-in-hand transmission knowledge by observing a craftsmen were the first vestiges of learning such a craft activity (Hussain & Khan, 2014).

Figure 5
The tooth worm, Sumerian myth representation about tooth decay



Note. Source: Forrai (2009)

Books have come to be a good complement for training practices. In this sense, Pierre Fauchard, who is considered the father of modern dentistry, published 'The Dental Surgeon' (originally in French: 'Le Chirurgien dentist') in 1798, where he began to describe processes affecting dental health with a sense of scientific rigour (Spielman, 2019).

Dentistry was highly linked to Medicine in its origins, and apprenticeships to acquire the practical skills needed to perform dental procedures were frequent at the beginning of the profession. In 1841, in the United States for example, to become a dentist it was necessary to become a physician first, and independent training and the practice of dentistry only appeared much later in the 1800s. Since then, the United States has gone on to lead training and educational practices (Spielman, 2019). Therefore, it is not surprising that one of the first association seeking to standardise educational practices was born there in 1923, an institution known today as the *American Dental Education Association* (ADEA).

In the UK, The British Dental Association was established in 1880 and aimed to control and prevent malpractice and incompetence in the dental profession within the United Kingdom (British Dental Association, 2020). On a European level, a similar organization was established in 1975, known as the Association for Dental Education in Europe (ADEE). Since then, the ADEE has provided the guidelines for the profession in Europe. There have been no similar continental regulatory bodies formed in Latin America. In Chile, the accreditation board for higher education has looked for concordance between curriculum contents and source objectives rather than specific core contents (Mariño et al., 2016).

Parallel to regulation in practice there has been a growing development of research with the beginning of the first scientific journals (i.e., The American Journal of Dental Science, The New York Dental Recorder, The British Journal of Dental Sciences). Consequently, these journals have promoted the interests of scientific development in supporting dental practices. This was followed by the foundations of societies of practitioners which aimed to promote good practices in the field. This suggests that research has been developed alongside the constant updates needed for the learner, which with the adoption of theories of learning as presented in Chapter 2, have moulded and ultimately determined the educative practices in dental education.

In this vein, Table 1 summarises the evolution of dental education through history, starting from the informal self-taught craft, where healing and arts had no clear separation (Hussain & Khan, 2014). Then, transitioning from barbers as dental care

providers to a recognised profession with its own regulations, programmes, and curricula. It also incorporates the educational tools and strategies used at the time providing comments considered important to understand how the craftsmanship is acquired and how it has evolved to the prevailing modern conception of the dentistry and the dentist today. Summarising, it is noteworthy that Dental Education has long followed an apprenticeship model, until Medical Education first and Dental education later emerged as university disciplines, followed by the growing interest in developing evidence-based practices (Forrai, 2009; Fugill, 2013; Horst et al., 2009; Spielman, 2019). In the present, dental education considers different materials, facilities, examinations and accreditation bodies (Spielman, 2019). However, much of the principal focus is still on curriculum development, including technological advances in information processes and delivery (i.e., on-line, virtual, and simulation). These topics will be addressed in the following sections.

Table 1
Dental education, its evolution, practices, and tools for learning

	Description	Educational Practice	Tools for learning
Informal	**5000 BC**		
	Antiques practices: Based on magic and superstition. Curse and evils as explanations of pain, where magic seems to be the cure.	- Self-taught craft - Observation	- Observation
	1550 BC Ancient Egypt		
	Barbers and dentatores: Itinerant services offered, where the more skilful one's ended up working for aristocrats or even kings. - Ebers Papryrus, enlightens medical practices including dental treatments and recuperated old practices -since approximately 3700 B- It is quite possible that dental practice was based on its recommendations.	- Apprenticeship - Trial and error system	- Observation of a more skilled other. - Texts with registration of the procedures conducted.
Formal	**Modern Practices**		
	Dentistry as a specialised profession: First in Prussia in 1685, then in France in 1699. -Modern Dentist practices start with Pierre Fauchard's publication of Le 'Chirurgien Dentiste' in 1728, which has been subsequently translated into many languages. -Lectures in Guy's Hospital in London by Joseph Fox (1799) and at the University of Würzburg (Germany)	- Apprenticeship - Practice under supervision - Observation	- Observation of a more skilled other. - Books, collection of crafts known about dentistry at the time.

School Based Dental Education (Horst et al., 2009): Simultaneous education of entire cohorts of dental students, with the additional introduction to phantom head by Fergus in 1894 to promote motor and procedural skill development (Fugill, 2013). Development of a dental curriculum. The creation of the first dental school of the world in USA: Baltimore College of Dental Surgery – 1840- . Then in 1858 in Canada and the first one in UK, London School of Dental Surgery set up by John Tomes.	- Apprenticeship - Practice under supervision - Lectures - Simulated practices	- Lectures - Observation - Demonstrations - Guided Practice - Phantom heads
Contemporary Practices		
Student based Dental Education enhanced by technology	- Apprenticeship -Student-based practice and billing (Horst et al., 2009) - Practice under supervision - Lectures - Reflection - Peer Learning - Simulated practices	- Lectures - Observation - Demonstrations - Guided Practice - Phantom heads - Learning Platforms - Haptics simulators

Note. Elaborated by the author based on the information presented by (Forrai, 2009; Fugill, 2013; Horst et al., 2009; Spielman, 2019) . Practices were classified as informal (light grey) and formal (dark grey).

3.2 Dental Curriculum

A curriculum can be understood as the set of experiences encountered by students that enable them to achieve specified learning outcomes. It includes: content to be covered, learning outcomes, teaching and learning methods, educational strategies, context and learning environment , and assessment procedures (J. Grant, 2019). From the perspective of a student, the curriculum is therefore the "individual story of every student as they develop their knowledge, skills and attitudes"(Harden & Laidlaw, 2021, p. 53).

The art and science of dentistry is at the service of society, and its teaching and learning process has been evolving over time, transitioning from a short prelude to an apprenticeship model and more recently, to a comprehensive programme of professional education. However, dental curricula do not evidence the transition to a modern educational system, and:

> the curriculum is crowded with redundant or marginally useful material and gives students too little time to consolidate concepts or to develop critical thinking skills. Comprehensive care is more an ideal than a reality in clinical education, and instruction still focuses too heavily on procedures rather than on patient care (Institute of Medicine (US) Committee on the Future of Dental Education, 1995, p. 6).

Access to information is not a problem today and what needs real attention is the development of skills that provide students with tools to cope with the amount of information they need to assimilate in order to be able to consistently select the best possible solution for their patients.

Dental curricula can be understood from two perspectives. Firstly, at the level of regulatory accrediting bodies which set the guidelines for future competent professionals in determined geographical areas. Secondly, at the level of the institution where the curriculum is developed, including the relationships and coherence between the content and the contribution to the development of the competencies that it pledges.

3.2.1 Dental curricula ensuring competent professionals

Being a competent dentist means that the student has progressed during the programme, developing the ability to become a general dentist, who can work independently and

unsupervised in dental practice. Curricula can be understood as a means to ensure that new dentists graduating from any institution are competent and contribute to meeting the oral health needs of the population (Howard et al., 2009). Therefore, in dentistry, there is tendency to homogenise curricula according to the recommendations of different stakeholders and the regulations emanating from different regional bodies, such as the General Dental Council in UK, The American Dental Association in the United States (Howard et al., 2009) or The Association for Dental Education in Europe (J. Field et al., 2017). Similarly, medical education has been aligned with different bodies such as the General Medical Council in the UK, the Accreditation Council for Graduate Medical Education in the United States, and The Royal College of Physicians and Surgeons in Canada (Harden & Laidlaw, 2021). In Chile there is a lack of consensus, and the criteria and standards for the evaluation of Dental programmes came from the National Commission on Accreditation (CNA) which is a national organisation that aims to ensure the quality of higher education more broadly in Chile.

The competencies which the graduates need to acquire during their training are explicitly set out in the guidelines provided from the accreditation commissions (Hoskin et al., 2019), or their quality assurance procedures. The General Dental Council in the United Kingdom has their own explicit guidelines. They considered four domains of learning outcomes for different professional memberships of the dental team (General Dental Council, 2015a). In the same way, both the ADEE and the ADEA presented areas of competencies aiming to provide a guideline for dental curriculum development, helping to determine the learning outcomes and suggesting methods of teaching, learning and assessment, including methods of quality assurance (J. Field et al., 2017; Kassebaum & Tedesco, 2017).

Table 2 summarises the accreditation commissions in the UK, Europe, the USA, and Chile which aim to ensure that the dental programmes provide competent dentists in each of the countries with their guidelines applied. Interestingly the Chilean Commission provides a criteria and standards for evaluation in contrast to the other institutions who provides guidelines for best practice in educating future dentists.

Table 2

Accreditation commission in UK, Europe, USA, and Chile in charge of dental programmes, their Aims and Area of Competences

	UK	Europe	USA	Chile
Accreditation Commission	British Dental Council	ADEE	ADEA	CNA
Aim	Sets out the standards of conduct, performance and ethics that govern a dental professional' (a).	Provide guidelines for dental curriculum development, determining learning outcomes and suggesting methods of teaching, learning and assessment, and quality assurance (b)	'Lead institutions and individuals in the dental education community to address contemporary issues influencing education, research and the delivery of oral health care for the overall health and safety of the public'(c)	Criteria and standards for evaluation of Dental programmes (d)
Area of competence	**1.** Clinical **2.** Communication **3.** Professionalism **4.** Management and Leadership	**1.** Professionalism **2.** Safe and Effective Clinical Practice **3.** Patient-Centre Care **4.** Dentistry in Society	**1.** Critical thinking **2.** Professionalism **3.** Communication and interpersonal skills **4.** Health Promotion **5.** Practice management and informatics **6.** Assessment, diagnosis, and treatment planning **7.** Establishment and Maintenance of Oral Health	**1.** General competences (thinking development and basic knowledge) **2.** Professional Competences (relates to biomedical sciences and professional practice) **3.** Complementary competences (help professional practice)

Note. Source : Author summary based on:

(a) Standards for the dental team (gdc-uk.org)

(b) Graduating European Dentist | ADEE - Association for Dental Education in Europe

(c) About ADEA | https://www.adea.org/about_adea/Pages/default.aspx

(d)(Comisión Nacional de Acreditación de Pregrado, 2003) CNA_Chile

Having presented the role of curricula in ensuring delivery of the competent professional and the role of different accreditation commissions, what follows is an analysis of the curriculum in practice at the level of the institutions where it is developed.

3.2.2 Dental Curriculum in practice, at an institutional level

In general, when different curricula were analysed in practice, their elements, i.e., teaching and learning strategies, content, assessment procedures, and evaluation processes (McHarg & Kay, 2009), were found to be poorly integrated and redundant (Howard et al., 2009; Kassebaum & Tedesco, 2017; Ryder & Morio, 2011). In comparison with the ideas on an integrated curriculum, which enable learners to recognise how different concepts and or processes are interrelated, the structure that describes dental curricula tends to be discipline-based, which causes difficulties in applying a holistic approach to patient care in the real-world (Snyman & Kroon, 2005).

Additionally, it is suggested that there is not a smooth transition between the first courses that students must follow (e.g., biological sciences), with the subsequent preclinical courses and the final clinical practice (Howard et al., 2009). On the contrary, it is expected that students make connections from the didactic material almost automatically (Boyd, 2002; Ryder & Morio, 2011). This is not always achieved, and different approaches had been considered to facilitate the integration processes. Some have used or suggested problem or case-based approaches (Kassebaum & Tedesco, 2017; Ryder & Morio, 2011), the promotion of critical thinking (Ryder & Morio, 2011), and reflective practice (Boyd, 2002).

Finally, technological innovations have been used aiming to support and enhance desired integration within and across disciplines (Howard et al., 2009). In the same way, tools for curriculum mapping have been developed either using manual or electronic strategies, aimed at improving the connection between the learning outcomes and the competencies programmes require their students to achieve (Harden, 2001; Vashe et al., 2020).

3.2.3 Learning domains in Dental Curriculum

When a collective national agreement is achieved in terms of the minimal content in a Dental Curriculum, each institutional education provider needs to organise them. The curriculum needs to provide students with the capacity to interrelate the development of the three domains (i.e., cognitive, affective and psychomotor) (McHarg & Kay, 2009). Thus,

to understand how the curricula are organised to promote the development of knowledge, skills, and attitudes, the taxonomy used by the General Dental Council (2015a) will be used, as no equivalent was found in the literature for Chilean Dental Education. This taxonomy was developed with the aims of protecting patients, regulating the dental team, and using the domains of learning when articulating learning outcomes and their application, as seen in Table 3.

Table 3

Taxonomy used for the development of the learning outcomes in dental programs in the UK according to the General Dental Council (GDC)

	Keywords used in the learning outcomes	**Application**
Knowledge	Describe, recognise, explain, discuss, interpret, identify, evaluate	Recall or recognise information, explain or interpret meaning from a given scenario or statement
Skills	Use, apply, manage, produce, implement, perform, record, extract, modify, refer	Use or apply knowledge and skills
Attitudes/Behaviours	Participate, contribute, act, take responsibility, respect	Receive and respond to information, react, and participate actively, prioritise and display values.

Note. Source: Preparing for practice: Dental team learning outcomes for registration (General Dental Council, 2015b, p. 14)

It is noteworthy that this recommendation from the GDC is not linked to any taxonomy. However, when reviewed in detail, it is possible to see that knowledge, skills and attitudes are part of the spiral curriculum (Harden & Stamper, 1999) as presented previously (see in 2.7). Accordingly, while the student progresses in the curriculum it is possible to recognise different and more complex learning objectives such as the keywords used in the learning outcomes by the GDC. Thus, for example, considering the knowledge outcome, at the first levels, students may be asked to describe and recognise predetermined information. Later, they will need to interpret and evaluate. For skills, first they will use and apply, but close to their final year's students need to perform, modify, and refer. The same for the attitudes and behaviours. First, they participate then they

take responsibility and respect. This process of students progressing in the dental programme has been compared with a metaphor of climbing a mountain by Baume and Scanlon (2018), which refers to the way that in education there is no Everest and every achievement situates the learners in a place where they can observe future challenges to develop as competent professionals.

3.3 Developing Clinical Skills

In dentistry, the development of motor skills has been at the centre of the curriculum, which designates a significant amount of time to students practising the acquisition of sufficient manual dexterity and precision (Bugaj & Nikendei, 2016; El-kishawi et al., 2021; Schwibbe et al., 2016; Vann et al., 1981; Velayo et al., 2014). Phantom heads (see Figure 6) are the artifact that have been linked to motor and procedural skills development, since their design by Fergus in 1894 (Fugill, 2013).

Figure 6
Phantom heads. The centre of skills development

Note. Source: History and Curiosities
https://www.artedentalclinic.com/en/dental-phantom-do-you-know-what-it-is/

From a cognitive perspective, when a learner approaches a psychomotor task there are visual, auditory, haptics and other stimulus which require learner attention. This leads to an internal mental organization and representation of the task before conducting it. Later, the learner executes the task, and repeats it until mastering it (Schwibbe et al., 2016; Shaker, 2018). Therefore, much of the current literature on the methods to develop clinical skills pays particular attention to the delivery of the instruction and to ways of assessment. The delivery focused on lecture and demonstration, followed by a simulation whereby students repeat a procedure to accomplish the intended outcome of the learning activity (Fugill, 2013; Shaker, 2018). Assessment focused on the development of objective instruments, aiming to overcome the reported subjectivity of a supervisor (C. Taylor et al.,

2013) evaluating the performance of the students, i.e., Objective Structured Clinical Examination (OSCE) (Manogue & Brown, 1998), incorporation of technological innovation to evaluate students' performance (Khalaf et al., 2020).

The training of clinical skills, has been traditionally taught in Clinical Skills Laboratories (CSL), and has been characterised by the use of low to high-fidelity simulators (Fugill, 2013; McGleenon & Morison, 2021), where students practice their skills under supervision. Additionally, the literature has described many different approaches implemented in CSL such as structured practice and repetitive, deliberate practice (Suksudaj et al., 2012), aiming to provide the student with a more autonomous way to develop their skills, and to standardise patient treatment (Amano et al., 2004; Logan et al., 1999). Furthermore, the incorporation of information and communication technology along with clear advances in virtual environments also provided an extension of previous practices (McGleenon & Morison, 2021). Thus, they are incorporated aiming to enhance lectures and demonstrations. The literature has described the use of videos to reinforce the demonstration (Botelho et al., 2019; McGleenon & Morison, 2021; Mohammed et al., 2017; Ott, 1980; Vázquez-Rodríguez et al., 2019), online platforms, i.e., Blackboard, Moodle, which the development of different learning experience with varied interactivity for students (McGleenon & Morison, 2021).

Such approaches, however, have failed to fulfil the reported gap between theory and practice. The reported lack of transfer into the reality of patient treatment could be associated with the standardisation promoted during the learning experiences in CSL. In other words, each patient is a different case, far from the standardisation where the training was carried out (Fugill, 2013). Therefore, research has suggested that further examination of the influence of cognitive skills as well as the affective skills that affect performance of dental students is necessary (Schwibbe et al., 2016). Consequently, considering previous guidelines in the field of dental education (see in 2.7) when a student gains the psychomotor skills there is a need to approach skills development in an integrated fashion.

There is scarce evidence in the literature that recognises the level of the students' skills development and applies educational strategies that enhance student transference to real clinical practices. One longitudinal study (Schwibbe et al., 2016) investigated the performance of dental students in two consecutive preclinical technique courses in relation to the phase of skill acquisition and the ability required in each phase. They use

Ackerman's (1988) theory of ability determinants to explain the difference of performance so that dental students when they conduct consistent-simple (first course) v/s inconsistent-complex (second course) preclinical dental techniques. The model assumes a link between abilities and performance and includes three phases of skill acquisition. The first **cognitive stage** represents the mental representation, when students understand the instructions and develop a mental image of the task recognising the best way to approach it. This is followed by practice that leads towards increased performance levels and a decreased error rate, i.e., the **associative** phase. Finally, after multiple trials and less cognitive focus on the task, the next stage is related to psychomotor abilities, and the student reaches an essentially **autonomous** phase. They found that there was an association between task complexity and skills acquisition, both being associated with spatial and manual abilities. They suggested that for more complex skills, the students in their second preclinical course just reach the first stage (i.e., cognitive phase of skill acquisition) of Ackerman's model (Schwibbe et al., 2016). The research could have been further ameliorated by considering a wider range of complex skills development in advance preclinical courses and the relationship to the transference of those skills to real scenarios had been explored.

Consequently, when treating patients, students need to additionally select which clinical procedure is the most adequate one in order to respond to the patient's needs, the student needs to apply their background of facts and evidence in context, to be capable of solving the patient needs (McHarg & Kay, 2009). Additionally, a further understanding of patient context and a particular situation is required, in order to provide them with the best possible treatment. Thus, when the students hone their psychomotor skills there is a need to parallel this development with the affective and cognitive domains, approaching skill development in an integrated way. Reflective practice seems appropriate to fulfil the theory and practice gap, however its incorporation is reported at the level of clinical practice, rather than on preclinical courses (McGleenon & Morison, 2021).

The integration of skills, knowledge and attitudes is needed (McHarg & Kay, 2009). As a way of promoting integration, different pedagogical approaches have been taken into account. For example, the use of scenario-based simulation (Higgins et al., 2020), problem-based learning, and lately treating real patients into virtual reality previous real patient treatment (Dutã et al., 2011; Serrano et al., 2020), and the use of Robots patients (McGleenon & Morison, 2021; Tanzawa et al., 2012) have been reported.

Simulation is widespread in dentistry, however, best evidence practices have only been developed in recent years, extensively and with a growing body of literature mainly in nursing education (INACSL Standards Committee, 2016), with just a small body of research in dentistry which includes the theory behind students' skills acquisition in simulated environments.

Emanating from nursing education, the implementation of simulated practices required effort from both academics and institutions. Thus, a sequence of stages is recommended. The first one, **preparation** refers to the provision of materials and resources to prepare students for simulated practice. **Briefing**, previous to the simulation, refers to setting expectations, clarifying the scenario, and defining roles. **Simulation** refers to the students being immersed in the activity and receiving **feedback** from supervisors. This is followed by the **Debriefing** stage, which is the essential opportunity for students to discuss their performance with supervisors who facilitate and clarify understandings from the experience (INACSL Standards Committee, 2016). This is an important part as it allows students to connect with future practices, facilitated by **reflection** and by the feedback provided (Thomas et al., 2020). The process ends with the evaluation of the affective, cognitive, and psychomotor domains of learning. It is either summative or formative and is required for all simulation-based experiences (INACSL Standards Committee, 2016). Those standards for best-practice simulation are not reflected in dentistry, and therefore there is an opportunity to improve those practices to provide the optimum teaching and learning for dental students (Higgins et al., 2020).

Furthermore, it is important to highlight that the dental curriculum is composed off the students' experiences and progress, educational strategies, course content, learning outcomes and the educational environment (Harden, 2001; McHarg & Kay, 2009; Pyle, 2012). Therefore, enhancing simulated practices will contribute to the curriculum development of the institutions in question. With this in mind, the following sections will be focussed on the use of technologies to enhance teaching and learning, with special attention devoted to the use of photographs as this present research considers them as a vehicle to promote reflective practice.

3.4 How technologies enhance teaching and learning in Dentistry

Studies in different areas of Health Professions Education have shown different applications of technology to enhance the global learning experience of students (Jin & Bridges, 2014). Consequently, in dentistry there was speculation about the revolutionary effects that technology could have on teaching dentistry (Mattheos et al., 2008; McGleenon & Morison, 2021). However, the most common initiatives are simply an extension of traditional educational practices (McGleenon & Morison, 2021). One study explored this issue, highlighting the possible benefits of incorporating technology in dental education regarding learning and patient management (Manakil & George, 2017). They pointed out the importance of the educator knowing how their students learn and acknowledging the potentialities of technology, because it seems that the use the dental student gives to technology in education at the undergraduate level is oriented towards effort performance (Manakil & George, 2017).

In the same vein, there has been a recent systematic review evaluating the effectiveness of technology-enhanced teaching and assessment methods with regards to quality of preparation, time taken to complete the preparation and students' satisfaction (Khalaf et al., 2020). They found that the strategies evaluated within their selected research, i.e., digital scanning software, virtual reality, and augmented feedback to visualise student's preparations, may allow them to improve hand piece manipulation, and work in better ergonomic positions. Additionally, when objective assessment was considered, they reported the possibility that the student has to grasp technical skills. They found no agreement in relation to the provision of feedback, as some reported that frequent feedback can cause a dependency and act in detriment of a given student's performance. On the other hand, some studies reported that groups of students who received frequent feedback performed better. Although more studies show differences between traditional methods compared with technology enhanced ones, the review did not attempt to understand the theoretical background of the interventions included, and focused largely on comparing performance, concentrating mainly on the acquisition of motor skills.

The development of mobile technologies, which are devices that are part of people's daily life used for communication and entertainment, equipped with cameras, location tools, offer the possibility to create an interactive multimedia learning content for

educational purposes (Jeng et al., 2010). They are small, versatile and powerful devices that can be included during educational activities facilitating the anytime/anywhere learning environment (Khatoon et al., 2013; McGleenon & Morison, 2021), by allowing for example, saving verbal comments using digital applications (Sandars, 2009) or recording practices and evaluating them later to improve professionalism (Zijlstra-Shaw et al., 2017). In the same vein, those reported possibilities are complemented by the reported used of mobile devices by dental students and the amount of applications available (Khatoon et al., 2013; Masters et al., 2016).

Summarising, from the last section we can observe that the strategies used for teaching and learning in dentistry have been relatively static over time. An example in how teaching dentistry is associated with how dentistry has been practiced could be the images and drawings from an important textbook when teaching Prosthodontics. The textbook is part of the complementary literature for the unit considered with this current study (Syllabus de Asignatura MDPI-IV, 2018). Shillingburg created a series of handouts for dental students that ultimately became the *'Fundamentals of Fixed Prosthodontics'*, which was first published in 1976, with the latest 4th edition in 2012. When a Porcelain Fused to Metal crown (PFM) was presented (see Figure 7), they have included the same image and guidelines since 1984, pointing out that the same technique is still valid, and the image is a good representation of it.

Figure 7
Example of use of image in dental books over the years

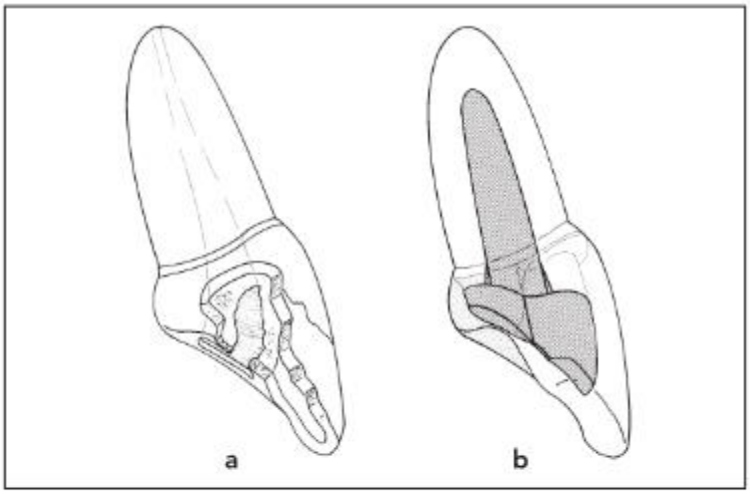


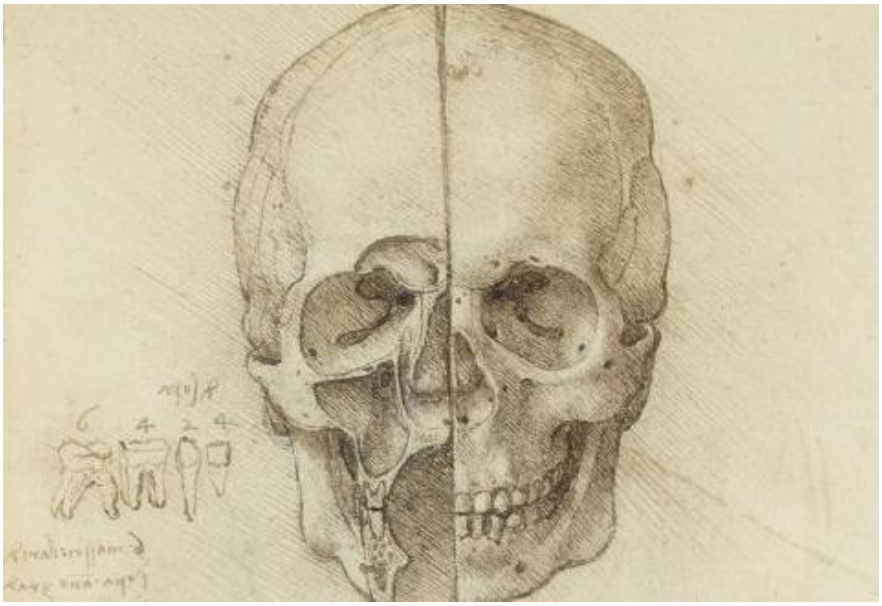
Fig 13-32 A single-rooted pulpless tooth with a severely damaged crown *(a)* usually will require a dowel core before placement of a crown *(b)*. (Reprinted from Shillingburg and Kessler[59] with permission.)

Note: Source: Taken from Shillingburg et al. (2012, p. 215).
The same image was used in previous editions of the book, as observed in the third edition (Shillingburg et al., 1996). The original image is authored by Shillingburg and Kessler (1984)

Nowadays dental teachers are not teaching students how to conduct sacrifices and rituals, however part of the procedures taught are delivered in a way that mimic the hand in hand transmission of the skills and knowledge as it had been done in the past, or referring back to Shillingburg et al.(1996, 2012) , the same image served for decades to teach a procedure that has not changed over time and which is still valid.

Even Leonardo da Vinci provided a drawn representation of a human skull and tooth (see Figure 8), used as an important part of the first year in dental students' curriculum, when learning anatomy. Additionally, following the same example, technological alternatives have been developed in recent years, but the same images are presented in different ways with the benefits offered by the new devices, programmes and platforms (as seen in Figure 9), where interaction with the skull is allowed, and the student is allowed to freely navigate and play with the tissues and anatomical structures.

Figure 8
Leonardo DaVinci's Skull and teeth representation



Note. Source Photograph: Royal Collection Trust, acceded online[3], dating from 1489.

Figure 9
Anatomy Learning 3D Skull

Note. Source Screenshot from a free version of 'Anatomy Learning 3D' App for iPad.
Notice the different layers than one can add and use the scalper tool to remove and separate bones and tissues.

[3] https://www.irishtimes.com/culture/art-and-design/visual-art/art-in-focus-leonardo-da-vinci-the-skull-sectioned-1.3774596, acceded on 17/05/2021.

3.5 Diagnostic Images and photographs in dentistry

Images are widely used in dentistry for many purposes. The most associated images to the field are x-rays that provide important information for diagnoses and for evaluation of the hard tissues concerned with dental labour. Students learn how to produces those images that are used as a diagnostic. However, photographs are also part of it, but teaching of dental photography if and when it occurs is frequently associated with postgraduate programmes and not as a core component of undergraduate training (Zoltie & Shemwood, 2019).

This section includes the different type of images used in dentistry and how they are taught and used in dental programs.

3.5.1 Diagnostic Images

Clinical examinations provide helpful information about a patient's condition. However, there are cases where more information is needed to visualise certain structures of the human body that are not visible directly (Pasler & Visser, 2007). Thus, here is where radiography, magnetic resonance imaging, scintigraphy, sonography among others indispensable tools in dental practice are used to complement clinical examination (Mitchell, D., Mitchell, L., & McCaul, 2018; Pasler & Visser, 2007).

Consequently, students are taught about the principles of x-rays, including the production and examination of the images to the intellectual process to obtain a diagnosis. Interestingly, from the knowledge of the clinician about production and the interpretation of radiological images, pathogenesis of oral diseases, clinic/pathogenic correlation, outcome diagnostic test, among other, the image can be interpreted and becomes useful for the role of dentists, in the same way as photographs recently have.

Due to the importance of these X-rays images, both for the performance of the profession and regarding concerns about safety issues in relation with its production, many institutions worldwide have regulated both teaching and performance. As a result, there is a speciality of Dental and Maxillofacial Radiology, and thus the general dentist must develop the adequate competencies stated in their programmes alongside having the capability to recognise the need for additional diagnostic tests and the need for referrals to the specialist (Parker et al., 2007).

3.5.2 Photographs in dentistry and dental education

Photographs have been used in dentistry for decades, and the field of dental photography has been evolving through the years (Desai & Bumb, 2013; Kalpana et al., 2018; Sharland et al., 2004; Stieber et al., 2015; Wagner, 2020). Photography started as a highly specialised field to become a more accessible site due to the reduction of equipment needed and thereby less investment needed for its application. Additionally, the growing development of digital photography has consequences for dental practitioners, it contribute to the well-known description of dentistry as being the fusion between art and science (Ahmad, 2009a; McDonnell & Newsome, 2010; Sharland et al., 2004). Furthermore, Ahmad (2009a) stated that a series of ten papers about the topic of dental photography , in part 1 states that "the possibilities of dental photography, as with photography for other applications, are limited only by the imagination" (p. 403).

Therefore, it is not surprising that the author, and also recently Casaglia et al., (2016), when listing extensively the uses of photography, included communication, portfolios, legal documentation, and marketing.

For communication, photographs can be used to show the patients the outcome of the treatment and to help patients visualise the proposed treatment to take informed decisions about the procedures that the dentist will carry out (McDonnell & Newsome, 2010). In other words, it may help with the consent process prior to the treatment. Additionally, it helps the information flow between clinicians and laboratories. Photographs help to illustrate colours, shapes and provide important information that improves the technicians' laboratory results without the patient being there. This has become especially important nowadays, as the development of aesthetic dentistry provide results that mimic the natural aspect of the tissues. Thus detailed information is inextricably related to better results (Wagner, 2020). In the same way, it allows communication with an external specialist in the case of patient referral. The same is true in the case of academic presentations, helping to prepare lectures, congress participation and Journal presentations of cases and treatments.

There are books and courses that are specialized in dental photography to enhance professional practice (Ahmad, 2009b; Casaglia et al., 2016; McDonnell & Newsome, 2010). Some of them teach dentists to become better photographers teaching them the equipment and specialized knowledge they need to use them effectively managing the light and the contrast, among other issues (Desai & Bumb, 2013). In contrast with dental

and maxillofacial radiology, there is much less information about the educational guidelines for photographs in dental programmes. Therefore, little is known about how teaching and learning may benefit from the use of photographs. Consequently, Table 4 includes some examples from the literature of the uses of photographs in dental education, showing that photographs offer an alternative to register a view training from another perspective. It is noticeable that they were used to study ergonomics (Partido & Wright, 2018), to improve diagnostic skills (Luz et al., 2015) and to learn from experience in a community-based course (Strauss et al., 2003). However, there is no evidence of the use of photographs in the development of clinical skills. Therefore, it could be interesting to evaluate if those prominent results could also be applied at that level.

Table 4
Examples of the use of photography in dental education

Activity – the use of photographs (author, year)	**Area**	**Study-Course level**	**Results**
Feedback involving photography and self-assessment (Partido & Wright, 2018)	Ergonomic	Randomised control design, N=135 undergraduate dental students.	Photographs as a pragmatic method to improve self-assessment skills and promote students' awareness of posture deviations from the norm.
Design of an experimental digital learning tool (DLT) to enhance clinical caries detection training using digital photographs of sound and carious teeth (Luz et al., 2015)	Caries Diagnostic using ICDAS	A clinical study with pre-post intervention test. N=32 undergraduate dental students.	The use of DLT tended to increase the sensitivity of ICDAS, improving the ability of the students to use IDCAS in detecting and assessing caries lesions at different stages.
Photographic documentation as part of a formal reflective activity (structural reflection assignments) to enhance community-based training (Strauss et al., 2003)	Community-based dental education	Descriptive study, N=10 volunteers Second- and third year dental students during their community-based training.	Reflective learning is considered as an important tool to promote learning from community-based encounters. Reflection was prompt formally using documental photography, and critical incidents reports. As a result of the reflective learning experience, participants found their community-based experiences more meaningful, rewarding, and interesting.

Finally, the use of images and photographs imply ethical consideration (McDonnell & Newsome, 2010), and thus many institutions have developed protocols to guide the use of sensitive data from patients (Stieber et al., 2015). However, this is something that did not cause undue concern in this current research, as photographs were obtained from an inanimate model (phantoms or mannequins). However, the phantom heads represent future patients' treatments, and their photographs provide information for the activity designed, where they were used as a prompt for reflection about the process conducted during practical sessions.

3.6 Summary of the chapter

This chapter has explored dental education, considering how the development of dentistry influences the ways in which it is taught. General aspects of the curriculum at the level of accredited bodies and at level of the institutions were presented. Subsequently, different pedagogical approaches to fulfilling the curricular content were explored, paying special attention to the technological innovations and its applications.

Regulatory bodies of dentistry worldwide are looking for a safe beginning of new dentists, influencing the way the dental curriculum is developed and implemented. Additionally, the primary objective of dentistry is to contribute to better oral health for patients in any given context, considering scientific, technological, political, and economic factors. Therefore, dental education should contribute to the training of future professionals to achieve this goal.

Although technology was presented as a possible revolutionary element of dental education, the initial incorporation of technology-mediated alternatives mirrored the way things had traditionally been done. Thus, technological innovations considered new ways of delivery and reinforce demonstration and repeated practice. Consequently, it is argued that new ways of integrating the development of clinical skills are needed. Thus, considering the widespread use of photographs in dentistry, it seems appropriate to incorporate them as a tool to promote reflective practice, aiming to contribute to the closure of the theory-practice gap.

Chapter 4 Research Design

Following on from the previous chapters, this research seeks to design an educational intervention to ease the transition between pre-clinical and clinical practices by promoting students' reflective processes. Additionally, photographs were considered as a tool to trigger students' reflections in a shared online environment. Gaining understandings from how the intervention has been designed and applied to usual practices in a traditional dental school in Chile are integral parts of this research.

This chapter will detail the research aims, overarching objectives and research questions. These are followed by the philosophical underpinnings and an exploration of the methodology and methods used. Subsequently, a brief description of the intervention to understand data collection processes and participants will be presented, ending this chapter with reflections around the ethical considerations.

4.1 Research Aim, objectives, and research questions

From the previous chapters (see 1.1), the research problem could be summarised in two main points. Firstly, the **theory and practice gap**, especially in the transition from pre-clinical to clinical courses. This is evidenced when students are in transition from working with phantom heads to treating real patients and can transfer what they have already learnt into practice. Secondly, the **difficulties of acquiring reflection skills** in the early stages of trainees' development.

4.1.1 Research Aim

The aim of this study is to investigate the intervention of using photographs taken with mobile devices to encourage reflection in dental education and its impact in developing professional knowledge and skills in future dentists.

4.1.2 Objectives

Therefore, the objectives of this research are:

1. To design an intervention which promotes reflection in dental pre-clinical practices based on the lived experience of the researcher and on the available literature.
2. To study the impact of the designed intervention to the learning and teaching process in relation to the theory and practice gap.

4.1.3 Research Questions

The research sought to investigate three main questions (RQ):

RQ1: How does Design Based-Research inform the design and enactment of the educational intervention?

RQ2: What are the students' experiences and perceptions about the impact of the educational intervention on the teaching and learning processes?

RQ3: What are the experiences and perceptions of the tutors about the impact of the educational intervention/ reflective practice on the teaching and learning process?

4.2 Research framework

Many decisions were taken during the design and conduct of this research. This chapter will explain the course of those decisions, to clarify how and why those decisions were taken and why the research was conducted in the way that it was. Aiming to contribute to the solution of the research problem, this research will follow the principles of DBR which are outlined within the following sections.

4.2.1 Pragmatism: setting the starting point of this research

Pragmatism is suitable for this study as the umbrella under which all procedures and decisions during this research were taken (see Figure 10). It involves finding solutions using any of the available approaches and choosing the methods, techniques, and procedures which best meet the needs and purposes as suggested by Creswell (2013).

Moreover, pragmatism focuses on socially situating the consequences and meanings of how a worldview-laden researcher tries to understand a given action or event (Brinkmann & Kvale, 2015; Dillon & Wals, 2006; D. Morgan, 2014a). Under these circumstances, it is important to mention that the researcher's previous work (see 1.2.2) influences how this piece of research was elaborated, theorised, and conducted. Whilst these acknowledgements may constitute an undesired drift into subjectivity within another paradigm (e.g., Positivism), here it is considered an opportunity. Consequently, the researcher's previous work enhanced inputs in designing the intervention and the outputs in understanding its consequences and meanings. Thus, the researcher's experience as a dental student, dental teacher, dentist, and as a researcher each contribute to DBR as the most effective strategy to conduct this piece of research.

In terms of ontology and epistemology, pragmatism moves away from traditional debates about the nature of truth and reality and focuses instead on practical understandings of real world issues (D. Morgan, 2014b). Pragmatism as a research paradigm offers an alternative way of understanding research. It goes beyond the traditional conflicting paradigmatic views of objectivity and subjectivity in the mind-world scheme followed by the mainstream philosophical traditions like positivism and interpretivism (Creswell, 2013; D. Morgan, 2014a). Pragmatism considers the concept of experience developed by Dewey (1933), and further elaborated by Biesta (2010) and Morgan (2014b), as being a basis of reality where knowledge emerges as a social construction which is valid and can be analysed within a given context. Furthermore, the only way we can acquire knowledge is through the combination of action and reflection (Biesta, 2010), which is, in part, what this study pursues: building knowledge about how to improve teaching and learning practices in dentistry, incorporating a new activity (i.e., action: intervention) while also considering researcher reflections. Thus, this research did not attempt to control the inevitable effect of the researcher's subjectivity in the context, but rather sought to acknowledge it, understand it, and to use it productively (Maxwell, 2013).

4.2.2 Design-Based Research (DBR)

Design-Based Research (DBR) is the selected strategy to improve teaching and learning in dental pre-clinical practices by recognising problems and designing solutions as done in this case. This strategy seeks to contribute to theory, methodology, and practices and even to make an impact on curriculum design (Abdallah & Wegerif, 2014; Barab & Squire, 2004; Herrington et al., 2007). Thus, the intervention is a tool for understanding and for improving learning and teaching (Barab & Squire, 2004) in the real-life context of third year students' practical sessions at the Clinical Skills Laboratory.

Historically, DBR is a tradition that began over 100 years ago with Dewey, who studied teaching and learning interventions systematically (Bell et al., 2004). Dewey's framework was then followed by many related traditions (e.g., design experiments, design studies, local science research, teaching experiments). DBR was recognised by the Design-Based Research Collective (The Desgin-Based Research Collective, 2003), who used this phrase as a term to differentiate it from experimental designs or with trial teaching methods.

"Education is not a form of human activity that is susceptible to natural laws in the way that some other more biologically based practices are" (Herrington et al., 2007, p. 9). This

sentence, to a large degree encapsulates the essence of this research and explains the approach taken. It goes beyond the researcher's background as a dentist that came from a mainly positivist world from understanding and applying research in the health sciences within clinical practice (Ringsted et al., 2011). However, the researcher, as a teacher, is immersed in a world that demands further understanding to develop some activities (interventions) that enhance the experiences of students and tutors to contribute to the development of learning and teaching methods, theories and practices that might help future practitioners. Therefore, to accomplish that objective, a range of available tools were considered, focusing on the possibilities that technologies seemed to offer in education in general and designing an intervention that used them. Thus, DBR was adopted to capture the complexities of a learning environment where an intervention with the objective of enhancing and supporting learning was designed, applied and structured within dental pre-clinical practices (Barab & Squire, 2004). The practices considered within this study came from the researcher's journey throughout her career, from being a student, practising dentistry and now being a tutor, and researcher, all of which contributed to the experience and directly impacted on the formulation of both the research problem and the design for the intervention.

DBR enables researchers to relate theory to practice, philosophy to reality, and abstract ideas to real contexts (Abdallah & Wegerif, 2014). Consequently, DBR is considered to be "exploratory and speculative [in nature, as well as being a] socially responsible enterprise" (Herrington et al., 2007, p. 8). Consequently, an intervention was engineered "based on theoretical descriptions that delineate why they work, and thus render them reliable and repeatable" (Brown, 1992, p. 143). Under DBR, the interventions are carried out in a social context, which is essential to understand the messiness of real-world practices and explain the difficulties of replicating findings in different scenarios (Brown, 1992). However, DBR aims to:

> Lay open and problematise the complete design and resultant implementation in the way that provides insight into the local dynamics. This involves not simply sharing the designed artefact, but providing rich descriptions of the context, guiding an emerging theory, design features of the intervention, and the impact of these features on participation and learning (Barab & Squire, 2004, p. 8).

Thus, the research objectives are the main driver which guides the research process (Abdallah & Wegerif, 2014).

Thus far, the intervention has been a developmental process through the progressive refinement of designs and theories in an iterative process of analysis and design, development and execution, and evaluation and revision (Abdallah & Wegerif, 2014). It has not been a single-phase intervention to test if it works or not (Dolmans & Tigelaar, 2012). Instead, it has considered the interaction with participants (Barab & Squire, 2004) to further improve their practices and learn how the intervention interacts with them. Additionally, it has included all of the contextual elements instead of controlling for variables, which seemed difficult or almost impossible in this educational context. So, instead of isolating variables, they were characterised in their context (Juuti & Lavonen, 2006), similarly to a case study, where a case is studied when its particularity and complexity is a focus of interest (Stake, 1995).

DBR shares the goal of improving educational practices by connecting research and practice in education with other approaches, i.e., action research and formative evaluation (Abdallah & Wegerif, 2014; Denscombe, 2014; Ringsted et al., 2011). However, what differentiates DBR from other methodologies and approaches is that it not only seeks to improve practice. The core of design-based research is to refine theory about the nature of complex learning environments, therefore, DBR contribute to both, improving educational practice and testing refinement theories (Dolmans & Tigelaar, 2012; The Desgin-Based Research Collective, 2003).

4.2.3 Mixed Methods Case Study (MMCS)

From a pragmatic point of view, Denscombe's description of Mixed Method Research (MMR) included the elements considered in this study. It "combines alternative approaches within a single project. It refers to a research strategy that crosses the boundaries of conventional paradigms of research by deliberately combining methods drawn from different traditions" (Denscombe, 2014, p. 137).

Thus, alternative, and diverse approaches were followed to study the intervention and to answer the research questions. This acknowledges that a complement between quantitative and qualitative research can improve the study's overall reliability (Denscombe, 2014; Hibberts & Johnson, 2012; Ringsted et al., 2011). Additionally, as described by Onwuegbuzie and Leech (2005) MMR allows flexibility in choosing the investigative techniques and having the intention to study the phenomena holistically to

answer the research questions and try to develop an appropriate solution to the problem presented. Thus, different methods were mixed in order to look for complementary ideas. For example, in this research, investigating the level of engagement with reflection or the commitment to the activity a student had was related to the assessment process. Likewise, recognising a student who takes photographs but did not share them online. Nonetheless, it can be surmised that he or she reflected while taking them.

MMR studies follow the guide of research questions and then creatively use different techniques in order to satisfactorily answer them (Ringsted et al., 2011; Teddlie & Tashakkori, 2012). Furthermore, it is possible to find definitions of MMR that include elements of other methods, research processes, philosophies, and research designs. This study sought to incorporate all these elements. Different methods and processes were considered, taking into account the experience of the researcher as a student and tutor. Regarding philosophy, Creswell and Plano Clark (2018) consider MMR as a research design with its own philosophical assumptions and methods of inquiry. These assumptions guide the collection and analysis of data and how they are mixed to obtain a better understanding of the research problem, as opposed to using each approach separately. The same authors added the core characteristics of MMR to the definition, adding actions that researchers undertaking MMR should follow in the different stages of their research. According to this, researchers should persuasively and rigorously collect and analyse all the data obtained and then decide how these should be integrated or merged in order to "provide in-depth evidence for a case(s) or develop cases for comparative analysis" (Creswell & Plano Clark, 2018, p. 185).

In the case of this research, educational practices at a traditional university in Chile were considered. Thus, a real life-context was presented as a subject matter which is looking for an extensive and in-depth description of a specific social phenomenon while retaining the holistic and meaningful characteristics of this context (Yin, 2018). The study will attempt to explain, describe, illustrate, and enlighten the links between a real-world intervention and its impact. The intention is not only to explain if an intervention works or not but also to elucidate how and why it works (Ibid). It will focus on the particularities of the case in order to deeply understand them (Denscombe, 2014; Punch & Oancea, 2014). There, "description, exploration and comparison" (Denscombe, 2014, p. 55) are key issues where significant features could be compared among participants to understand the connection and interrelationships between them.

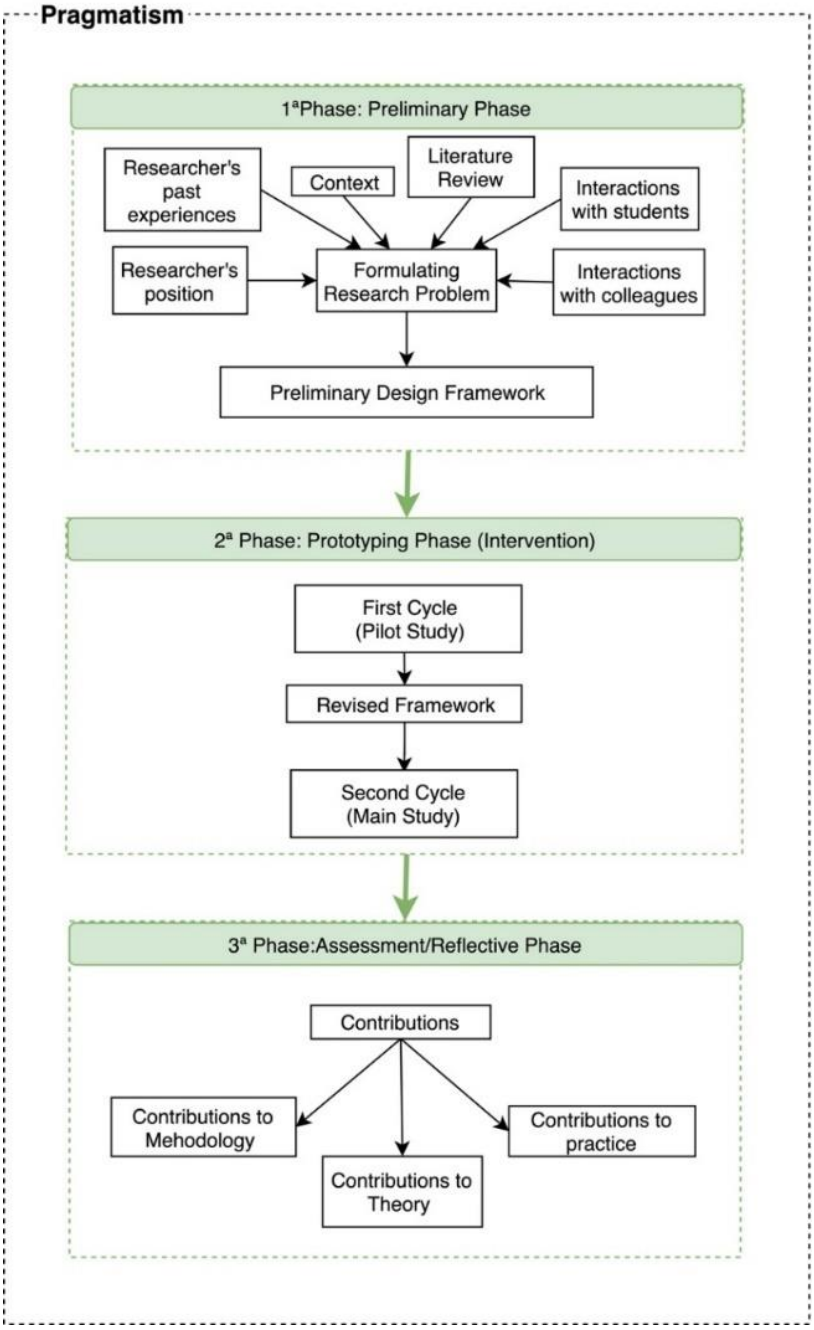
Summarising, this study integrates quantitative and qualitative data collection and analysis while designing and studying an educational intervention which aims to solve the problem described previously (see in 1.1).

4.2.4 DBR and MMCS in this research

Under pragmatism, the study followed a systematic approach to inquiry, as proposed by Dewey (1933). In addition, pragmatism rationalised why DBR was the strategy used during this research. It could be simplified into being a three-phase study (Abdallah & Wegerif, 2014), i.e., preliminary research phase, prototyping phase, and assessment/reflective phase.

Figure 10 guides the reader through the underlying ideas and main concepts followed to structure and conduct this research. It shows an overview of those ideas and concepts considered by the study and how they are interconnected. The model presented in Figure 10 is based on ideas from Abdallah & Wegerif (2014), who propose a model for studies "targeting the integration of new technologies and literacies into educational contexts" as this research does. Moreover, principles of DBR taken from Herrington et al. (2007) were also included within the model and are analysed throughout this chapter.

Figure 10
Research Framework



Note. Source: Author representation, based on Abdallah and Wegerif (2014) ideas and from Herrington et al. (2007) about Design-Based Research. Pragmatism is the umbrella of this study. Green boxes represent the phases; white boxes consider the elements of each phase of this research.

4.2.4.1 Preliminary Research Phase

This incorporates data and information from several sources and perspectives listed here: researcher position, the past experiences of the researcher, the social context (see 5.1), literature (see Chapter 2 and Chapter 3), and finally, the researcher's interactions with

colleagues and students. Considering all these elements, a specific situation was recognised as being problematic (see 1.1) which led to the formulation of the research problem: the lack of integration between theory and practice and, fundamental difficulties in the incorporation of reflection. Later, a possible line of action to tackle this dual problem was designed: An intervention (see 5.2) that considers the optimal use of technologies (e.g., mobile phones, virtual learning environment) to support students by promoting students' reflection about their practices. The next phase is the implementation of this preliminary design framework.

4.2.4.2 Prototyping Phase

This phase was comprised of two iterative cycles: the Pilot Study and the Main Study. Each considered: design, implementation, and evaluation of an educational intervention. The Pilot Study was applied in 2017, with 14 participant students from the third year 2017 cohort, from a traditional university in Chile. Based on the results of this phase, the preliminary design framework was modified, and a second cycle was conducted in 2018, at the same institution, with 56 participant students and seven tutors.

The data collected and analysed within the cycles contributed to improvements in the intervention within the cycle and improving the design when the pilot ended, and the main study was planned.

4.2.4.3 Assessment/Reflective Phase

A final assessment reflective phase was conducted to answer the research questions. Theories, artefacts and practices are expected as outputs from DBR practices (Barab & Squire, 2004). Therefore, these outcomes would serve as the basis for future beliefs and actions, besides contributing to theory, methodology and practice. This phase will be described further in the Discussion (see Chapter 9) and Conclusion chapter (see Chapter 10).

4.3 Students' selection

The participants of this research were third year undergraduate dental students and their tutors at a traditional university in Chile. Fourteen students from the 2017 cohort participated in the pilot study, and in the main study 56 students from the 2018 cohort. It was decided to work with the third year students as they were in their final year before treating their own patients, therefore, being those who would live the transition from pre-clinical to clinical practices (described in 1.1). Additionally, it was considered that if there

were any deficiencies in the skills, it could be a good point in student development to identify and potentially remedy them, aiming to improve students' first experiences with real patients and to enrich their future practices.

Participation was voluntary, and in the pilot study, the number of students was selected in order to facilitate an evaluation of the usefulness of the intervention and its applicability over the duration of normal educational practices.

4.4 Data collection methods

Methods are viewed as the tools, instruments (Dillon & Wals, 2006), techniques or procedures (Crotty, 1998) which are used to generate, gather and analyse data. In this research, the main source of data was generated from the intervention which includes photographs, comments, and reflections online (named as contributions), and the views of students and tutors about the intervention. For this reason, what follows is a brief description of the intervention designed for the Pilot Study. However, fuller details will be provided in the next chapter, these being essential to understanding the rationale for the changes incorporated in the main study as the result of the pilot study.

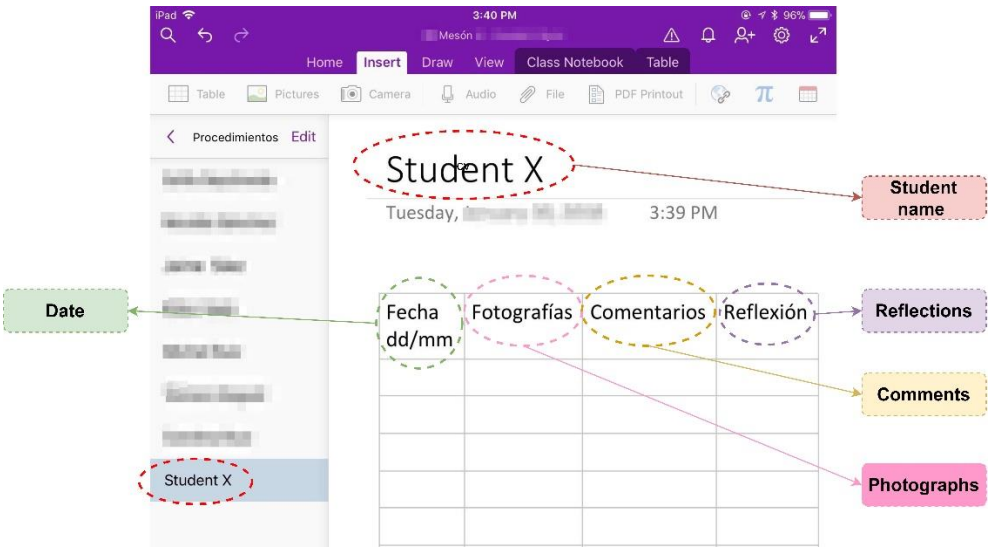
4.4.1 Brief description of the intervention

The intervention was designed to be conducted in parallel with normal practical sessions for third year students who are undertaking the 'Dental Materials and Integrated Preclinical – IV' unit (for details, see 5.1.4). Students who decided to participate were requested to take photographs with their mobile devices and to share them with comments and reflections on a shared online page designed specifically for this purpose. OneNote[4], a free application from Microsoft, was selected due to its versatile properties in allowing sharing and collaboration.

Each student had a collection of their own procedures as well as those shared by their colleagues in their group. The main overview of the shared environment is illustrated in Figure 11.

[4] https://www.microsoft.com/en-gb/microsoft-365/onenote/digital-note-taking-app

Figure 11
Student's view in OneNote



Note. Screenshot from a students' OneNote page, with important content highlighted and translated from Spanish.
'Student X' is highlighted twice with a red circle, to indicate that the student had access to their own content and the content of their peers, which appear listed on the left side of the figure. Names are intentionally blurred to protect students' identities.

4.4.2 Data collection overview

As mentioned previously, this research considered multiple sources of data as summarised in Table 5. It is important to note that due to the developmental nature of this research design, some methods were added once the cycles had already started.

Table 5
Summary of methods, data obtained, and their relationship to the RQs and Research aims

Method	Data	Relation to RQs and Research aims
Cycle 1: Pilot Study		
Documentary Data	Chilean documentation about the regulation of higher education and dental programmes. University documents related to the Programme, study plan and units [Quan + Qual]	To develop an intervention which fits the purpose and provides evidence of its applicability to a broader context. Justify the design (RQ1, RQ2 and RQ3)

Method	Data	Relation to RQs and Research aims
RTQ	Scores students obtained across four scales (HA, U, R and CR) [Quan]	To evaluate the understanding of the instrument and its applicability (RQ1)
Summative Evaluations	Theoretical and practical grades from the students in relation to the intervened unit. [Quan]	To classify students' performance (RQ1)
Focus Group - Interview	Transcript from Focus Groups by table and the interview with one student. [Qual]	To understand if the designed intervention is applicable to a broader cohort of students. Improve the design (RQ1)
Students' One note Pages	OneNote pages containing photos, comments, and reflections. [Quan + Qual]	To understand and describe the content shared by the students (RQ1 and RQ2)
Final task	Reflection produced by the students based on the guidelines provided. [Qual]	To understand and describe the experience lived by the students (RQ1 and RQ2)
Observation	Fieldnotes [Qual]	To retain and illustrate student experience during the intervention (RQ1, RQ2 and RQ3)
Cycle 2: Main Study		
Documentary Data	Chilean documentation about regulation of higher education and dental programmes. University documents related to the Programme, study plan and units [Quan + Qual]	To complement what was obtained in Cycle 1 and help to answer the RQs. (RQ1, RQ2 and RQ3)
RTQ	Scores students obtained in four scales (HA, U, R and CR) [Quan]	To ascertain the level of engagement with reflection (RQ1)

Method	Data	Relation to RQs and Research aims
Summative Evaluations	Theoretical and practical grades from the students in relation with the intervened unit. [Quan]	To classify students' performance (RQ1)
Focus Groups with Students	Transcript from focus groups with different group of students. [Qual]	To understand students' experience and perceptions about the intervention (RQ2)
Final Questionnaire	Answers from students in relation to the intervention performance. [Quan + Qual]	To understand students' experience and perceptions about the intervention (RQ2)
Focus Group with Tutors	Transcripts from a focus group with all participants tutors. [Qual]	To understand tutors' experience and perceptions about the intervention (RQ3)
Observation	Notes from each theoretical and practical session. [Qual]	To describe students' and tutor interactions. (RQ1-RQ2-RQ3)
Students' OneNote Pages	One Note pages containing: photos, comments, and reflections. [Quan + Qual]	To understand and describe the content share by the students (RQ1 and RQ2)
Final task	Reflection produced by the students based on the guidelines provided. [Qual]	To understand and describe the experience lived by the students (RQ1 and RQ2)
Tutor's corner	Tutor corner pages [Qual]	To describe what was shared by tutors (RQ1 and RQ3)

Note. Cycle 1, N= 13 students from cohort 2017, Cycle 2, N=56 Students from cohort 2018 and 7 tutors. RTQ=Reflective Thinking Questionnaire (Kember et al., 2000), Habitual Action (HA), Understanding (U), Reflection (R) and Critical Reflection (CR).
[Qual]= Qualitative Data, [Quan]= Quantitative Data, [Quan + Qual] = The source provides both Qualitative and Quantitative data.

4.4.3 Documentary Data

Documentary data within this study provides evidence supporting the design of an intervention in a determined context. It consisted of gathering together relevant Chilean

documents related to the dental educational regulations. Additionally, at the level of the university where the intervention was carried out, documents related to the programme and unit intervened were also considered and are quoted within this dissertation.

Documents are important for considering because they contain the regulation under which the dental curriculum is developed in a determined Chilean university. Considering such data offered the opportunity to compare with other universities and expand the application of this intervention to further contexts.

Documents are social facts constructed, produced, and shared in social organised contexts. In conjunction with other sources of data they can be useful for information triangulation (Matthews & Ross, 2010; Punch, 2005; Silverman, 2015). Thus, for example, the data from the syllabus that provides information about the regulation of assessment within the intervened unit is contrasted with the university regulations and its influences on students' interactions within the intervention.

4.4.4 Reflective Thinking Questionnaire (RTQ)

It could be suggested that the most important role of this preclinical course is to enhance the focus on patient safety (Fugill, 2013; Madhavanprabhakaran et al., 2015; Swanwick, 2019). Therefore, students were able to practise on a phantom head the procedures which they would perform later on patients without the risk of causing any harm to them. For this reason, the capabilities that students developed during this period would be essential for their future work with patients. This was done acknowledging that the development of skills needed to perform as a dentist are manifold and complex.

In the context of this study, it is important to know the extent to which students engage with reflection in order to work on the development of this skill during their training period at the preclinical stage. For this purpose and considering that there is not a robust means of assessing reflection(Ahmed, 2018; J. C. Williams et al., 2019) and assessing it was not the aim of this study, Reflective Thinking Questionnaire (RTQ) (Kember et al., 2000) was considered. The questionnaire is an instrument which "assesses the extent to which students engage in reflective thinking during their educational programme" (Lethbridge et al., 2013, p. 321). This present research utilised the RTQ adapted and validated to be used with dental students by Tricio et al (2015) (see Appendix B). By applying it, it was possible to achieve comparability with the existing body of literature and also determine the extent to which a designed educational intervention

could impact upon learning and the teaching process depending on the respective student levels of engagement with reflective thinking.

In this vein, Kember et al. (2000) recognised the necessity for a tool to assess reflection due to the omnipresence of reflection promoted in the literature. For this, they developed a questionnaire based principally on the theory that emanates from Mezirow's (1991) work (see in 2.4.2). It consists of a four-scale instrument measuring four constructs: **Habitual Action** (HA), **Understanding** (U), **Reflection** (R) and **Critical Reflection** (CR). Summarising, the scales (Kember et al., 2000, pp. 383–385), **Habitual Action** refers to activities that are performed almost automatically and that demand little conscious thought to be performed. **Understanding** is what Mezirow (1991) refers as thoughtful action, considering action as a cognitive process. **Reflection** belongs to the internal process of meaning-making with regards to one's experience. Finally, **Critical Reflection** considers the transformative aspects of knowledge, meaning people are aware why they perceive, think, feel, and act the way they do.

Each scale is measured by four items (see Table 6), assessed by a 5-point Likert scale. The items are a description of an action and how it is performed. The results of each scale are obtained by assigning a value which ranges from 5 for strongly agree to 1 for strongly disagree. Thus, the total score for each sub-scale ranges from 4 to 20. From the literature, they identified the different possible scales and generated items for each one (Kember et al., 2000).

Table 6
Scales and items on the Reflection Questionnaire

Scale	Item	Descriptor
Habitual Action	1	When I am working on some activities, I can do them without thinking what I am doing.
	5	In dental training, I do things so many times that I have started doing them without thinking about it.
	9	As long as I can remember material presented in class for examinations I do not have to think too much.
	13	If I follow what the lecturers say, I do not have to think too much about my dental training.
Understanding	2	Dental training requires me to understand concepts taught by the lecturers.
	6	To pass dental training examinations you need to understand the content you are studying.
	10	I need to understand the material taught by the teacher in order to perform practical tasks.
	14	In dental training you have to continually think about the material you are being taught.

Reflection	3	I sometimes question the way others do something and try to think of a better way.
	7	I like to think over what I have been doing and considerer alternative ways of doing it.
	11	I often reflect on my actions to see whether I could have improved on that I did.
	15	I often re-appraise my experience so I can learn from it and improve for my next performance.
Critical Reflection	4	As a result of my dental training I have changed the way I look at myself.
	8	Material learned during my dental training has challenged some of my firmly held ideas.
	12	As a result of the material learned in dental training I have changed my normal way of doing things.
	16	During dental training, I discovered faults in what I had previously believed to be right.

Note. Scales taken from Kember et al. (2000).

For validation, Kember et al. (2000) applied the first questionnaire with 350 students from a health science school and analysed the properties of the questionnaire, changing some of the items and replacing them with ones more closely related to the emerging categories. They conducted three further cycles of analysis, considering reliability tests and confirmatory factor analyses. Finally, a sample of 303 students was used to test the instrument, and its reliability, using Cronbach Alpha, was rated as acceptable (HA=0.621, U=0.757, R=0.631, CR=0.675). Confirmatory factored analysis showed a good fit for the four-factor structure. They found that the items only contribute to their scale and that there were inter-relationships between the scales, but the explanations are given by the literature. For example, the relationship found between Habitual Action and Critical Reflection could be explained by Schön (1983), as “experienced professionals tend to deal with common cases in a routine or habitual way, often without thinking very deeply about them” (Kember et al., 2000, p. 389).

In the few last years, some studies have used the questionnaire, like that of Sargent (2015), who included 802 undergraduate students from different programmes. She studied the differences in reflective thinking in different areas (humanities and non-humanities), by gender, age, and year of study, using the RTQ. She found the lowest scores in Habitual Action in students who were learning new skills, while older students obtained higher scores in Reflection. Moreover, gender appeared to be affected according to subject matter, with men reporting to reflect more in business courses, but less so in humanities and sciences than women. Recently, Ghanizadeh and Jahedizadeh (2017) used and validated the questionnaire in the context of teacher education. They studied the

interrelationship between reflective thinking and academic achievement and found higher correlations between understanding and reflection with grade point averages. They also evaluated if there were differences in gender, concluding that there were no statistically significant differences in reflective thinking.

The questionnaire was adapted for use with dental students, and was authorised to be used within this research by Tricio et al., (2015). They looked for a relationship between dental students' reflective habits, which were measured using the RTQ, with the academic achievements of the students. They included 324 students. Among this number there were undergraduates and postgraduates. Reflective thinking scores were compared between cohorts and were duly correlated with students' academic performance. They found significant differences in the extent to which students engaged with reflection between cohorts with an increased mean in reflection and in critical reflection among higher level cohorts. In addition to this, the students' scores in the four subscales correlated differently to their diverse examinations, i.e., short answer questions, written essays, multiple choice questions, clinical examination, suggesting that a comprehensive assessment that includes diverse methods could stimulate the different construct measured by the instrument (Tricio et al., 2015).

The RTQ questionnaire has a wide application across disciplines (Ghanizadeh & Jahedizadeh, 2017; Kazemipoor & Hakimian, 2018; Tricio et al., 2015). This allows some potential for making comparisons. However, it is necessary to recognise that a weakness of this self-reported instrument is that what one person reports may differ to what he or she thinks (Sargent, 2015). In general terms, Tricio et al (2016) highlights the transition of newer students with higher levels of Understanding during the first years where they need to study hard to understand complex concepts. Later in the programme, they achieve higher scores in reflection and in critical reflection.

In the current research, a paper copy of the questionnaire was applied at the beginning of the intervention, during students' first session in CSL. It provided information relevant to the level of engagement of the student with reflective thinking. However, it is one thing is to engage with reflection and report it in a self-reported questionnaire and it is another to show in practice that you are actually reflecting. For this reason, the RTQ was complemented with other methods and activities. However, this questionnaire provides information related with the students' own perceptions about their engagement with reflective practice, which contribute to the answer to RQ1.

4.4.5 Observation

Participants were observed by the researcher while they took part in the intervention during their practices and their lectures in relation to the studied procedures (more datils in 5.1.5). The observation was interventionist due to the introduction of a modification in regular practices (Punch & Oancea, 2014). Furthermore, field notes were gathered by the researcher on a mobile device (phone or tablet) using the OneNote application.

Observations were considered as they offered the possibility to the researcher of having direct contact with participants, and being available to record information as it occurred (Creswell & Creswell, 2018; Silverman, 2015). Although there was the risk of being intrusive (Creswell & Creswell, 2018), participants were asked to consent to this type of observation. The aim of such an approach was clearly explained to participants, including the role of the researcher as observer and their role as participants in relation to the intervention.

An open-ended approach to observation, with no previous categories or classifications, was followed (Creswell & Creswell, 2018; Punch & Oancea, 2014). These observations aimed to gather data with relation to the development of the intervention (RQ1), and the experiences of students and tutors (RQ2 and RQ3). This was developed as the interactions were evolving during the practices. The first approach was to include one group each time in order to have a general description of the group of students working, then the focus changed as previous observations led to recognition of some participant interactions, actions and behaviours in relation to the designed and implemented intervention.

Additionally, photographs were taken to subsequently elicit and complete the field notes. In each session the OneNote application was used to record the field notes (see Appendix C). The OneNote application facilitated a straightforward process. For example, it was possible to take pictures and write comments on the same page, and at the end of the working day, complete the field notes with the pictures that had been taken.

The developmental characteristic of this research meant that reflecting on all aspects of the intervention while it was running became an important aspect in the decision-making process. Consequently, some improvements were introduced during its development, to accomplish the aims of the intervention. Thus, after the pilot study, and considering that the main study would involve more participants, other tools were added to the observational strategy. Thus, a table was created in Microsoft Excel to track student progression through the unit, and this complemented the notes taken in OneNote.

The principal limitations of taking notes were the different roles (Creswell & Creswell, 2018) assumed by the researcher. Sometimes, these were balancing dual roles. That is to say, requiring to be a participant on hand to explain and assist the students and tutors while creating their accounts in OneNote, or solve any of the obstacles suffered during the sessions in relation with the intervention (e.g., how to install and use the app, and the possible options they had if their phone did not work). The researcher was available to help solve these problems. However, this action was generally time-consuming. A solution to this was taking photographs and adding them to the fieldnotes to remember the interactions, actions, or details observed.

4.4.6 Focus groups

Focus groups were carried out as they generate data by permitting interactions between participants which would be more difficult without this interaction. The researcher acted as the moderator and facilitator of these interactions (Punch & Oancea, 2014), and contributed to balancing the interaction by encouraging equal participation, as in these situations participants might not be equally articulate and perceptive (Creswell & Creswell, 2018)

As set out earlier, the present study evaluated the perceptions of students (RQ 2) and tutors (RQ 3) when an intervention promoting reflective practice was incorporated into their educational schedules. In the case of students, different focus groups were conducted with those who worked under the supervision of the same tutor. This approach has been suggested by the literature, indicating that when conducting focus groups it is generally better to have groups as close as possible to real-life situations in order to make sense of their lived experiences (Barbour & Schostak, 2011).

The focus group with tutors was added to the main study as the information provided from observations did not offer sufficient evidence of tutor's roles and merely hinted at tutors' overall experiences. To prompt discussion among tutors during the focus group the researcher asked each tutor to bring to the meeting a screenshot[5] they had taken of one of their students' contributions in OneNote which caught their attention. Thus, during the meeting, the screenshots allowed the researcher to stimulate deeper discussion

[5] A screenshot is an image of what is shown in a computer (or mobile device) screen so it can be copied or saved.
https://dictionary.cambridge.org/dictionary/english/screenshot

about the meaning of the intervention for tutors, and also gain access to their beliefs and values (Richard & Lahman, 2015).

Semi-structured questionnaires were developed in advance for each of the focus groups (see Appendix D and Appendix E) which were conducted in a special room facilitated by the dental school (see Figure 12). Schedules were agreed with participants, and the interactions were recorded using a camera and a voice recorder, the former to recognise each participant during transcription, and the latter to ensure the clarity of speech for the same process.

Figure 12
Focus Groups setting

Note. Source: Researcher's fieldnotes. Circular distribution to facilitate communication.

4.4.7 OneNote Pages

As presented previously in 4.4.1, the intervention consisted of contributions the students and tutors made online in OneNote. The **'OneNote students' pages** contained photographs, comments and reflections shared by the students. This was considered a data collection method, which facilitated making sense of the students' experiences during their practices, as well as collecting comments and reflections about them. For tutors, it was a repository of demonstrations and examples, and each of them had a page named '**Tutor's corner'**.

OneNote provided the opportunity for each participant to share their views of their experience in relation to a studied procedure, providing a visual and creative representation of it (Creswell & Plano Clark, 2018). The OneNote pages provided a multimodal and visual method of data collection generated by the intervention (Punch & Oancea, 2014). It allowed data collection which contributed to answering each of the three research questions (see in 4.1.3).

Each student had one page which their peers and tutor could view. 'Tutor's corner' was a section created in OneNote after the first cycle. It aimed to be a space for tutors to share complementary materials with their students. As will be discussed later, iPads were obtained and assigned to each group. Tutors could use either their mobile phones or iPads. Further details of the design are presented in 5.2. When students finished their procedures and their contributions in OneNote, their pages and the ones from their tutors were downloaded and stored as a PDF document for later analysis (see 4.5.2). Additionally, OneNote does not provide analytics of its use, so in order to track participation, the different contributions the students and tutors made over time were counted manually. This was possible by accessing and navigating across different versions of each page, as recommended by OneNote's developers[6].

4.4.8 Final Task

The final task was an activity developed during the Pilot Study (first cycle of DBR) as a result of mostly descriptive comments shared by students rather than reflective contributions in OneNote. Additionally, results from the reflective thinking questionnaire in the pilot study showed that students engaged with reflection (see in 5.3.3). Therefore, the task consisted of a series of questions based on the literature to encourage student reflection about their recent experiences (see Appendix F). The final task was collected either by email or from OneNote if the students decided to share with their peers.

4.4.9 Final questionnaire

The final questionnaire was a purpose-built questionnaire created to gather an overview of all participants' perceptions and their experiences of the intervention (see Appendix G). This method allowed the collection of views from all participants and also provided the

[6] https://answers.microsoft.com/en-us. This webpage corresponds to 'Microsoft community' where users share their experiences and solutions. The suggestion of counting manually using 'versions of page' was the solution proposed by the developers to a user with the same interest in having access the analytics of their documents on the application.

researcher with a general overview of the intervention, previously conducting the focus groups.

The instrument was a semi-structured questionnaire (Matthews & Ross, 2010) which considered questions about how many photographs students took, shared, and if they made comments or reflected on them. Also, participants were asked when they used theirs or any of their peers' photographs, comments, and reflections, and when and where they used and uploaded them. Additionally, open-ended questions were added to gather data about the advantages and drawbacks that the activity presented to them and a final section where students could add any comments or useful suggestions they had.

4.4.10 Summative Evaluations

Both the theoretical and practical assessments undertaken by students, and included within the intervention, were graded (for details see 6.6). The process to determine a pass or fail is explained later in 6.6. Grades were collected on an Excel spreadsheet and for analysis, those grades which have a particular connection with the unit within which the intervention occurred (i.e., fixed prosthodontics) were considered.

Grades were considered within the current study, as they provide a quantifiable measurement of student performance, contributing to understanding the enactment of the intervention (RQ1) and complementing understandings of the experience and perceptions of both the students and tutors (RQ2 & RQ3). Additionally, the literature suggested an interrelationship between the performance of dental students in pre-clinical and clinical courses (Velayo et al., 2014), and between the level of performance in their assessments with their engagement with reflection (Loka et al., 2019; Tricio et al., 2015).

4.5 Analysis of the data

Analysis of the data collected followed abductive reasoning (Van Maanen et al., 2007), meaning that while the coding was conducted and a new concept emerged, it involved the researcher returning to the literature and to the data to explain the concepts and to understand what the findings suggested. The approach is consistent with pragmatism (see in 4.2.1), which looks for explanations of actions or events in a social situation focusing on their consequences or meaning (Brinkmann & Kvale, 2015; D. Morgan, 2014a).

Consequently, the integration of qualitative and quantitative methods was embedded within the level of analysis. Thus, quantitative data provides the researcher with a starting point to understand the enactment of the intervention, in terms of participation and the

characteristics of the participants and their performance. This point provides a lens to see the qualitative data, and vice versa. Then when the data were seen from both perspectives it was condensed and presented in relation to each case, aiming to understand the teaching and learning process behind the intervention and answer the research questions.

The following sections present the data analysis within cycle 2: Main Study (see Table 5). The next chapter presents cycle 1: Pilot Study (see 5.3), in which data analysis focused attention on evaluating possible weaknesses and failures in the methods, and improvements in the intervention design. Additionally, some methods were added because of the Pilot Study (for details, see 5.4), which were considered pertinent to mention after presenting the intervention prototype (see 5.2).

4.5.1 Quantitative data analysis

For quantitative data, Excel was used to organise and clear the data. Following this, SPSS software was employed to conduct the tests and to process the data. Continuous variables were reported using descriptive statistics, including frequencies and percentages. The mean was used as a measure of central tendency, and standard deviation as a statistic that captured the dispersion of the data (A. Field, 2013). In the same vein, as most of the data presented were found to be dispersed, quartiles and mode were reported to provide a complete picture. Additionally, some scatter plots and box plots were presented to summarise the data.

Inferential statistics were used to investigated associations and differences between variables (A. Field, 2013). For example, the grades obtained by the students were associated with the number of photographs they took during the intervention (see 6.6.3).

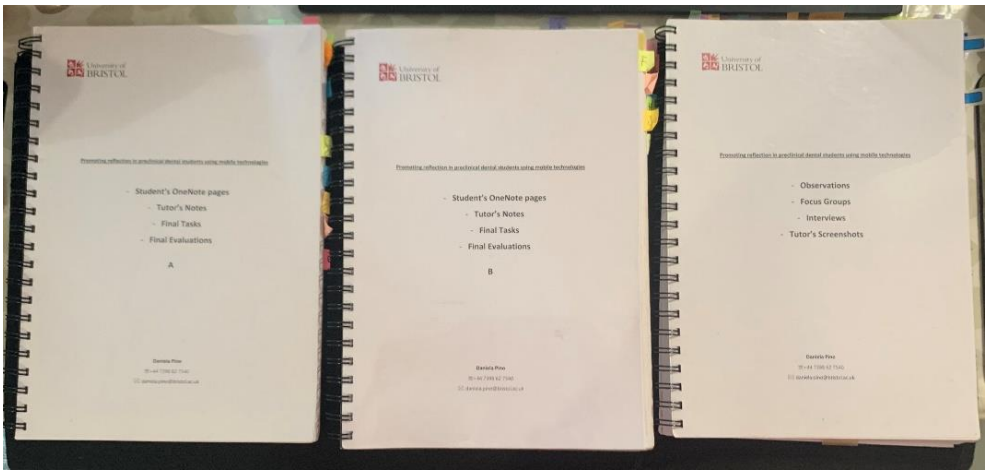
4.5.2 Qualitative data analysis

Qualitative data were imported into the qualitative data analysis Software NVivo. There the data were organised into folders and prepared for coding. The content from OneNote (i.e., student's pages, tutor's corners, fieldnotes) was imported into NVivo in a PDF format. Names were changed by a random number to anonymise participants, and a pseudonym was assigned to each. Focus groups were transcribed verbatim. For this purpose, the audios were imported into NVivo and transcribed manually, using the tools available on the app. To recognise which student was talking the video recording was played simultaneously. Notes about group comments, jokes and observations were also

transcribed to contextualise and reflect the richness of the conversation with students and tutors. Fieldnotes were imported using the same system. The final task was collected and imported, as well as the final questionnaire.

Additionally, everything was printed out for initial reading and coding (see Figure 13). The reason for this was to make general sense of all the data before coding it within the software. To have an idea of the codes the researcher wanted to consider and become immersed in, the experiences of the participants once again since the researcher was fully occupied in the collection of the data in the first instance.

Figure 13
Data printed for the first coding



The data was coded, understanding that a code represents 'a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute to a portion of language-based or visual data' (Saldaña, 2016, p. 4). The codes condensed meaning, aiming to construct a narrative (Brinkmann & Kvale, 2015; Kvale, 1996).

For coding purposes, in the beginning, a simple system of coloured bands on the printed version of the data collected was used to make general sense of the data. Subsequently, based on this initial analysis and looking to obtain better connections and deeper analysis, this system was combined with the use of computational software. At this stage, NVivo was used to organise and look in detail for possible connections. The software simplified the management of the amount of data collected and moreover simplified visualisation of patterns and possible relationships.

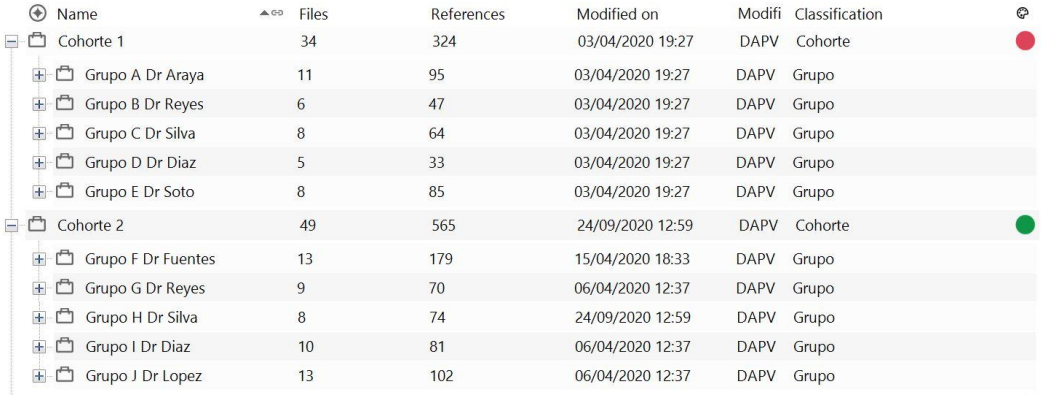
The unit of analysis was each student considered within his or her group. Therefore, each source of data within a group was considered, checked, and coded while making notes about their overall contributions to the learning process. Subsequently, new patterns were investigated for follow-up data and were returned to the previous one in case of new patterns being identified. This iterative process was undertaken until no new patterns within the data were observed. Thus, OneNote students' pages were coded according to the type of contributions made, i.e., photographs, comments, and reflections. Following this, each comment and reflection was coded as reflective or descriptive, based on the definition of reflection (see 2.4.1). Later, each contribution was coded according to its content (see Table 7).

Table 7
Code organization for Students' OneNote pages

Type	Classification	Content
1.Photograph	1. Descriptive	1. Self-assessment.
2. Comment	2. Reflexive	2. General description of practical stage.
3. Reflection		3. Theoretical knowledge as a reason to determined action.
		4. Description of mistakes and how to solve them.
		5. Detailed description of the procedure.
		6. Tips.
		7. Connection with real practice.
		8. Emotions.

Each group of students was coded (see Figure 14) and the most important aspects of the data were added to the summary by group, where the integration from other sources of data provided a complete picture of the lived intervention and the reporting of results was facilitated as best possible. This is known as a joint display of data (Creswell & Creswell, 2018, p. 220).

Figure 14
Data compilation by Cohort and by Group in NVivo



Name	Files	References	Modified on	Modifi	Classification
Cohorte 1	34	324	03/04/2020 19:27	DAPV	Cohorte
Grupo A Dr Araya	11	95	03/04/2020 19:27	DAPV	Grupo
Grupo B Dr Reyes	6	47	03/04/2020 19:27	DAPV	Grupo
Grupo C Dr Silva	8	64	03/04/2020 19:27	DAPV	Grupo
Grupo D Dr Diaz	5	33	03/04/2020 19:27	DAPV	Grupo
Grupo E Dr Soto	8	85	03/04/2020 19:27	DAPV	Grupo
Cohorte 2	49	565	24/09/2020 12:59	DAPV	Cohorte
Grupo F Dr Fuentes	13	179	15/04/2020 18:33	DAPV	Grupo
Grupo G Dr Reyes	9	70	06/04/2020 12:37	DAPV	Grupo
Grupo H Dr Silva	8	74	24/09/2020 12:59	DAPV	Grupo
Grupo I Dr Diaz	10	81	06/04/2020 12:37	DAPV	Grupo
Grupo J Dr Lopez	13	102	06/04/2020 12:37	DAPV	Grupo

When all the data was coded, and in order to facilitate the narrative process, a table was constructed in Word for each group of participants to condense and ease the interpretation process (see an example in Appendix H). Once all data were coded, they were then summarised using XMind[7] to see connections among codes and ease narrative reporting (see Appendix I). This allowed different sources and methods to be contrasted by triangulating the data (Ringsted et al., 2011; Yin, 2018). Therefore, this systematic approach contributed to a 'compelling narrative' (Habermas, 1971, p. 230), which was impossible if each source of data, case, and interaction were considered independently. Further details are provided as results are presented in the following chapters.

4.6 Ethical considerations

After the Preliminary phase of this design, a research protocol was written and submitted to the authorities of the university where the research was planned. The ethical committee approved the protocol (see Appendix J). Additionally, it followed the requirements from the School of Education (SoE) of the University of Bristol. The ethical approval from the University of Bristol was also duly granted (See Appendix K). The ethical form describes the preliminary research questions, however, they evolved due to the developmental characteristics of this research. The other aspects considered within the form continued as stated, i.e., Research access/exit; Information given to participants; Participants right to withdrawal; Informed consent; Complaint's procedures; Safety and well-being of participants and researcher; Anonymity and Confidentiality; Data Collection;

[7] https://www.xmind.net/

Data Analysis and Storage; Data protection act, Feedback, Responsibilities to colleagues and Academic Community; Reporting Research.

When, ethical approval was granted, the next stage was to contact potential participants, and information sheets were distributed among them (for students see Appendix L, for tutors see Appendix O) in both cycles. When students and tutors agreed to participate, consent forms were signed (for students see Appendix N, for tutors see Appendix P).

The following section is an extension of the ethical issues. First the ways whereby anonymity was guaranteed and secondly an important aspect regarding the power relationships that were taken into consideration during this research.

4.6.1 Anonymity of participants

Anonymity of participants was guaranteed in the consent form, and random names were assigned as attributing numbers depersonalised them. The selected names are typical names from Chile, obtained from the civil register office. A list was made, adding names that were familiar to the researcher to complete the list of participants with different Chilean names, and they were randomly assigned to the students. For the case of tutors, typical surnames from Chile were selected and were assigned randomly. As the majority of tutors were female, the female pronouns were used with all of them to help anonymisation.

Additionally, to facilitate interpretation of fieldnotes, helping the researcher to remember some interactions, actions, procedures (Richard & Lahman, 2015), some photographs of the practices were taken. When students and tutors were visualised, an application called "Skitch"[8] was used to blur the faces and participant's names on the scrubs, ensuring anonymity.

4.6.2 Power relationships

Power relationships exist in any social context and may influence the way individuals decide to act, defining their roles (Hayward & Lukes, 2008). Knowing the role a person has within a context is important, as roles are social constructions which are inherently shaped by institutional rules and social laws and influence the way people interact (Symonds, 2020). With this in mind, it was necessary to acknowledge that the researcher

[8] https://evernote.com/products/skitch

was known as a former lecturer and student within the institution where the study was carried out.

Traditionally, in the context of higher education, lecturers hold greatest power, their role being to transmit knowledge to the students. Nowadays, with the growth of more student-centred approaches and the view of lecturers as guides and supporters for learning, the perspective changes to being a co-construction of knowledge, and the relationship between learners and teachers could be described as being a partnership (Symonds, 2020). Additionally, there are other cases where the students are seen as consumers who demand experiences perceived as being value for money (Lomas, 2007; Naidoo & Jamieson, 2005).

Acknowledging the possible influence of these power relationships, this research gained ethical approval from the university, meaning that it followed the requirement at an institutional level. Additionally, knowledge and understandings were obtained as a co-construction between the researcher, students, and tutors. Therefore, in order to promote non-hierarchical relationships, the research offered many opportunities for participants to raise their voices and collect their opinions. In this regard, they were guaranteed that they could withdraw from the study at any time if they wanted to.

4.6.3 Reflexivity

As part of the methodological approach the researcher is a key element in the design of the intervention. The reflective process is considered to be an essential part of DBR (see 4.2.2). Thus, continual scrutiny, reflection and interrogation of the data was needed, with the intention of reporting 'interpretations' rather than 'facts'(Guillemin & Gillam, 2004).

Researcher reflexivity was present in the design of the intervention, when considering the presentation to a committee for project evaluation, during data collection and data analysis, and during the reporting of results, discussions and the conclusion.

Additionally, ethical tensions (e.g., interactions with participants, anonymity, power relationships) were present during all developments of this research, as considerations in taking one direction or another. Moreover, transparency (Bazeley, 2013; Brinkmann & Kvale, 2015) was required to demonstrate those decisions, and show the researcher's perspective rather than conceal its presence (Ringsted et al., 2011).

4.7 Summary of the chapter

This chapter provides the research aims (see 4.1), objectives (see 4.1.2) and the research questions (see 4.1.3). It is followed by the presentation of the philosophical underpinnings (see 4.2.1) and the methodology (see 4.2.2), and the methods used (see 4.4). Then, the intervention (see 4.4.1) was introduced to contextualize the data collection process and the selection of the participants (see 4.3). The chapter ended with a discussion of the ethical considerations (see 4.6).

This research aims to investigate the intervention of using photographs taken with mobile devices to encourage reflection in dental education and its impact in developing professional knowledge and skills in future dentists. The training aims to improve learning and the transferability of clinical skills during the preclinical practice of dental students, facilitating the transition to clinical practice. An intervention was designed, implemented, and studied during the practices of third-year dental students at the clinical skills lab (CSL) using Design-Based Research (DBR). The selected methodology allowed the integration of the researcher's position, past experiences, context, literature review, interactions with students and colleagues to formulate the research questions and present a prototype intervention. The intervention was applied in two iterative phases of design, implementation and evaluation (i.e., pilot study (see Chapter 5) and the main study (see Chapter 6 Chapter 7 Chapter 8). This methodology was applied with the umbrella of Pragmatism, which focused on socially situated consequences and meanings of an action or event under the view of a worldview-laded researcher (see 4.2.1).

Different methods and data sources were considered (see 4.2.2) to look for complementary ideas. Thus, multiple data sources, either quantitative or qualitative, contributed to understanding the phenomena holistically. The integration of qualitative and quantitative data was at the level of analysis to integrate each case (i.e., student, group of students and the relationship with their tutors) and built a compelling narrative of each of them. The integration of data followed abductive reasoning (see 4.5), meaning that it was a process of returning to the literature while moving forward into the data to explain concepts and understand what the findings suggest.

Finally, this chapter presents the ethical considerations of this research piece, considering aspects such as the anonymity of participants, their right to withdrawal, informed consent, complaints procedures, the safety and well-being of participants and the researcher. A deeper discussion (see 4.6.2) around the power relationships at play,

highlighting the promotion of non-hierarchical relationships between participants by offering many opportunities to raise their voices and collect their opinions.

The next chapter describes the first cycle, also named the Pilot Study.

Chapter 5 Prototyping and Pilot Study

The intervention was designed as a tool to enhance learning and teaching practices in dental education. It was proposed as a possible solution to the research problem (see 1.1) by means of an educational intervention that offered students the opportunity of reflecting on their preclinical practices in conscious and structured ways. The intervention was intended to allow students to develop reflective practice and use it to enhance learning from their experiences. It used a virtual learning environment where sharing of photographs, comments and reflections complemented regular practices during the sixth term for dental students at a traditional university in Chile.

Design-based research (DBR) (see 4.2.2) guided the development of the intervention. Thus, the prototyping phase included the preliminary design framework, which is the intervention's supporting ideas, theories, experiences, and context. The latter was described at an international and national level in health science education and dental education in Chapter 2 and Chapter 3, respectively. However, to provide a complete contextual picture, specific elements of the university programme and unit where the intervention was implemented will be presented and discussed in this current chapter.

This chapter begins with a description and analysis of the context where this research was undertaken. This is followed by the prototyping intervention, including the first cycle of implementation or Pilot Study. The last part of this chapter presents the findings of this first cycle and how these determined decisions were taken for the Main Study.

5.1 Context

The main context of the research is the field of Health Professions Education (HPE), specifically dental education. This section includes elements of the context related to the university, programme, and the unit where the intervention was implemented. Understanding these elements will clarify the design of the intervention

5.1.1 Dental Programme in the Chilean Higher Education

Higher Education programmes in Chile transited from a social perspective of the universities to a mercantile model (Tjeldvoll, 2010) in the early 1980s, where, as a general description, education became a product, and the students became clients (O. Espinoza & González, 2013). This shift in the model deregulated higher education in many

professions, including dentistry, causing an increase in the number of professionals without the same upturn in job vacancies (Alcota et al., 2016).

Chilean higher education has two kinds of universities, those created before 1981, called 'traditional', whether public or private, and those formed under the free-market system designated as 'private', which are unique private institutions (O. Espinoza & González, 2013). However, in 2015 the government created two public universities in regions where there were none of these types of universities (*Ley 20.842*, 2015).

Related to regulations in Chile, the Council of Chancellors of Chilean Universities (in Spanish: Consejo Nacional de Rectores, CRUCH) is charged with coordinating universities in the country and promoting performance and quality. It is composed of the traditional universities of the country and those created by the government after 1981. The CRUCH predominantly controls selection and admission of students in its constituent universities and develops regulations associated with higher education quality assurance and a system of solidarity funds (*Consejo de Rectores de Las Universidades Chilenas*, 2018).

At the time of the present research, there was a cohort of students who entered traditional universities in Chile. They were required to pass the University Entry Test (Prueba de Selección Universitaria, PSU). This was implemented in 2003, replacing the Scholastic Aptitude Test (Prueba de Aptitud Académica, PAA), which had been established in 1966 (O. Espinoza & González, 2013). Dental students used to obtain higher scores in those tests. However, in recent years decreasing average scores have been apparent, mainly due to the influence of private universities which lowered the entry requirements of their students (L. Espinoza, 2014).

In Chile, an exponential growth of dental schools was observed between 1997 and 2011 (Asociación Chilena de Enseñanza de la Odontología, 2020), and with a prediction of 77.5% oversupply of dentists by 2025 according to the World Health Organisation's criteria (Cartes-Velasquez, 2013). However, this growth in the number of professionals is not mirrored with better oral health among the population, as observed in other developing countries (Singh, 2010). This could be due to a lack of job vacancies in the public sector or a lack of increase in the amount of research by the new universities. Consequently, research is seen as the basis for better levels of oral health in the new generations (Ryder & Morio, 2011; Uribe et al., 2012).

As a result of these problems, the Professional Association of Dentistry of Chile has been fighting for obligatory accreditation for all the schools of Dentistry in the country. Recently, a new regulation emanated from the National Congress which states that: "starting from the 1st of January of 2020, all educational establishments must certify their educational programs for dentistry according to the National Commission of Accreditation" (Colegio de Cirujanos Dentistas de Chile, 2018).

The National Commission for Accreditation (CNA from the Spanish: Comisión Nacional de Acreditación) promotes and verifies the quality of higher education in Chile. The CNA presented a document with all the criteria and standards in 2003 to guide the accreditation of dentistry in Chile, and it becomes mandatory for all the schools of Dentistry from 2020. This document outlined the expected profile of students at graduation considering the minimum competencies, including those that are required as a professional and others that are complementary or more general. Besides this, the document also incorporates the minimum elements of the infrastructure needed for the development of future dentists and links with their future professional environments (Comisión Nacional de Acreditación de Pregrado, 2003).

Additionally, in Chile, there was a lack of consensus related to a standard curriculum and recommendations for dentistry (Carrizo, 2016). Recently the Association for Dental Education in Chile (In Spanish: Asociación Chilena de Enseñanza de la Odontología: ACHEO) published a document aiming to homogenise curricula in dental schools, including a list of the minimal content a dental programme should consider, and describing the learning objectives (Asociación Chilena de Enseñanza de la Odontología, 2020). This needs to be seen as a framework aiming to guide the reordering of the content of the curriculum and facilitate the integration of the course material (Ryder et al., 2008) at an institutional level in Chile. These recommendations were established after the present study was conducted, and they have just recently been published; therefore, there is no evidence about their impact yet.

5.1.2 The University

The intervention was designed to be undertaken at a traditional university in Chile, it being founded in 1919, and the third oldest Chilean university. It is located in Concepcion (see Appendix A), and according to international rankings [9] it is positioned as one of the

[9] https://www.topuniversities.com/universities/universidad-de-concepcion, Accessed on June 23th 2021.

most prestigious universities in the country. The university was accredited in 2016 for seven years [10], by the Akredita Agency, under the supervision of the CNA. The accreditation comprised the compulsory areas of institutional management, undergraduate teaching and the elective areas of research, postgraduate teaching, and outreach and public engagement. Additionally, the university adopted an educational model for all its undergraduate programmes (including dentistry). The model is based on learning objectives oriented to the development of competencies. It is regularly reviewed and updated, aiming to align with international trends. Thus, undergraduate students are able to continue their training at a postgraduate level in any university worldwide.

The university decided to train all its undergraduate students in four key generic competencies, considered essential for any professional working in society. These competencies are i. Critical thinking; ii. Communication; iii. Entrepreneurship and interdisciplinary teamwork; and iv. Social responsibility.

Additionally, the model requires each undergraduate programme to include at least four integral units that evaluate the continuous development of the graduate profile (Navarro Saldaña et al., 2015). In this vein, to achieve the key generic competencies pursued by the university, students are required to demonstrate reflective skills. Therefore, in the present research context, reflection is promoted in the first integral unit, which coincidently occurs in the final year of preclinical training of dental students that took part in this study.

5.1.3 The dental undergraduate programme

At the time of the Pilot Study (see 5.3.1), 93 cohorts had graduated from the dentistry programme and there was a current total enrolment of 509 undergraduate students from year 1 to year 5. The programme received accreditation from the National Commission for Accreditation (CNA) for seven years in 2012, from 2012 to 2019. In 2020, it was accredited for another seven years. The most recent version of the programme and graduate profile was from 2015, and its content is still valid and applicable to students' training.

The programme consists of eleven terms (see Appendix Q for details). It amounts a total of 221 credits used by the university, which is equivalent to 360 credits from the Transferable Credit System (SCT). The curricular content is separated between a

[10] http://www.udec.cl/pexterno/node/152, accessed on March 15th 2018.

preclinical stage and a clinical stage (see 3.2.2). Thus, during the first years of study, students must acquire, under supervision, the knowledge and skills that will support their future clinical actions. The last stage is a professional internship in an external service, where the students must demonstrate all the competencies they have developed.

The study programme includes four integrative units, the first of these being Dental Material and Integrated Preclinical IV (DMIP-IV) (see Figure 15). This means that in DMIP-IV, students need to integrate all the competencies developed during the unit with all the other disciplinary knowledge acquired up until this point of training. Thus, students need to show their level of integration and the development of the four key generic competencies promoted by the university (Navarro Saldaña et al., 2015).

Figure 15

Integrative units and Dental Materials and Integrated Preclinical (DMIP-IV) in Dental Programme

Note. Excerpt from the 2015 study programme (see complete programme in Appendix O), applicable from 2015 to 2020.
Each orange square represents a year of training. Each year is comprised by two terms (in green).
The total duration of the programmes is 5.5 years or 11 terms.
The grey squares represent the units in each term. The four integrative units defined in the 2015-20 study plan are highlighted with orange outer lines.

Third year students were selected for this research, considering both the programme structure and the main aim of designing an intervention (described in 1.1). Students in their third year were preferred over first or second year students because they were to get a more extensive background of theoretical knowledge and experiences to reflect on as they have progressed further through the programme. In addition, tasks undertaken by second year students are general ones that encourage them to be familiar with dental instruments and procedures. In contrast, third year students' studies involve more complex procedures and techniques which seek to integrate previous knowledge. Moreover, third year students are very close to starting their clinical training with patients. Therefore, they are at a crucial point in their development as professionals, and this is seen as an opportunity to develop the reflective skills promoted by the present study. Additionally, the unit of Dental Materials and Integrated Preclinical (DMIP-IV) is the first integral unit assessing the development of the graduate profile. Thus, any deficiency detected as a result of the intervention might be addressed before the student faces real patients.

5.1.4 Dental Materials and Integrated Preclinical (DMIP-IV)

There are four Dental Material and Integrated Preclinical units taught in Years 2 and 3 (see Appendix Q). The 'Dental Materials and Integrated Preclinical-IV' unit covers the skills taught in term 6 (Year 3 students). The unit provides students with the relevant knowledge and skills to treat a patient who requires the techniques of Operative Dentistry or Fixed Prosthodontics. Moreover, the unit includes integration of two components: theoretical and practical.

According to the study programme, this unit must contribute to the development of the nine competencies from the graduate profile with four Learning Outcomes (LOs) (see Table 8).

Table 8
Competencies and Learning Outcomes in Dental Materials and Integrated Preclinical IV (DMIP-IV)

Competencies:
1. Stabilise the oral environment by controlling the etiological factors.
2. Diagnose the state of maxillofacial oral health according to signs and symptoms.
4. Predict the result of the treatments performed.

Competencies:
5. Plan treatments according to priorities.
6. Execute treatments of prevalent pathologies.
8. Manage human, financial resources, technological systems, equipment, and inputs in the public exercise as private.
9. Apply the civil liability and legal regulations framework of the Chilean Ministry of Health and other standards and standards in the context of dentistry, health plans and environmental care.
11. Coordinate the selection, storage, conservation, and disposal of dental inputs considering their rules of use and legal implications.
20. Disseminate research results in specialised groups and communities in general.
Learning Outcomes (LOs):
LO 1 Describe the biological and physical principles of restorative treatments in Fixed Prosthodontics.
LO 2 Relate composition, properties, handling, and indications of materials used in operative dentistry and fixed prostheses, for cementation and restoration.
LO 3 Perform temporary and definitive restorations of preparations made in the subject of Dental Materials and Integrated Preclinical-III, by a direct or indirect method in a simulated environment.
LO 4 Perform custom-made post and cores and their respective provisional restorations in an ergonomic position in a simulated environment.

Note. Excerpt from the study programme (Facultad de Odontologia, 2014),
Numbers are not correlative as they relate to specific competencies within the entire programme.
Translated by the author.

The theoretical component consists of lectures, which require the attendance of the whole cohort of students; discussion forums through an online platform; and team presentations. The practical component involves completing tasks focused on the simulation of treatments and the complementary laboratory work needed to accomplish them. For this purpose, students work in the Clinical Skills Laboratory (CSL), being split into two cohorts, and work according to a timetable for each one. Within the unit, students must complete different practical tasks in a predetermined number of sessions. These tasks could be all the steps to produce a fixed unitary crown, a temporary restoration, preparation for Inlays and Onlays, among others, and are conducted on a phantom head or a mannequin (a simulated patient) under tutor supervision.

Assessments of practical and theoretical components of the unit must be passed independently.

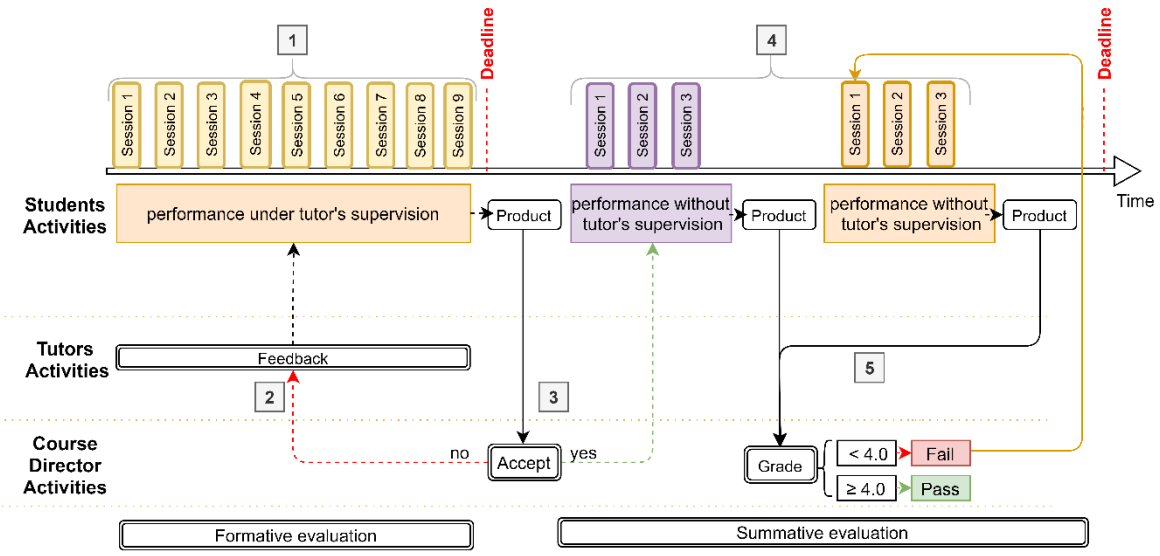
Regarding practical sessions, students are distributed alphabetically, dividing the class into two equal groups (i.e., cohort_1 and cohort_2). They are further divided into alphabetically ordered subgroups of six to eight students which are randomly assigned a tutor. Groups are fixed during the term, which means students sit in the same place and work with the same classmates for the duration of the unit.

Figure 16 summarises the workflow during practical sessions while students follow each task considered in the unit. Students must generate a completed product, first under the supervision of a tutor, receiving feedback throughout all the sessions (1 and 2, in Figure 16). Then, they must present their work to the course director[11], who, in consensus with the tutor, accepts it, suggests improvements, or rejects it, this last outcome requiring the students to start the process again if they have time according to the calendar (3, in Figure 16). Later, when the product is accepted, the students move forward to summative evaluation (4, in Figure 16). The assessment can be repeated if initially failed. During the summative evaluation period, a guide is used to evaluate the students' process and product. It is graded on a scale from 1.0 to 7.0 (see Appendix S), with a minimum approval grade of 4.0 (5, in Figure 16).

[11]'Generally, not involved as laboratory teacher. Acted as a monitor in the laboratory to ensure that students and faculty followed the learning methods prescribed for their respective groups', same as described by Vann et al. (1981, p. 569).

Figure 16

Session distribution, activities of students, tutors, and the course director in the Dental Materials and Integrated Preclinical IV (DMIP-IV) unit



Note. **1** indicates work under supervision (where the intervention was planned), **2** highlights tutor feedback received throughout the process. **3** emphasises the role of the course director. **4** highlights the assessment period, and **5** summarises the grading process.

For the purpose of the current research, Fixed Prosthodontics was the topic selected from the DMIP-IV unit. It was selected because it includes complex procedures that require students to integrate previous knowledge to accomplish them. For instance, they need to prepare a tooth in the simulators and send part of the work to the laboratory. Therefore, students need to evaluate their and others' work while practising their skills.

5.1.5 Fixed Prosthodontics

The topic of fixed prosthodontics incorporates learning outcomes (1), (2) and (4) (see Table 8). Before practical sessions, students had demonstrated knowledge of the theory (LO 1) from previous units and from the lectures considered within the DMIP-IV syllabus. According to the unit programme, during practical sessions students are expected to prepare a tooth to support a crown using a custom-made post and core and the corresponding provisional crowns (LO 4). All of this was undertaken in an ergonomic position. In addition, students were required to relate the composition, properties, handling, and indications of the materials used (LO 2). The theoretical and practical assessment combined LOs 1, 2 and 4 from this unit's element.

Third year students study the treatment of an endodontically treated tooth by performing a porcelain fused to metal (PFM) crown. The element consisted of 27 practical hours (illustrated in Figure 16 as nine sessions of 3 hours each) and 3 hours of theoretical lectures (see Table 9). The practical working hours are distributed according to subgroups (i.e., Cohort_1 and Cohort_2).

Table 9
Description of the practical and theoretical sessions and assessment within the intervened element

Sessions	**Description**	**Assessment** [b]
Practical	**27 hours** [a]	**9 hours**
	Sessions where the students conducted clinical procedures and some of the associated laboratory work needed to perform a porcelain fuse to metal restoration (PFM) under the guidance of a tutor.	A summative evaluation that included some of the procedures studied and described in advance to the students.
Theoretical	**Four sessions (45-minutes each)** Traditional lectures using Slide presentations delivered by different tutors. **1st session:** Introduction to the course and extended description of the practical activities. **2nd-4th sessions:** Reconstruction of endodontically treated teeth.	**1. Mini-Test_1**[b] (during 3rd session): included the topics of the first two theoretical sessions. **2.Theoretical Assessment**: 1-hour written evaluation that included the topics treated during the theoretical and practical sessions, but not only the element intervened.

Note.
[a] Distributed according to each cohort schedule, related to 3 hours sessions presented in number 1, Figure 16.
[b] Used the same criteria for evaluation presented in number 5, Figure 16.
[c] Mini-Tests are short theoretical evaluations. These tests aimed to encourage students to study lesson by lesson.

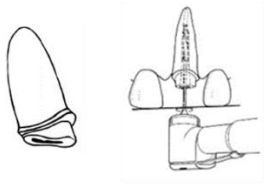
Students undertaking different parts of the procedure during practical sessions needed to achieve the required treatment and associated techniques (for sessions details, see Appendix R). In session one, they adapted teeth to work in artificial jaws that are later adapted into the phantom heads (see Figure 17). A student can start preparing the tooth

when the teeth are adjusted, and the jaw is placed into the phantom head. In the second session, they continue with what they had already started and prepare the root canal to receive a post. Then they must prepare the post and core. They continue until the tooth is ready, with its provisional restoration and its casted post and core.

Figure 17
Phantom head. Jaw with teeth adapted

The milestones described in Table 10 are pre-established actions as control points for the review of students' progression. Three pre-defined milestones allow students to progress to the summative practical evaluation when a product of the required standard is completed and accepted by the course director. A schedule with all the sessions is available for students to check where they are in their work.

Table 10
Milestone Procedures

	Milestone Procedure	Description
1		Crown and root preparation.
2		**Duralay® pattern** before sending it to the laboratory for casting.
3		**1st temporary post and core crown**. Chair-side made temporary with wire extension to the root canal.

Note. Pre-established procedures need to be accomplished by a student before entering their practical examination—a complete description of the process is in *Appendix R*
This table is an author representation based on Syllabus Dental Material and Preclinical Integrated. Images adapted from Shillingburg et al. (1996), descriptions complemented using Mitchell, D. et al. (2018).

5.1.6 Working in the Clinical Skills Laboratory (CSL)

Practical sessions are carried out in the Clinical Skills Laboratory (CSL). There, each student is assigned to a workstation. Tutors provide a group demonstration (as shown in Figure 18) at the beginning of the procedure and deliver further demonstrations when at least one of the students is ready to continue with the next stage. Additionally, further group demonstrations are conducted if the tutors recognise an example that can be useful to all their students. The tutor explains by means of drawings, models, or by performing the technique, thereby demonstrating how to generate the determined dental treatment.

During these practical demonstrations, tutors complement theoretical knowledge their students have been exposed to during lectures. Therefore, students can start working on their phantom heads (in case tooth preparation or other actions conducted in the 'patient's mouth') or in their workstations if they need to undertake another associated technique outside the 'patient's mouth'. When the demonstration has finished,

students return to their workstations and can ask for individual feedback should it be required.

Figure 18
Distribution of the students and tutor during a procedural demonstration in CSL

Students are discouraged from talking to each other; thus, they can focus on their work. Additionally, as shown in Figure 18, some screens physically divide their workstations in two, limiting students' interactions with peers while working. Consequently, their work is relatively isolated. Despite this they often make the effort to communicate and ask each other for advice. With this in mind, and recognising the potentials of student's interactions, the educational intervention actively encourages students to share their experiences.

5.2 Intervention Prototyping

Activities included within the intervention encourage embedding reflection during students' practices in an attempt to reduce the gap between theory and practice, under a socio-constructivist understanding of reality, knowledge, and learning (Amineh & Asl, 2015). The study gives students the opportunity to take and share digital photographs along with producing a written reflection about their practices. This enables them to learn

from others and expand their experiences and knowledge, and with it, reduce the ZPD through social interactions mediated by technology (see in 2.3). Technologies offer the possibility of fostering these interactions in an online space, where the experiences will be shared. Thus, the construction of meaning will be a process influenced by the experiences of each person in the learning community, where each participant will have pride and ownership over the task, which can lead to the generation of new and personalised motivational opportunities (Bonk & Cunningham, 1998).

In the proposed intervention, actions and interactions of the entire group are considered as a base for the teaching and learning process. The aim is to move from a student working alone to them interacting with a group of students, so they can work and learn together. In this context, there are many actors involved:

a) **Technology**: as a facilitator, consultant, guide, or a resource provider of learning (Huang, 2002).

b) **Tutors:** as mediators of students and environments (Brooks & Brooks, 1999). This current research considers teaching and learning to be fully integrated. Therefore, the study of educational practice should include both students and teachers, as well as the context to understand the complexities underlying them.

c) **Photographs, comments, and reflections shared by the students:** as a physical piece of material that could extend the sensory experience and may facilitate mental reasoning of the students (Watson, 2001), and enable the tutor to understand how students do and do not think about a concept more clearly (Brooks & Brooks, 1999), and thus help them to accomplish their goals. Moreover, these could be considered as cultural artefacts that shape actions and thought possibilities using Vygotsky's work, according to Daniels, Cole and Wertsch (2007).

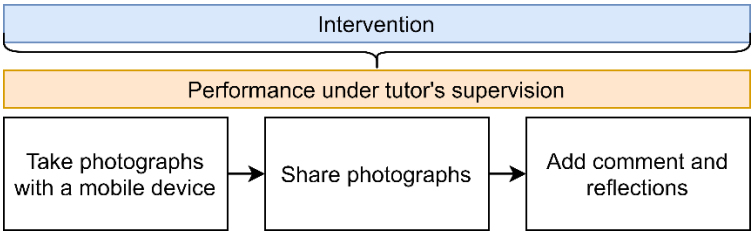
d) **Peer-learning**: as part of the context where the learning experience occurs, valuing this rather than the undervalued informal aspect of education that has always happened (Boud, 2001).

e) **Third year dental students**: selected in concordance with the literature and practical reasons regarding the dental programme where the intervention was designed. First, the literature suggested that these students are most

concerned about transitioning from the preclinical stage to the clinical stage (Botelho et al., 2018). Consequently, in the context of this research, third year students were close to facing that transition. Secondly, where the intervention was introduced within the dental programme (see 5.1.3). The unit of Dental Materials and Integrative Preclinic-IV (see 5.1.4) is the first of the four integrative[12] units included in the eleven-term programme that facilitates the achievement of the graduate profile. Thus, third year students face this integrative unit alongside their last year of preclinical training. Therefore, this is an important point in the dental curriculum to enhance the transition students are required to make. Additionally, the skills the intervention sought to promote will be required by students when they start treating their patients in year 4 (i.e., connecting theory with practice).

Summarising, the intervention consisted of an activity located during the practical sessions of dental students while working under the tutor's supervision (see Figure 19). The activity consisted of a set of volunteer activities conducted by students and tutors during their practical sessions. It was part of Fixed Prosthodontics (see 5.1.5), while students were simulating the treatment of an endodontically treated tooth (see Appendix R for details of each session).

Figure 19
Students' actions required by the intervention



Note. Intervention located during practical sessions.

Photographs are important in dentistry and dental education, as presented in previous chapters (see 3.5). However, in a tutor-led environment, students have the relatively passive role of observing photographs during lectures (e.g., Figure 20) rather than producing them for any educational purpose. From the literature and experience of the

[12] Units tending toward or promoting integration (see Appendix Q)

researcher, photographs are commonly used to explain complex processes, such as those preparations studied in fixed prosthodontics units (see 3.4). However, there has not yet been much research to explore the impact of students taking photographs and how this impacts their learning. Thus, by reviewing the literature and talking with students and colleagues, the first design of the intervention was developed. It sought a pedagogical use of photographs as a tool produced by the students aiming to trigger reflection that could improve, help, or promote learning. Additionally, the use of mobile devices by young people reported in the literature (Khatoon et al., 2013) and the multiple theory approach to learning in Health Professions Education (see 2.7) assisted design of an educational intervention.

Figure 20
Use of photographs in lectures

Having decided to incorporate photographs taken by students to promote reflection and peer learning as the intervention, the next challenge was deciding how to manage them. Therefore, as described previously (see 3.4) multiple platforms could be used for educational purposes. Previous researcher experience (Careaga et al., 2014) using various platforms (e.g., Google Drive, Edmodo, Educreations) directed the need for a platform that could offer free access, straightforward navigation, and offline recording. OneNote, one of the multiple applications from Microsoft Office, provided a solution to these requirements.

5.2.1 OneNote. The selected platform

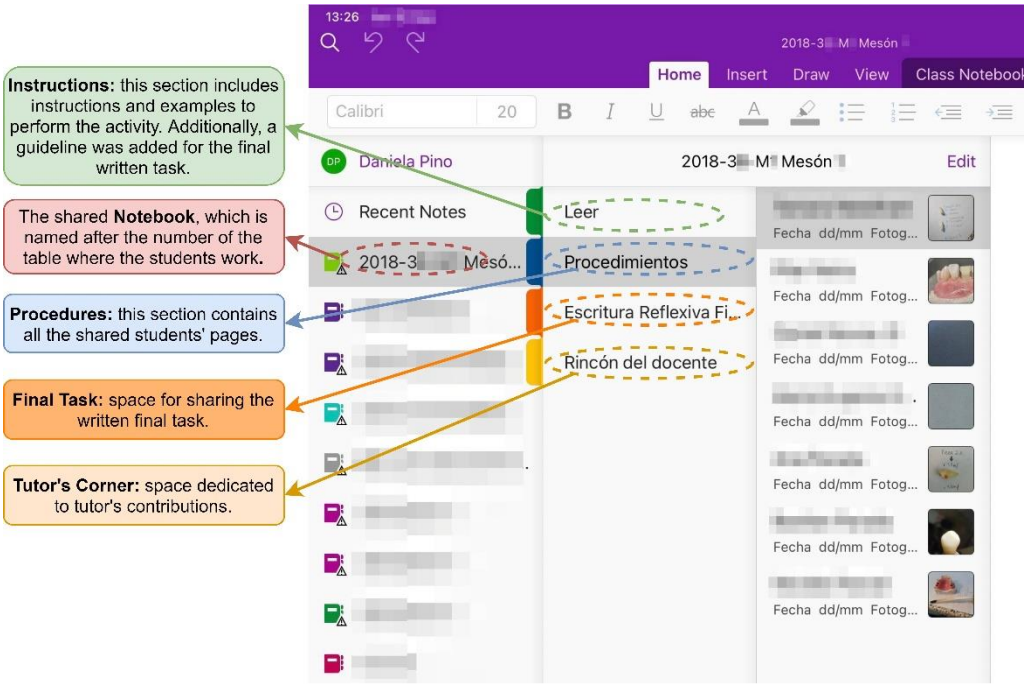
OneNote was the platform selected as an online learning environment for the purpose of this educational intervention. Additionally, it serves as a means for data collection: from student's and tutor's OneNote pages (see 4.4.6), from observations of the researcher to gather field notes (see in 4.4.5), and final written tasks (see 4.4.8).

OneNote could be defined as a note-taking programme for free-form information gathering and multi-user collaboration. The basic version is free, is easy to use, and is well supported by an online community of users who share their experiences [13]. In OneNote, based on the usual practices in the CSL as described previously (see 5.1.6), the intervention considered the experiences of each student as a learning opportunity, documented through photographs, comments and reflections. Therefore, each student could share their practices with their peers using the platform. Additionally, students could share their own experiences and reflections alongside those of their peers.

A shared notebook for each group of students participating in the activity and their tutors was created using their institutional e-mails. Figure 21 shows the design of the OneNote group page. Each Notebook was named after the number of students places of work (e.g., Table One, Table Two). Notebooks included four sections: instructions, procedures, final tasks, and tutor's corner (details in Figure 21). The **instructions** section ('instrucciones' in Spanish) contained the directions students were required to follow to navigate the application. These included a description of what they will find in the shared Notebook. Additionally, instructions indicated to students that they can check what their peers do, advised caution in not changing others' content, and included directions to write a final task. In **Procedures** section (**'**procedimientos' in Spanish) students could access pages assigned to them. A table containing four columns was added to each student page. The columns were for dates, photographs, comments, and reflections (see Figure 22). The table was completed during students' practices according to the instructions provided. The **final tasks** (see 4.4.8) and **tutor's corner** (see 4.4.7) were described previously.

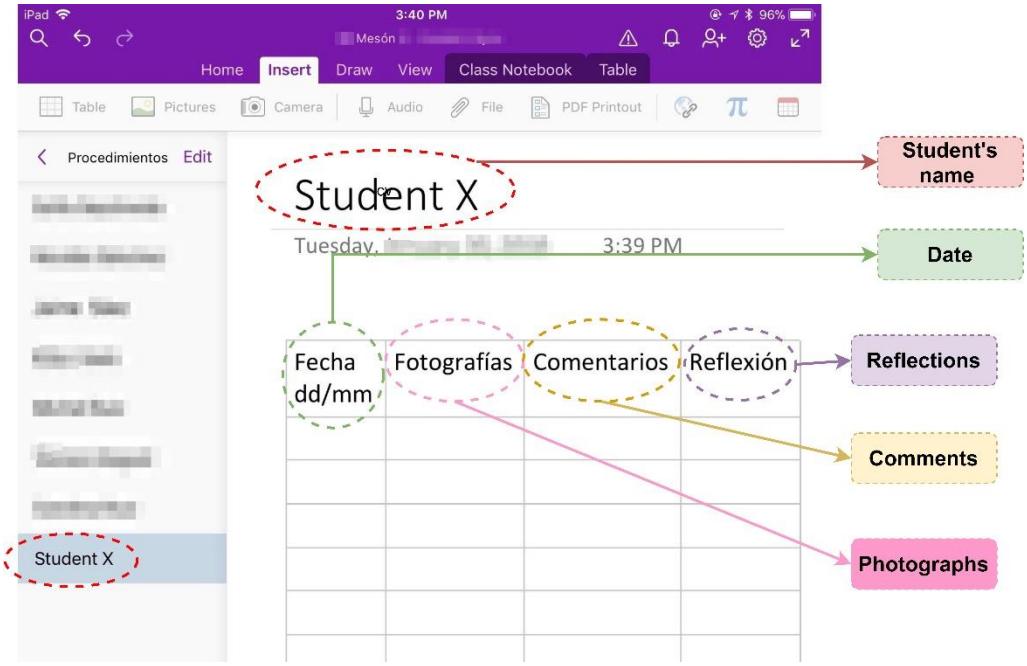
[13] https://support.microsoft.com/en-us/office/introducing-onenote-38be036d-5b5a-49ad-83be-292fe53ad7b3

Figure 21
Shared Notebook by table ('Mesón')



Note. Instructions are shown in green, procedures in blue, Notebook in red.

Figure 22
'Student X' Page in OneNote



Note. Each student page visible by members of the same group. The students are listed on the left, where 'Student X' is highlighted.

5.2.2 Activities considered by the intervention

During the research, the activities required for participants could be summarised in actions needed at the beginning, during and at the end of their practices in the clinical skills laboratory (see Table 11). During each of these periods of time, participants were required to do their usual work in combination with the volunteers' activities as part of the designed intervention. As the design was improved through the cycles, new activities were required.

Table 11
General activities requested from the participants

Participants	**Intervention**		
	At the beginning	During their practices	At the end
Students	*Consent participation *Complete RTQ	*Complete their requirements. *Work on their OneNote pages.	* Write a final reflective task. * Do their summative evaluations. * Complete a final questionnaire. *Participate in a focus group.
Tutors	*Consent participation	*Supervise and provide feedback to their students. *Share demonstrations on OneNote. *Take a screenshot.	* Evaluate their students. * Participate in a focus group. * Share their screenshots during the focus group.

Note. RTQ=Reflective Thinking Questionnaire
Highlighted in grey the normal practices the participants needed to carry out.
In blue what was included considered at the beginning of the Pilot Study.
In red what was added during the pilot study
All the activities were considered during the Main Study.

The first cycle (or Pilot Study) was conducted once the first design was complete and ethical approval was obtained (see 4.6). In order to understand the performance and improve the development of the intervention (RQ 1), alongside characterising and understanding participant experience and perceptions (RQ 2 and RQ 3), different data collection methods and analyses were conducted, as described previously (see 4.4). What follows it is the first cycle of implementation of the intervention design, i.e., Pilot Study.

5.3 Pilot Study

The first cycle of DBR (see in 4.2.2), also named the Pilot Study, was conducted over a period of 2.5 months (October – December 2017) alongside the regular curriculum at the School of Dentistry. This small-scale study was undertaken to evaluate possible weaknesses and failures in the methods and intervention design. Thus, these could be addressed in preparation for the second cycle or Main Study (Lewis-Beck et al., 2004). This cycle mainly assessed feasibility regarding time, activity applicability, sources, and instruments. Thus, special attention was paid to the intervention and how it worked and was perceived by students.

The main limitation, however, was difficulty gaining access to participants when the pilot study started. Initially, the intention was to work with the two most homogeneous groups, meaning that they were beginning the same procedures simultaneously. However, when these students were selected and asked to participate, almost all of them declined. Coincidentally, these students were working behind the unit schedule compared to other groups in the cohort. Later, two groups of students in the other cohort agreed to participate.

5.3.1 Participants in the Pilot Study

The 2017 cohort consisted of 65 students. As presented above (see 5.1.4), students were divided into two sections (i.e., Cohort_1 and Cohort_2). There were five groups in each cohort. In Cohort_1, there were two groups with seven students and three with six. In Cohort_2, there were three groups with seven and two with six students. There was one tutor in charge of each group, only two tutors had students in both sections, and the course director was tutoring one group in the Cohort_2.

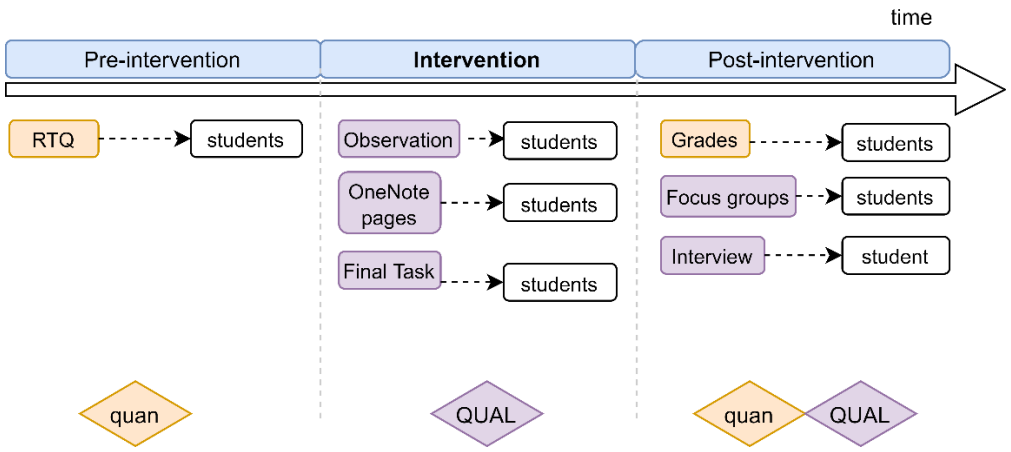
Fourteen students agreed to participate, signing the consent form (see in Appendix N). They were distributed into two groups, one with six and another with seven students (A and B). An extra participant from another group (C), who was proactively motivated to participate in the activity, was added to the study. The tutors did not receive further instructions other than doing their activities as they usually did.

Participants were aged between 20 and 29 years old, four were males, and ten were females. Two were doing the course for the second time, one had studied dentistry at another university before but did not finish her studies, and one student studied one year of Nursing before starting Dentistry.

5.3.2 Setting up, data collection and data analysis within the Pilot Study

The activity was explained to students, and special attention was given to the setting up of the application, OneNote, on their devices. During the first session, some students had problems with their devices, so two donated, recycled phones were loaned for use during the sessions. Once the application was installed and students started registering their practices (see Table 11), different data collection methods took place, as summarised in Figure 23.

Figure 23
Overview of data collection during Pilot Study



Note. RTQ= Reflective Thinking Questionnaire.
Capital letters indicate the dominance of qualitative (purple) methods over quantitative (orange)ones (Hibberts & Johnson, 2012). Integration is at the level of analysis and narrative report (see in 4.5). Constructs are the student's contributions (photographs, comments, and reflections) in OneNote.

The Focus group and the interview were transcribed verbatim and printed out for manual coding. Thematic and narrative analyses (Bazeley, 2013; Brinkmann & Kvale, 2015; Kvale, 1996; Saldaña, 2016) were used to analyse data collected from the observation, the focus group, the interview, and the students' constructs (OneNote activity and final written task)(see 4.5.2). Descriptive statistics were used to analyse the quantitative data (see 4.5.1).

5.3.3 General findings from the pilot study

Fourteen participants answered the Reflective Thinking Questionnaire (RTQ). However, one student left the course due to personal reasons, and her results were excluded. Descriptive statistics of the subscales that constitute the questionnaire are presented in

Table 12. The scales with higher results were Understanding (M=16.85, SD=2.30) and Reflection (M=16.46, SD=2.26), followed by Critical Reflection (M=14.77, SD= 3.09).

Table 12
Descriptive statistics of the Reflection Questionnaire Scales

Statistics	**Habitual Action**	**Understanding**	**Reflection**	**Critical Reflection**
M (SD)	*10.69 (2.14)*	16.85 (2.30)	*16.46 (2.26)*	*14.77 (3.09)*
Mdn	*11*	17	*17*	*15*
Min	*7*	12	*11*	*9*
Max	*15*	20	*20*	*20*
Q1	*9*	15.50	*15*	*12.50*
Q3	*12*	19	*18*	*17.50*

Note. N=13

Students shared a total of 144 photos, 125 comments and 60 reflections. Table 13 summarises the total contributions. Eleven of the participants shared their photographs, comments, and reflections. Two students did not provide contributions, despite taking photographs during the practical sessions. Only three students sent their final written task, these being received via e-mail. Considering the literature, the level of reflection achieved by the students could be classified as Critical Reflection, as they were fully present as writers, describing a challenge or issue and showing how they looked for alternatives to do their work (Wald et al., 2012). Additionally, they paid attention to their emotions and demonstrated transformative reflection and learning.

Table 13
Descriptive statistics summary of OneNote total contributions within the Pilot Study

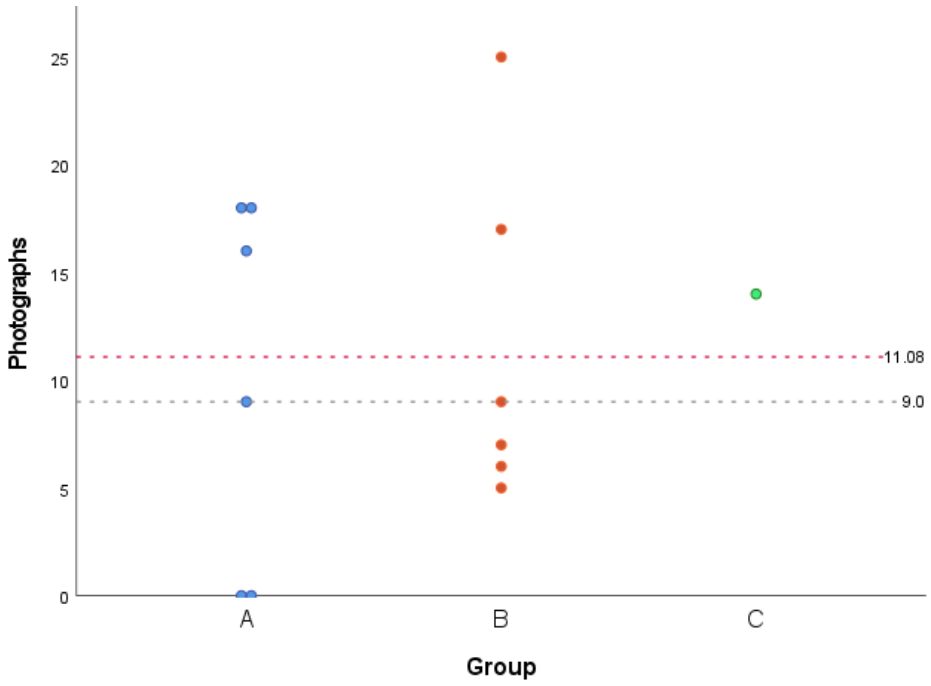
Statistics	**Contributions**		
	Photographs	**Comments**	**Reflections**
Total	144	125	60
M (SD)	11.08 (7.59)	9.62 (5.55)	4.62 (4.86)
Mdn	9	10	4
Min	0	0	0
Max	25	18	14
Q1	5.50	7	0
Q3	17.50	13.50	6.50

Note. N=13.

From the data in Figure 24., it is apparent that the participation online was variable amongst participants. The substantial standard deviation indicated this variability in participation. Additionally, when compared within the same group it was possible to distinguish participants who excelled compared with fellow participants.

Figure 24

Frequency of photographs shared by participants in each group



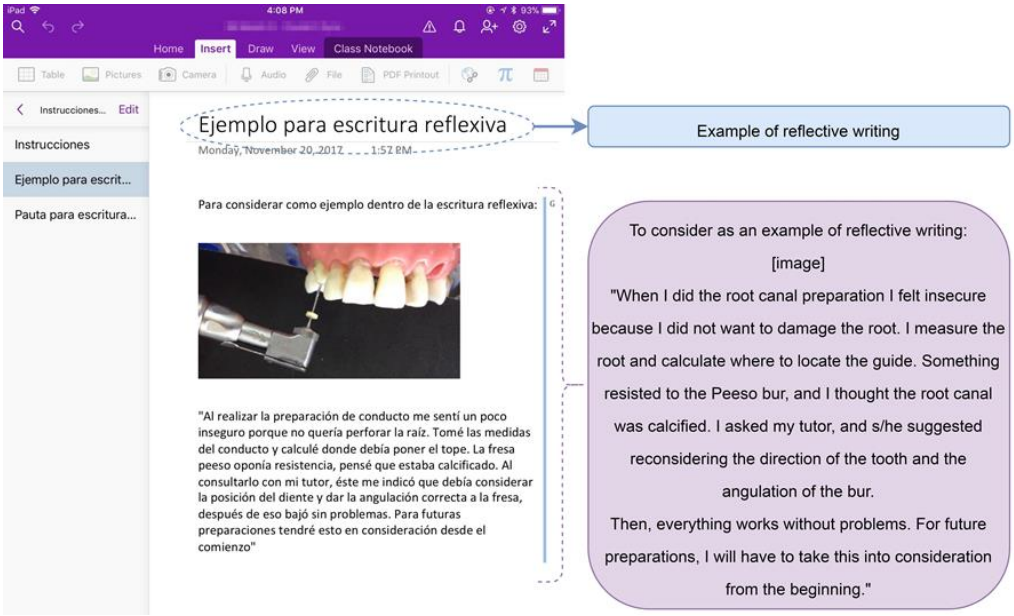
Note. N=13. Participants were distributed by groups; blue dots represented participants from group A; red dots participants from groups B and green dot the participant from group C. The pink dotted line represents the mean of photographs shared on OneNote by the participants, M=11.08 (SD=7.59), and the grey dotted line the median, Mdn= 9.

All participating students achieved the minimum pass grade (4.0) in the practical examination. Grades ranged from 4.4 to 6.3 (the scale ranges between 1.0 to 7.0); thus, according to the requirements, all the participants passed the exam on the first attempt.

During the first sessions most of the students tend to share only their photographs, and if any comments or reflections were added they were primarily descriptive. Therefore, to motivate and encourage students to reflect, an example was added to the section instructions (see Figure 25) to guide them while writing their reflections.

Figure 25

Example of reflective writing uploaded to the Notebook in OneNote

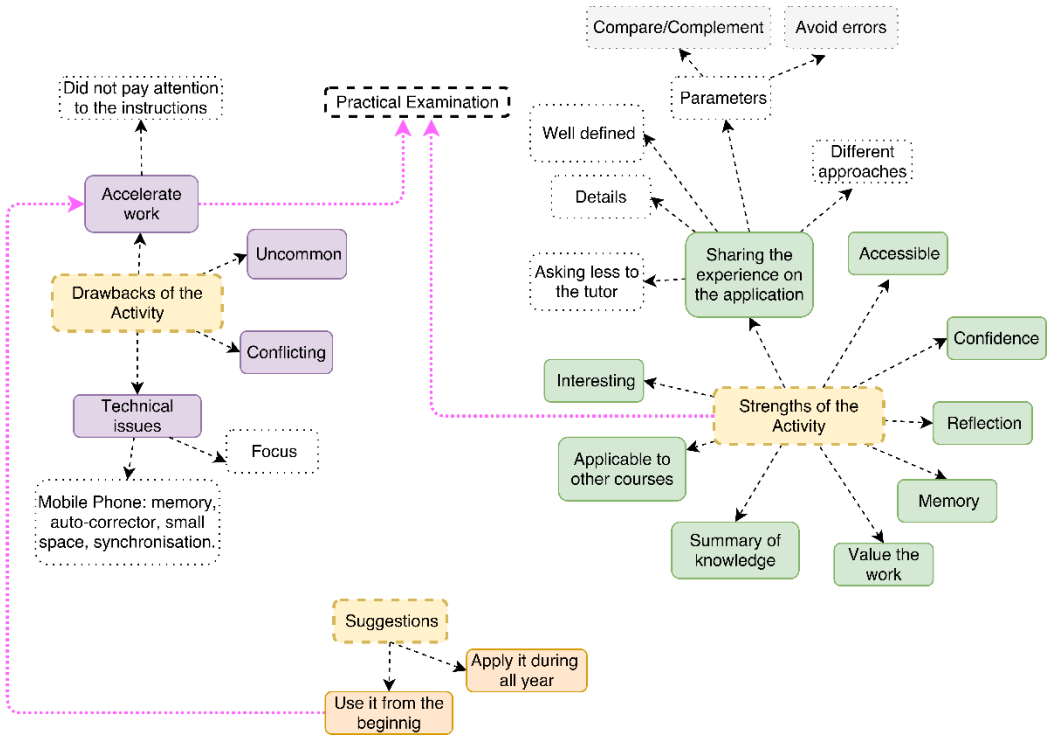


Note. This example was added under instructions (instrucciones). Translation added in bubbles.

5.3.4 Students' perceptions and experience

In order to understand students' perceptions and experiences with the intervention, the analysis focused on highlighting the strengths, drawbacks and suggestions of the activity, as perceived by students. Data obtained from the focus groups, interview and final tasks was coded and a code map was built to summarise what was found.

Figure 26
Code map from students' perceptions about the intervention



5.3.4.1 Strengths of the Activity

Regarding the students' perceptions, the information that emanates from the analysis shows that students consider it as a beneficial experience. They described it as an accessible and interesting activity, which provided them with a summary of knowledge helping them with memorising the stage considered within a studied procedure.

Special interest was given to the positive emotions evoked by the activity. According to students it contributed to enhancement of their practice. In their own words:

> When I took a photograph of something tiny that I had made, I looked at it and felt proud of what I had done, what all of us had done, it was meaningful and helped me to appreciate my work (Pablo, gA, focus group).

Photographs enhanced students' practices, as they provided details that allowed them to evaluate and reflect on their work. For example, one student stated: "When you write a comment, … you realise what was difficult for you, the details you need to take care of" (Pedro, gA, focus group).

Additionally, this was complemented via the view of another student who mentioned: “I took pictures of my mistakes… and in the moment of taking it, I realise what I was doing [wrong]” (student 7, focus group).

5.3.4.2 Drawbacks of the Activity

Not surprisingly, there were some drawbacks of the activity. These corresponded with the issues that needed to be reconsidered and improved for further design of the intervention. Drawbacks could be summarised into two mains themes: aspects evoking a negative feeling and the technical and practical issues.

Firstly, evoking a negative feeling in the words of the students was a problem of time to conduct their activities, as articulated by Camila:

> It [the intervention] was a little complicated because tutors hurried us because of the deadline, and there I said that I wanted to take photographs. However, I needed to hurry up, and then I run to the laboratory or took an impression (Camila, gC, interview).

Furthermore, the students were working very fast, fearing that they may not finish the requirements. An example of this was noted during the final exam or in previous days when students had to complete the requirements to have the chance to take the final exam, as students complained when the sessions were over. For example, from fieldnotes:

> Students, the session is over- Course Director, 6 pm 09/11/2017.
> Oh! - students complaining about the end of the session.

Or one week later, (16/11/2017):

> 2:10 pm, the doors were opened by one tutor.
> 2:19 pm, most of the students were working, regardless of whether their tutors had not arrived yet (Fieldnotes).

Secondly, another important factor was the use of mobile phones during clinical practice. One student found the use of phones during the intervention contradicted what they are taught about cross-infection control, in her words: “It was weird… As they told

us, no phones in the clinics and anything… It was a little contradictor" (Margot, gB, focus group).

5.3.4.3 Suggestions to improve the intervention design

It was essential to have the students' opinions about the activity to improve the intervention at this stage. According to them, they need more tutor involvement in the activity; for example, Doris mentioned: "[tutors need to] remember us to check the application [different sections]" (Doris, gA, focus group).

Additionally, they suggested having a bigger screen will make it easier to navigate on the application. "I will have bigger equipment, like a tablet, because I had some pictures and I have to maximise and minimise them. It was hard to write [on the phone]" (Camila, gC, interview).

Remarkably, a negative influence of the presence of someone observing the students during their practices was discovered in the field notes. It was complemented with the data that came from the final written task:

> I lacked confidence in myself because when the tutor was watching me while I was working, I felt that everything was going to be bad; it made me nervous. In contrast, in the practical exam, without so much pressure to show everything to him or her, only the final work…I felt more confident about what I was doing. I worked calmer and faster (Camila, gC, final written task).

5.3.4.4 Practical Examination Issues

The practical examination was a recurrent topic throughout the interview and focus groups, indicating students' preferences to use the intervention as a tool to improve their performance. However, students must apply knowledge and skills they gained during their preclinical training to their future clinical performance.

5.4 Reflections for next cycle

After this first cycle, it was possible to test the feasibility of carrying out the designed intervention during practical classes in the Clinical Skills Laboratory alongside the regular curriculum.

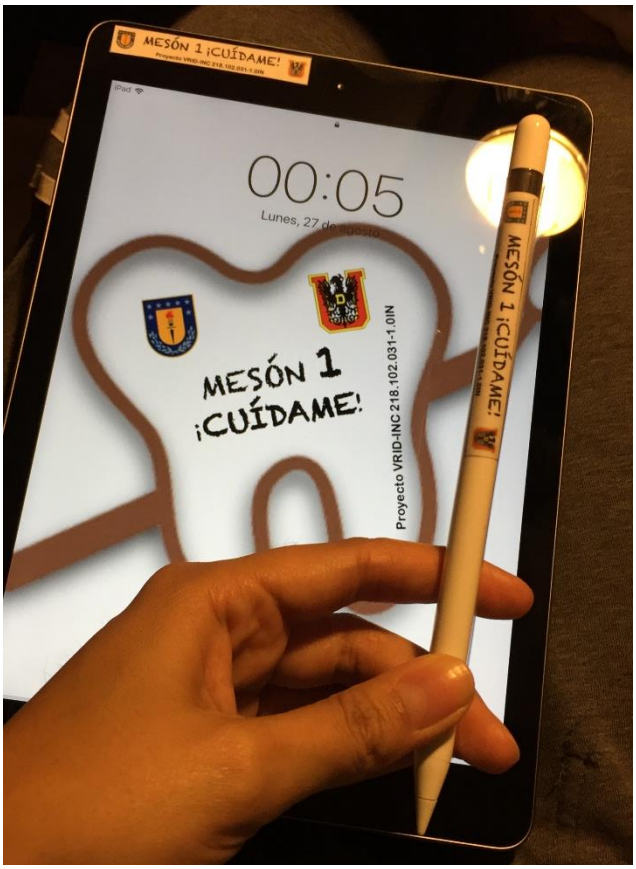
In the case of the first cycle (pilot), on the reflective thinking questionnaire, students presented higher levels of understanding and reflection than habitual action and critical

reflection, suggesting that third year students have the ability to reflect. However, this ability is not used accordingly in their educational activities.

Regarding the students' perceptions, the information that emanated from the analysis shows that students consider the intervention to be a beneficial experience, providing many suggestions which were considered later within the main study. First, an online place where tutors can collaborate was designed; it was named *'tutor corner'*. Secondly, an institutional project was presented aiming to obtain some equipment to work with the students and tutors and make the activity more accessible.

An institutional project: *'VRID-Iniciación 218.102.031-1.0IN',* was awarded (see Appendix T). Six kits consisting of iPad, apple pencil, keyboard, and protective case were acquired and prepared to be distributed to each group during the main study (see Figure 27). The tutor was in charge of the kit and used it with their students in their groups during the practical sessions.

Figure 27
iPad and Apple pencil prepared for group 1



5.5 Summary of the chapter

This chapter complements the context at a local level. This information is essential as it guides the decision-making process to design the educational intervention implemented and studied within the current research. Firstly, it highlighted the lack of regulation of dental programmes in Chile and the increased number of dentists expected for the coming years. Secondly, it presented the university context, which showed the institutional interest in adopting an educational model that encouraged students' development at the level of international standards. It introduced the orientation towards developing competencies and the importance of integrative units within the undergraduate programme. These units served as a quality assurance for the students' achievement of the graduate profile offered by the university.

Thirdly, based on the research problem, the literature and the contextual elements, the development of the intervention was fully presented, and third year students were selected as the most appropriate participants. Thus, the chosen unit was presented, describing in detail the studied procedure and the modality of teaching and learning,

based on commonly used lectures and tutors' demonstrations. Then, the selection of the tools and the implementation of the activity was detailed. In 5.2.1, the design of the educational environment in OneNote was introduced, including all the details of the content presented to the students and tutors.

Finally, the first cycle presented here offered evidence related to the plausibility to conduct such an intervention and provided the experience and evidence to implement the Main Study. Results showed that the student's participations varied, and at the beginning of the intervention, most of the contributions were primarily descriptive. Consequently, some examples were added to encourage students to reflect. Furthermore, in order to evaluate students' perceptions and experience, the analysis focused on the strengths and drawbacks of the activity perceived by the students.

In general terms, the intervention makes students feel proud about their work and helped them to enhance their practices. However, students raised some concerns about working under time pressures and following cross-infection protocols. In the same vein, students highlighted the need for tutors to take a more active role in encouraging them to use the application.

Thus far, incorporating the planned activity during the practices of the students was plausible, and some changes were made before implemented the main study, as seen in 5.4

Chapter 6 The intervention in action

This chapter describes how the designed intervention was performed during the training of third year students. It will provide the general characteristics of the unit considered within this research and of the participants (i.e., students and tutor). These will serve as a starting point for later analysis of the intervention. The generalities are presented to set the scene where the intervention was carried out, for example the description of the practical and theoretical sessions, participants' profile, results of the Reflective Thinking Questionnaire (RTQ) and the assessments the students faced during the intervention. Additionally, information about the students' contributions and how they generally use the materials available on the platform online will also be presented. Thus, this chapter's data will provide information for answering Research Question 1: **How does Design-Based Research inform the design and enactment of the educational intervention?**

6.1 Generalities of the unit within which the intervention occurred

The main study was conducted at the beginning of the second semester[14] of 2018, from August until November. It considered observing the theoretical and practical sessions during seven weeks, i.e., the time required to complete the required procedures (see Table 9) in addition to the tasks considered by the intervention (see 5.2). This observation period was followed by collecting data after the intervention, by conducting the focus groups with student and tutors, collecting screenshots from tutors and grades obtained from students from their practical and theoretical evaluations, as well as applying the last questionnaire to evaluate the intervention from students' perspective (4.4.9).

The design of the intervention incorporated improvements from the Pilot Study (see 5.3). The full cohort of third year dental students was invited to participate. The unit considered within this present research included both practical and theoretical sessions (see 5.1.5). The intervention was designed to be incorporated during the practical ones, and it was presented to the students and tutors during the first theoretical session. The purpose of this was to introduce the researcher to the students and to let them know that an activity will be incorporated into their practical training. Additionally, the activities considered by the intervention (see Table 11) were explained in detail, group by group,

[14] Second semester in Chile starts in August until December.

during the practical sessions, and consent forms were distributed to the students and tutors.

6.2 Profile of participants

In this section, general information about the participants will be presented. It provides a picture of the cohort of 2018 and how this affected activities during the intervention. For example, the number of participants in each group is essential. It might influence participants' experiences during the intervention, mainly impacting on the number of contributions each student had available on their devices over time.

Of the 65 students that made up the 2018 cohort, 56 (86.15%) agreed to participate in the intervention, voluntarily signing the consent form (Appendix N). Of these participants, 38 were female (67.9%) and 18 were male (32.1 %). This ratio reflected the gender ratio of the entire cohort (i.e., 41 females (63.1%) and 24 males (36.9%)) and did not indicate an increased tendency of women to participate in the intervention for example. At the time of the intervention, the participants had an age range between 19 and 39 years (M=21.55, SD=3.09), although 75% were 22 years old or younger. Three students had taken and failed this course previously, one twice and two once.

According to the students' group division (see 5.1.4), the entire cohort of students were separated into two groups (i.e., cohort_1 and cohort_2), having their practical sessions in different schedules and subdividing them into five subgroups each. Therefore, there were ten subgroups named from A to J (see Table 14). From cohort_1, 24 students, corresponding to 72.72% of the group, agreed to participate. In cohort_2, 32 students (100% of the group) agreed to participate. Additionally, all the tutors agreed to participate signing a consent form (see Appendix P), giving a total of seven tutors, 2 male and 5 female[15]. Three tutors had two groups, one in each half of the course. Thus, as described previously (see 5.1.6) in each of the practical sessions, a group of six to seven students were guided by the same tutor. Regardless of the entire group participation in the intervention, the demonstrations were the same for all students within a given group.

[15] For written purposes, to retain the anonymity of the tutors all of them were referred to as being female.

Table 14
Details of cohort participants by subgroups and gender

Group	**Participants**	**Female**	**Male**
Cohort_1			
A	7	4	3
B	3[a]	2	1
C	6[a]	5	1
D	3[b]	2	1
E	5[b]	4	1
Total Cohort_1	24	17	7
Cohort_2			
F	7	4	3
G	6	3	3
H	6	4	2
I	6	5	1
J	7	5	2
Total Cohort_2	32	21	11
Total	56	38	18
	(100%)	(67.9%)	(32.1%)

Note. Group size reflects students' willingness to participate.
[a] out of 7 students
[b] out of 6 students

From the students who agreed to participate (N=56), eleven (16.94%) had previously undertaken another degree. However, only one of them finished her major in an area other than Dentistry or Health Sciences. From the other ten students who did not finish their previous degrees, they pursued between one semester and four years, with completion of at least one year the most frequent with seven students. Six of them studied degrees in the field of Health Sciences or related disciplines. The other four students followed engineering-related degrees.

The tutors who agreed to participate, were dentists with vast experience in teaching between 8 and 23 years of experience. Additionally, they have a range of different educational backgrounds. All of them had undertaken different teaching qualifications offered by the institution, and three of them possessed Master's degrees in Higher Education related topics.

6.3 Reflective Thinking Questionnaire

The 56 participants answered the Reflective Thinking Questionnaire (RTQ). Descriptive statistics of the subscales that constitute the questionnaire are presented in Table 15. The scales with higher results were Understanding (M=17.89, SD=3.88) and Reflection (M=14.48, SD=3.21). From the descriptive statistics, it is noteworthy that 75% of the participants obtained 18 or more points in Understanding with 25% obtaining the maximum score on that subscale. Additionally, 25% of the participants obtained 19 or higher in Reflection. This is consistent with expectation at the level of training the students were at the moment of the intervention (see discussion in 9.2.2).

Table 15
Descriptive statistics of the Reflection Questionnaire Scales in the Main Study

Statistics	Habitual Action	Understanding	Reflection	Critical Reflection
M (SD)	11.75 (3.29)	17.89 (3.88)	16.48 (3.21)	15.13 (3.19)
Mdn	12	19	17	16
Min	4	4	7	5
Max	19	20	20	20
Q1	10	18	15	13
Q3	14	20	19	17

Note. N=56

6.4 Implementation of the intervention

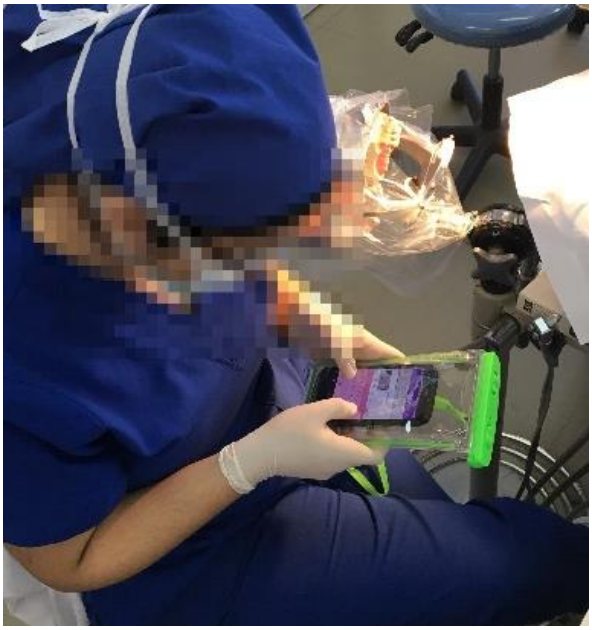
The central part of the intervention resided in capturing the different stages of a procedure (i.e., porcelain fused to metal crown, for details see Appendix R) during the practical sessions through photographs. These photographs subsequently served as a tool to trigger a detailed description of the procedures and some reflections about them. These actions are recorded in the OneNote application which includes what the students and their tutors shared online.

OneNote contributions were considered a starting point to evaluate students' and tutors' participation in the intervention. There were ten groups of students, as previously described (see Table 14), each group with its own OneNote notebook (see 5.2.1). The

shared notebook included a page for each student, where they shared contributions under different entries (i.e., photographs, comments, and reflections) about the different stages when they needed to perform a Porcelain Fused to Metal crown (PFM). Tutors had a specific online space called tutor's corner, where they freely shared parts of their demonstrations, summaries of procedures, and solutions to mistakes committed by the students.

Figure 28 shows a student working with the application during her practical sessions. On the image, on the mobile phone screen, it is possible to distinguish a picture of the procedure conducted on the phantom head (behind the student) and how she is writing up on the application. This represents how participation was realised during the design of the intervention (see 4.4.1). For instance, students taking pictures, sharing, and reflecting about them in real-time during their practices. However, students taking photographs and sharing them, and inputting their comments and reflections later were commonly seen.

Figure 28
Student working on OneNote during her practices



Note. A student is working on OneNote via her phone while conducting different procedures on the phantom head. A green bag to isolate the mobile phone is being used to prevent cross-contamination as the students use their devices beyond preclinical practices.

6.5 Students' participation

Quantitative data can provide a general overview of the contributions that students made online. However, in order to understand the contribution of participations to the teaching

and learning process, it is necessary to consider more data and to carry out further analysis. This qualitative data is presented later in the thesis (see Chapter 7). This section presents contributions quantitatively and analyses their evolution over time, considering the performance categorised by different subgroups and identifying factors which affected them.

6.5.1 Total contributions

An indicator of students' participation in the activity supported by the OneNote application were contributions the participants made by uploading their photographs, comments, and reflections on the shared online notebook. A total of 634 photographs, 431 comments and 258 reflections were shared online (see Table 16).

Table 16
OneNote total contributions descriptive statistics summary

Statistics	**Contributions**		
	Photographs	Comments	Reflections
Total	634	431	258
M (SD)	11.32 (9.94)	7.70 (7.5)	4.61 (5.93)
Mdn	8.5	6.5	3
Min	0	0	0
Max	40	32	28
Q1	4.25	0	0
Q3	15	11.75	7

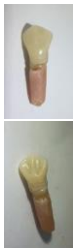
Note. N=56. All participants included.

A preliminary inspection of the data presented in Table 16 suggests that students shared more photographs than comments and reflections. One possible explanation for this is that students shared several photographs to describe the same stage of the procedure, but from different perspectives, as shown in Table 17. However, as will be discussed later, other factors influenced these differences among entries within the OneNote shared notebook. For example, when the development of the contributions over time was analysed, it suggested that students who posted photographs closer to the time where the procedure was done tended to write more detailed comments and reflections than others who only posted photographs closer to the practical examination date.

Table 17

Photographs shared by Tomas show a procedure from different perspectives

Original taken from Tomas' OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
		Corona provisoria terminada	Ahuequé nuevamente el provisorio para que adaptara al perno muñón y rellené con acrílico fluido para que terminara de adaptar, por último pulí con disco de lija con vaselina y goma para pulir para darle brillo.

Translation

Date dd/mm	Photographs	Comments	Reflections
{empty}	{Vestibular view} {Palatal view}	Temporary crown finished	I hollowed out the temporary tooth to fit it over the stump again. I filled it with fluid acrylic to adapt it. Finally, I polished it using a sandpaper disc with petroleum jelly and rubber polishers to make it shine.

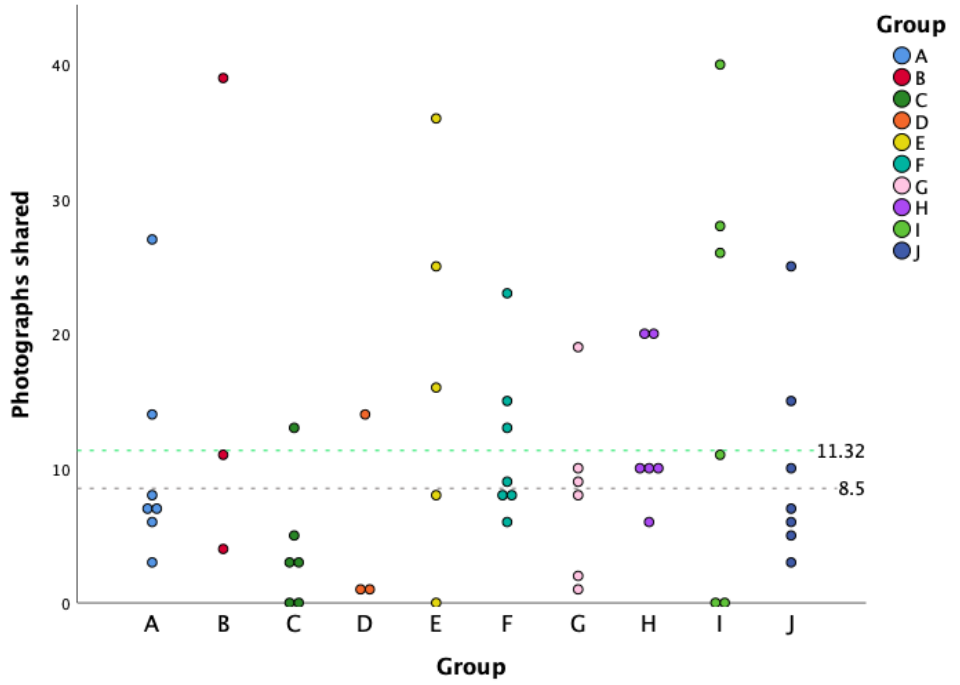
Note. The excerpt was taken from Tomas, S38, gF, OneNote page.

It is noteworthy that only one student did not take even a single photograph (i.e., Laura, S16, gI). All the other participants (55 students) took 3 or more photographs. In most of the cases, participants shared a higher number of photographs than comments (34 cases) and reflections (46 cases). There were 32 cases in which the comments were higher in number than the reflections shared. The Wilcoxon signed-rank test confirmed that the differences in number of photographs, comments and reflections were statistically significant and large according to Cohen's rules ($T=.00$, $p<.001$, $r=0.66$). It is not possible from these data alone to conclude that students who wrote fewer reflections did not reflect at all. This is supported by examples of reflections found elsewhere: in the students' contributions, in their final tasks, their final questionnaires, from interviews and from focus groups (see 7.2.2).

Students' online participation within the groups were highly varied, and in the same group individual students often exceeded the contributions of others (i.e., sharing contents). In some cases, certain students contributed just a little or definitively did not contribute anything at all online. As an example, photographs shared online were considered in Figure 29, where the number of photographs shared online by each

participant within their group is shown. A mean of 11.32 (SD=9.94) photographs were shared by all participants, shown with a green dotted line. It is possible to appreciate, as the standard deviation suggested, how diverse participations were in terms of photo sharing. The same pattern was observed for shared comments and for reflections (see in Appendix M).

Figure 29
Photographs shared frequencies by participants in each group

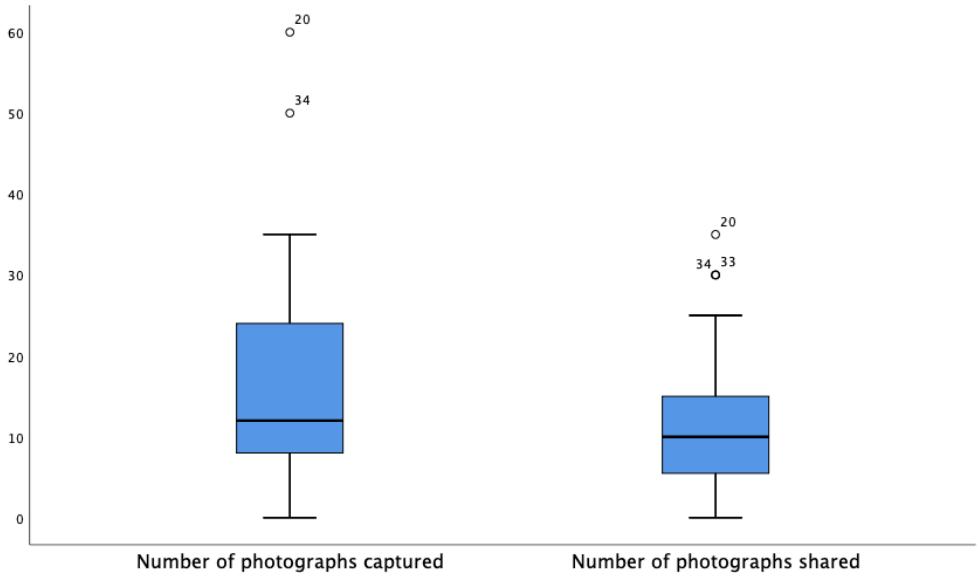


Note. N=56. Each group of preclinical work received a letter from a to 'A' to 'J' (total= ten groups), colours differentiate the participants in each group. Cohort_1 includes subgroups from 'A' to 'E.' Cohort_2 includes sub-groups from 'F' to 'J.' The green dotted line represents the mean of photographs shared on OneNote by the participants, M=11.32 (SD=9.94), and the grey dotted line the median, Mdn= 8.5.

It might seem from the data that photograph sharing is strongly predictive of engagement. However, it is worth noting in this regard that, the number of photographs shared is not equal to the number taken (Figure 30). In fact, considering the self-reported data, 854 photographs were captured, of which 588 were shared. Thus, approximately 68.85% of the images captured by the students were shared on the OneNote platform, while the rest were retained on the students' own devices. The photographs captured by the students were in the range between 0 and 60 (Mdn=12), although 75% of them took eight pictures or more (Q_1= 8, Q_3=24.5). On the other hand, the photographs' shared range was between 0 and 35 pictures (Mdn=10), where 75% of students shared five

pictures or more (Q_1= 5.50, Q_3=15). There were 29 cases in which students took more pictures than they shared. The Wilcoxon signed-rank test confirmed that the number of photographs captured was statistically higher than the ones shared, and in that regard the difference was large, according to Cohen's rules (T=0, p=.000, r=.66). Therefore, the use of photographs the students did not share might engender filtering effect vis-à-vis the material produced and the level of commitment to sharing all their experiences. Besides, student participation (engagement and learning) cannot simply be judged by the numerical value of their contributions, e.g., the quantity of the photographs uploaded. Not only are the quantitative counts unrepresentative of the quality of contributions but they also neglect the nature of the contribution and the learning which they represent.

Figure 30
Photographs captured and shared by the students



Note. N=56. From self-reported results, photographs captured, indicating that students took more photographs than they shared (Median for the number of photographs captured = 12 v/s Median for the number of photographs shared=10). The outlier's numbers indicate the identification number associated with different participants, for reference (20: Josefa, 33: Paola, 34: Andrea).

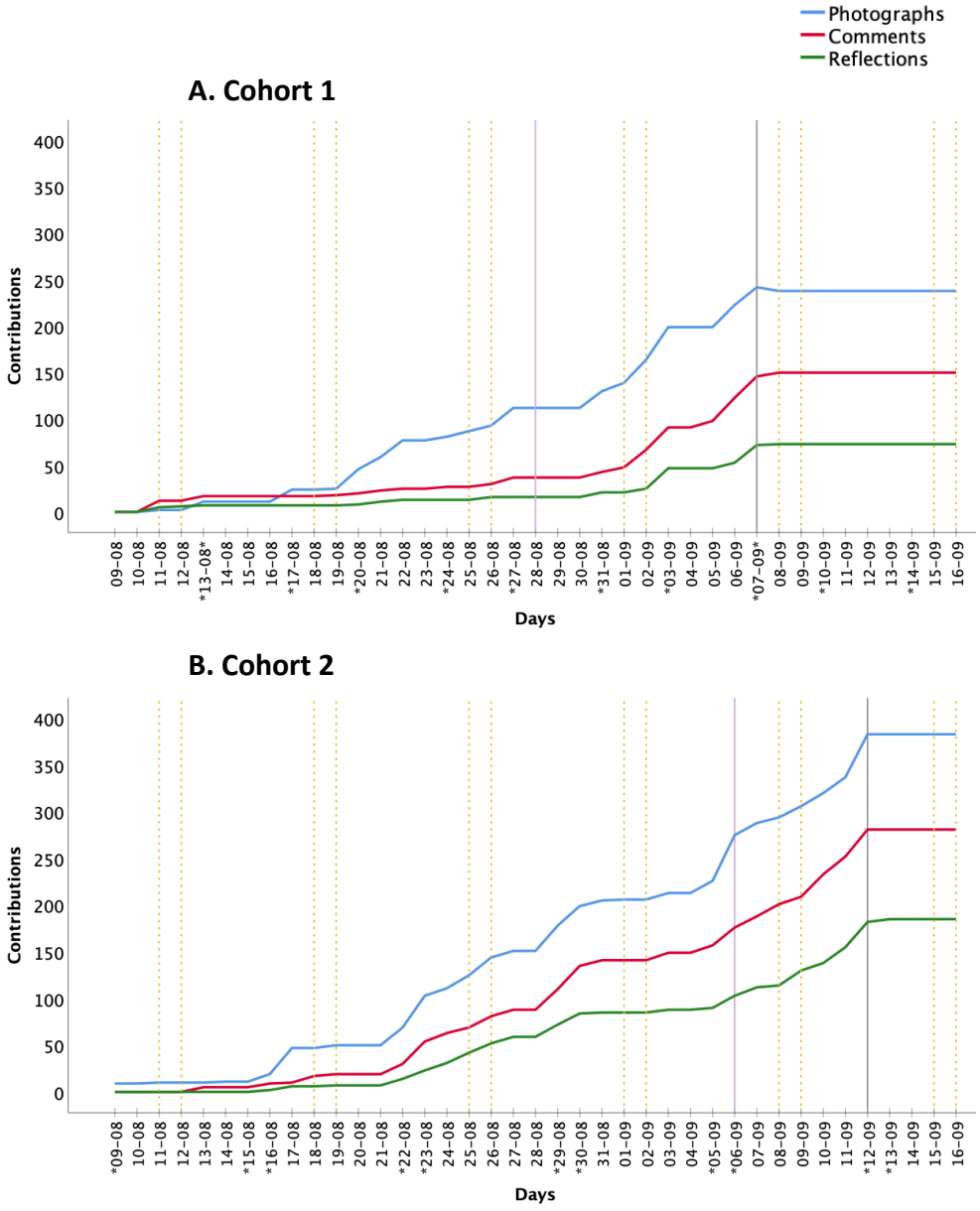
6.5.2 Contributions over time

6.5.2.1 Total overview

As mentioned in the previous section, contributions were varied in terms of quantity and type. This variation was also observed when they were analysed over time. This temporal analysis is summarised in Figure 31. Moreover, Figure 31 shows the difference between the number of photographs, comments, and reflections during the intervention. The

number of photographs shared was always the highest count. Comments and reflections were similar during the first sessions but then differentiated widely over time, especially close to the practical examination dates.

Figure 31
OneNote contributions over time by cohort



Note. Total of photographs (blue), comments (red) and reflections (green) shared online by students are shown. Panel A shows cohort 1 (n=24) and panel 2 Shows cohort 2 (n=32)
For each panel:
* indicates the day the cohort of students had practical sessions
Yellow dotted lines show the weekends.
The purple line indicates the date the reminder email was sent
The grey line indicates the date of the practical examination.

In general, the chart illustrates a gradual increase across the cohorts in the number of contributions after the first session. Students started by posting photographs online, following this up 1-2 weeks later with comments and reflections, all of which increased over time. Higher increments to their contributions could be observed the days when the students had practical sessions. In addition to this, there were increments of contributions between sessions, including weekends. This suggested that the students contributed with content online during their free time. This was even more noticeable the weekend before the practical examination.

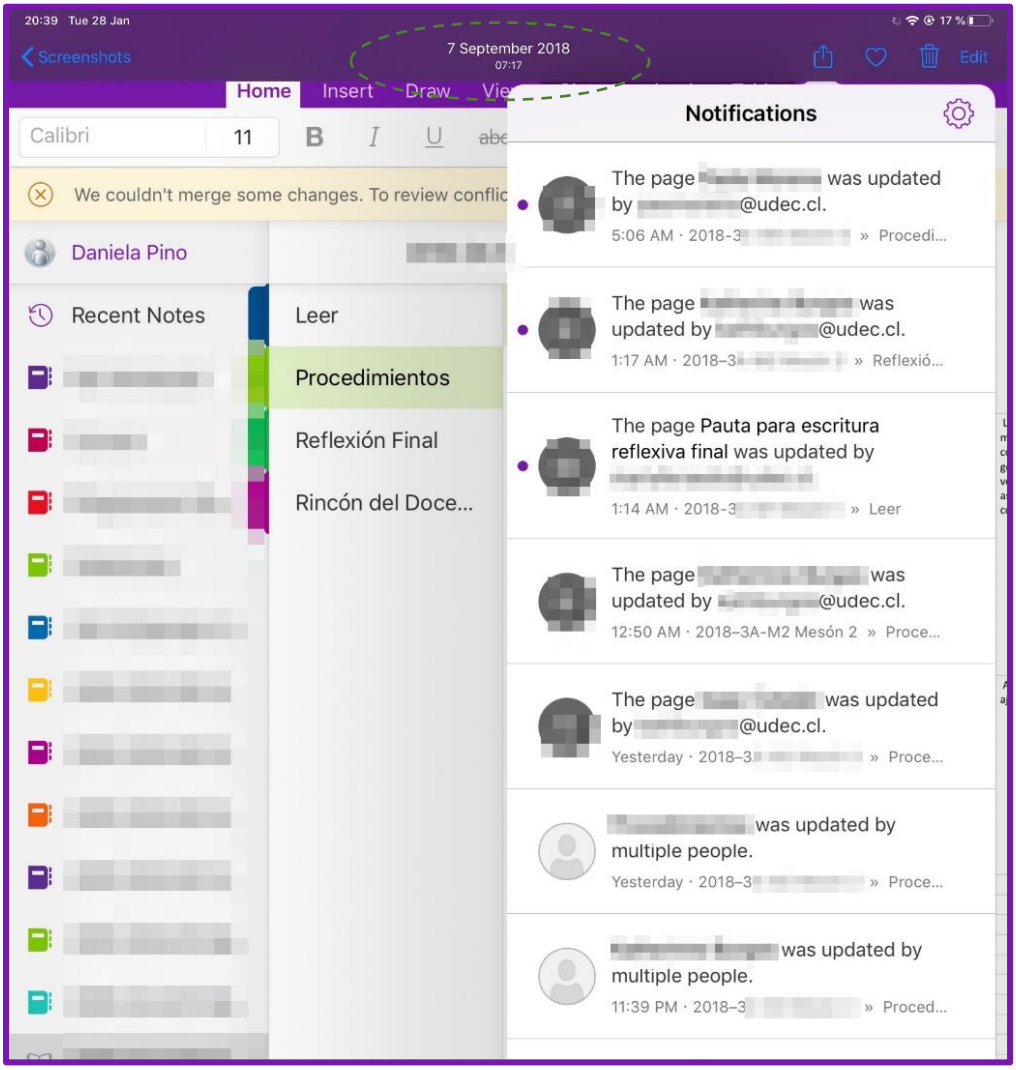
As can be seen in Figure 31, the number of contributions significantly increased in the days leading up to the practical examination. The proximity of the practical examination may have been associated with students' motivations to undertake the activity and is reflected with steady incremental contributions (i.e., photographs, comments, and reflections). Evidence about the importance of the practical examination was obtained from the final questionnaire and from focus groups. For example, this has been seen in the case of Alejandra, who took approximately 25 photographs and shared 12, mentioning: "I uploaded the photographs days before the practical examination…On the way home when I was reviewing them and reflecting on the work I have done [in her free time]" (Alejandra, S35, gE, FQ[16]).

Likewise, Vivian, who took 12 photos and shared 8, mentioned: "I took photographs, some I uploaded them immediately, others at home, and also when I studied for the practical examination" (Vivian,S49, gF, FQ). Complementing this trend, it is noticeable that the increments of online participation prior to the practical examination could be supported by the notifications received on OneNote (see Figure 32).

[16] (Student pseudonym, group, source). g = group, FG = Focus Group, FT= Final Task, I = Interview, FQ = Final Questionnaire)

Figure 32

OneNote notifications, the same day of the scheduled practical examination



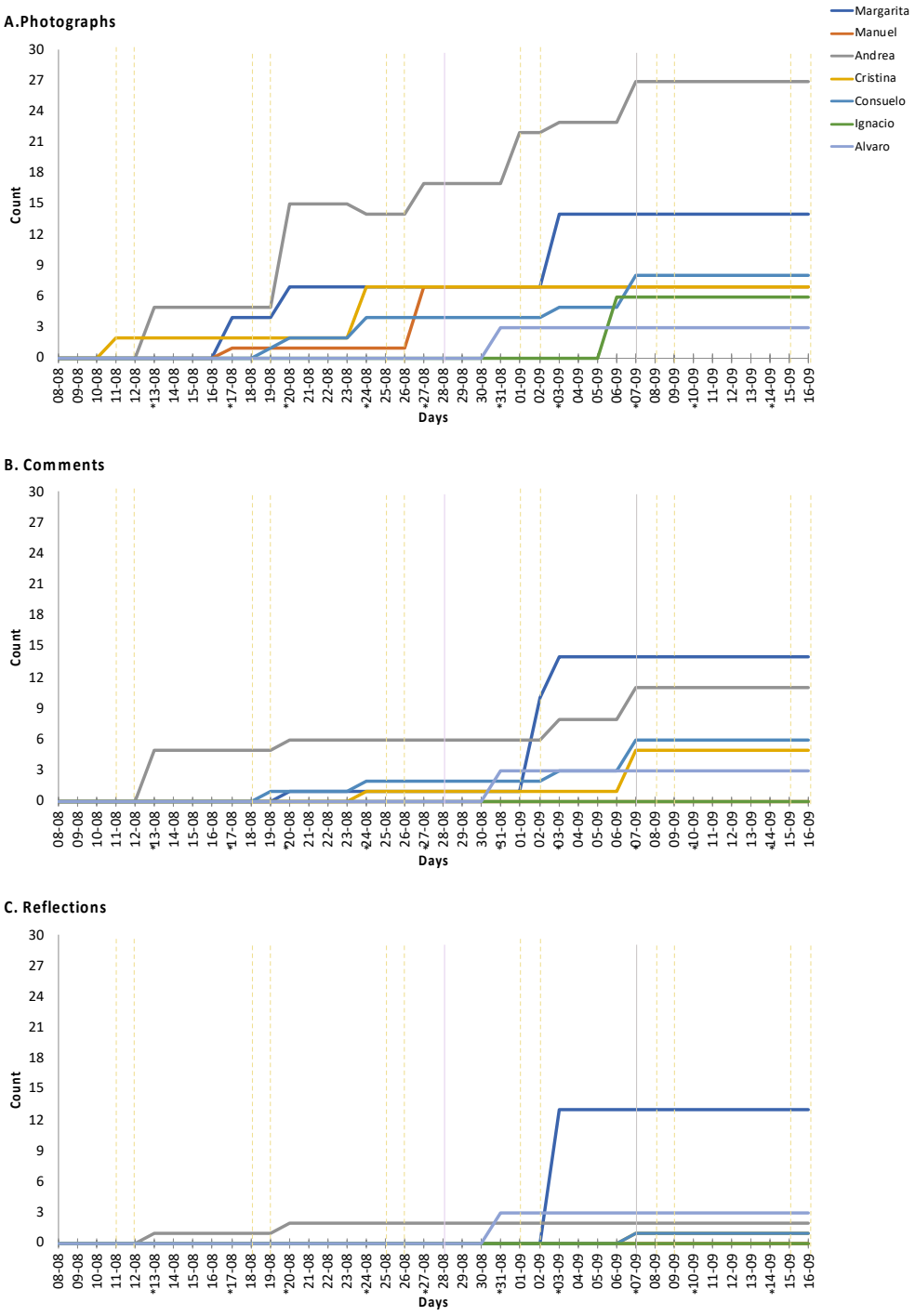
Note. The screenshot was taken the same day as the practical examination at 07:17 AM (see highlighted in green). Notice updates at 11:39 PM, 12:50 AM, 5:06 AM among others early posts. It suggests that some contributions were made just hours prior to start of the practical examination and/or very late the day before.

6.5.2.2 Each student over time. What did each student put online over time?

When total contributions were split over each participant, focussing on group A (see Figure 33) as an example, what can be clearly identified are participants who were constantly uploading contributions (e.g., Andrea) and those who leave everything for the days before the practical examination (e.g., Ignacio). From this data it is also possible to highlight photographs over the other entries, in term of count and periodicity of the contribution. The same trend was discussed previously (see Figure 31) when the contributions were presented as a total for cohorts. For example, the number of photographs Andrea shared exceeded her comments and reflections. Additionally, it

could be seen how she posted photographs before the other contributions. Interestingly, the first photograph she posted included more details than the later ones.

Figure 33
Contributions by each participant in group A



Note. Total of photographs (A), comments (B) and reflections (C) shared online by participants in group A (n=7)
* indicates de day the cohort_1 of students had practical sessions. The yellow dotted lines show the weekends. The purple line indicates the day the reminder email was sent, and the grey line indicates the day of the practical examination.

Previously two moments were highlighted: firstly, the day an email was sent as a reminder of the activity and secondly the increased students' activity shown days prior to the practical examination (see Figure 31). Closer inspection of the data separated by participants in a group, as shown previously in Figure 33, provided a rationale for the researcher to conduct one-to-one demonstrations. These demonstrations were included due to the lack of participation noted during the initial sessions, especially in terms of comment and reflections shared as seen on the graph. Consequently, the researcher carried out these demonstrations to explain to the students how to use the application effectively. Nevertheless, it is important to mention that during this period, students held their photographs on their own devices, so it was possible for them to backdate their contributions at this stage.

It was difficult to label students' participations on a meaningful spectrum, from being highly active to the other extreme of non-activity according to contributions. Contributions online are used as an indicator. However, the use of them and the application goes beyond the scope of this indicator, as OneNote does not provide the analytics to track their access to the application. Thus, it is not possible to differentiate between when students accessed the application to check something rather than contribute. For this reason, this information was complemented with data from other sources (i.e., focus groups, final questionnaire, interviews, observation) and will be presented in the next section.

6.5.3 The use of the contributions after producing them.

As indicated previously, the intervention requested students to capture photographs and to share comments and reflections about them in OneNote. In addition to this, tutors were asked to use the application to register their demonstrations and to support students' learning using a space specifically created for them on the application (i.e., tutor' s corner). Therefore, the evolution of these contributions was obtained manually (see 4.4.7). However, with the information provided by the platform, it was not possible to obtain any information about use of the material online by participants. Consequently, details were gathered from the final questionnaires, focus groups, observations, and interviews.

In relation to the final questionnaire, the overall response rate was high with 53 out of 56 participants (94.64%) returning it. When asked whether they reviewed their own contributions after posting them online, 50 answered with 32 indicating that they checked

their contributions after doing them, and 18 saying they just shared them and did not check them later. Almost two-thirds of those who responded affirmatively (68.75%) said that the main reason why they checked their contributions was to revise for the practical examination. A minority of three (9.38%) mentioned they used them to study in general, and two (6.25%) indicated that they particularly used them to study later for the theoretical evaluation.

When they were asked if they review their peers' contribution, 41 indicated that they did, 11 stated that they did not, and one did not answer. From the 41 that checked their peers, 20 mentioned they did so to study for the practical examination, 10 stated it was to study session to session, and 7 indicated it was to complement their work. Interestingly, there were students who were concerned about not being able to check anyone else online as their peers did not do the activity. This is the case of Paz, who came from a group of 3 participants, who mentioned that she did not have the opportunity to see her peers' work "because my classmates did not complete the activity" (Paz, gD, fq). Accordingly, in relation with the feeling of a lack of commitment from peers described by Paz one of the other participants of Paz's group who shared only one picture, mentioned: "The truth is that I never understood well how to use the app and I lacked motivation and time to perform it well" (Luis, gD, fq).

However, the same student acknowledged the potential advantage of the activity, recognising in part that the compulsory aspect of the activity should contribute to student participation and motivation. He said: "Being able to observe my work before the practice and study..." and add later: "perhaps it should be obligatory at first so that students can see and realise that this activity could really work" (Luis, gD, fq).

6.6 Academic Achievement

As shown previously, student participation in the intervention was uneven. Thus, within the same group, it was possible to identify different students and tutors' performances in relation to the intervention according to this diversity. Another diverse aspect was academic achievement, which was measured by the summative assessments that evaluated the clinical procedures studied during the unit considered within the intervention.

With relation to the intervention, students faced three summative assessments (i.e., one practical and two theoretical). The practical assessment consisted of performing a

crown preparation and its provisional restoration as studied during the practical sessions. The theoretical part included a written mini-test and the first theoretical evaluation.

What follows is an account of each of these assessments during the intervention, including the type of instruments used to evaluate students.

6.6.1 Theoretical Assessment

The theoretical assessment included Mini_Test_1 and the First Theoretical Exam.

6.6.1.1 Mini test_1

During the course, the students undertook nine Mini-tests. Those tests were introduced into the course to encourage students to study between sessions, revising the theory prior to their practical sessions, aiming for thorough preparation for the activity. Consequently, after the first two theoretical lectures, students took the corresponding test (see Figure 34). The test included 4 short-answer questions focused on the theory behind PFM preparations. Thus, question 1 asked about other names in the literature assigned to a PFM preparation. Question 2 is about the general requisites a tooth needs to accomplish to have a good prognosis if it is restored with a PFM. Question 3 looks for the student to describe the requirements needed for the root canal to be prepared (e.g., be previously endodontically treated). The final question refers to the dimensions the root needs to fulfil in order to be restored using a post and core system.

Figure 34
Mini_test_1

Mini test 1 20.08.2018

Name: ……..

Tutor: ……

1. **Which other name receives a mixed core preparation on a PFM preparation? (1pt)**

   ……

2. **What are the requirements of a tooth to be restored with a PFM with a custom-made post?..... (1pt)**

3. **Name the requirement that the root of the tooth needs to accomplish to prepare the root canal?**

   ……

   …….(4pt)

4. **The root canal preparation needs to measure: ……(1 pt)**

Note. This is the complete test; it had 7-points. Question 1 has three answers and receives 0.33 for each. Author translation to English.
PFM=Porcelain Fused to Metal

6.6.1.2 First Theoretical Exam

The first theoretical exam included was the first of two theoretical examinations which students were required to undertake. It included different types of questions (i.e., multiple choice and short answer) as in the example shown in Figure 35.

Figure 35
Example of a question on the theoretical exam

Place in sequential order the following stages to perform a temporary crown using an acrylic stock tooth.

( ) Isolate using Vaseline

( ) Remove excess material around the tooth neck and inner part

( ) Temporary cementation

( ) Acrylic lining

( ) Remove excess and polish

( ) Choose a tooth

Note. Extracted from the theoretical evaluation to illustrate how a question request a student to repeat information from memory.

6.6.2 Practical Assessment

The practical assessment is a summative evaluation which included part of the procedures carried out during the practical sessions. In order to be allowed to take the practical assessment, students were required to previously present and have accepted by the course director the 'milestones' procedures. These were a crown and root preparation, a Duralay® pattern, and a first temporary post and crown (see Table 10). These procedures coincidentally were also required for the practical evaluation.

The tutor who conducted the evaluation was different from the tutor that guided each group during the sessions, and they were assigned randomly on the evaluation day. Later, when the tutors were assigned, they had to go to their assigned group and complete a rubric while the students performed the requirements. The rubric had two parts: procedures and product (see Figure 36). The first one was evaluated by the assigned tutor and the second by the course director.

Figure 36
Extract of 1st practical assessment rubric

I. Procedures:

1. Adaptation of the tooth in the jaw socket and height with respect to neighbouring pieces

Acrylic reproduces the shape of the socket, **and** the neck of the tooth does not exceed 1mm in height with respect to the neck of the neighbouring teeth.	Acrylic reproduces the shape of the socket, **but** the neck of the tooth differs 1-2 mm in height from the neck of the neighbouring teeth.	Acrylic does not reproduce the shape of the socket, **or** the neck of the tooth height is at ≥2 mm with respect to the neck height of the neighbouring teeth.
2	1	0

[…]

II. Product:

Does it keep the root integrity: **yes no?**

1. Remaining Crown

1.1 Vestibular wear direction	Correct	4
	Moderately	2
	Incorrect	0
1.2 Proximal wear direction	Correct	4
	Moderately	2
	Incorrect	0

Note. It was extracted from the practical evaluation to illustrate how a procedure was repeated as it was performed during the practical sessions.

6.6.3 Results obtained by students.

Table 18 shows the grades obtained by the students in each of the summative assessments separated by cohort.

Table 18
Descriptive statistics of academic achievement of the participants

Statistics	**Cohort 1** (n=24)	**Cohort 2** (n=32)	**Total** (N=56)
Theoretical Assessment			
a. Mini test			
M (SD)	4.63(1.45)	4.91(1.43)	4.79(1.43)
Median	3.9	5.4	5.1
Q1	3.4	3.55	3.4
Q3	6.4	6.1	6.35
Min, Max	[2.6,7.0]	[1.9,7.0]	[1.9,7.0]
b. First Theoretical Exam			
M (SD)	4.26(.93)	4.02(.82)	4.12(.87)
Median	4.05	3.9	4.0
Q1	3.7	3.4	3.55
Q3	4.85	4.65	4.75
Min, Max	[2.8,6.2]	[2.7,5.6]	[2.7,6.2]
Practical Assessment			
c. Practical Assessment			
M (SD)	4.97 (.61)	5.0 (.51)	4.99 (.55)
Median	4.9	5.05	4.95
Q1	4.5	4.6	4.6
Q3	5.35	5.3	5.3
[Min, Max]	[4.1,6.5]	[4.0,6.0]	[4.0,6.5]

Note. Grades are in a scale 1.0 to 7.0. Minimal approval grade: 4.0 (see Appendix S).

There was no statistically significant difference in the means of the grades obtained by students from the different cohorts. However, what stands out in this table are the descriptive statistics values, especially when the marking scheme used to evaluate the students is considered (see Appendix S).

6.6.3.1 Mini_Test_1

As previously shown in Table 18, the mean for Mini_test_1 was 4.79 (SD=1.43). Half of the participants obtained a grade equal to or higher than 5.1. However, it is interesting to note that 25% of the participant obtained a grade equal or lower than 3.4. According to

the scale used this constitutes a failure (approval grade is equal or higher than 4.0). It is interesting because the questions did not require higher cognitive skills, just a brief description of the procedures they had been performed in their practices and studied during the lectures.

Cohort_1 had three practical sessions, and Cohort_2 had four prior to Mini-test_1 However, their grades did not differ statistically according to the Mann-Whitney test (U=653.5, p=.612).

In relation to the intervention, the number of photographs captured according to the self-questionnaire correlates with the grades obtained by the students on Mini-test 1 (Ƭ=.126, p<.05.) suggesting that the students who took more photographs performed better on the test. Consequently, if we consider the questions, the students could answer them with the information from the first group demonstrations, which were captured with photographs by the students and/ or shared by tutors in some groups.

6.6.3.2 First theoretical exam

As previously shown in Table 18, the mean for the theoretical examination was 4.12 (SD=.87). The median of 4.0 is worth highlighting as it means that half of the participants failed the theoretical evaluation. Returning briefly to the requirement to be successful in the unit, students needed to pass the theoretical part of it. Consequently, to do that, a student needs to obtain a grade equal to or higher than 4.0[17] as the mean between the two theoretical evaluations that they will face. In addition, if students did not accomplish this, they needed to take a third theoretical evaluation and then pass it separately (i.e., obtain a grade higher than or equal to 4.0). Thus, conserving the information presented in Table 18, half of the participants need to 'compensate' for their bad performance during the first theoretical evaluation obtaining better grades on the second theoretical evaluation. For example, a student who obtained a 2.7 for the first one, must obtain at least a 5.2 on the second one in order to pass the theoretical requirement of the course.

Following conversations with the tutors it was clear that they were troubled by the results and were trying to explain it in relation to the instructions received by the students during the evaluation (i.e., a tutor told them that more than one alternative could be correct). Furthermore, tutors mentioned that students had evaluations from other

[17] 3.95 is approximate to 4.0.

disciplines the same week. Thus, they considered external pressures as being a possible explanation for these initial poor results obtained by the students.

6.6.3.3 Practical Assessment

Close inspection of the practical examination results indicates than only one student failed it and repeated it later obtaining a higher grade sufficient for a pass. 50% of the participants obtained between 4.6 and 5.3 with 25% of the students obtaining less than 4.6.

6.7 Summary of the chapter.

The results in this chapter indicate that student participation in the intervention was varied quantitatively, in the type (see 6.5.1) of contributions made (i.e., photographs, comments, and reflection) and also in terms of how they developed over time (see 6.5.2.1). Some factors such as reminders and one-to-one demonstrations were identified which influenced students' contributions and how those contributions affected their later experiences and perceptions of students is described in more detail in the following chapter (see Chapter 7).

In general terms students took more photographs than they shared, commented, and reflected about. This means that a filtering effect of the content shared online, in itself involved student review and self-reflection. In the same vein, the number of photographs that the students took correlates with their grades obtained on the Mini-test 1 (τ=.126, p<.05.) (See 6.6.3.1). This suggested that taking and reviewing photographs helped students memorise and manually implement the different stages within the assessed procedure. Additionally, students reported the use of online content to study for the practical examination.

Results from the Reflective Thinking Questionnaire indicated that students engaged mostly with Understanding (M=17.89), followed by Reflection (M=16.48), Critical Reflection (M=13.19) and finally with Habitual Action (M=11.75). This provides insight for consideration of the content of assessments, which encourage the memorisation of facts (see 6.6.1) and mechanical repetition of procedures (see 6.6.2).

As an overview of the work during the intervention, students and tutors alike worked with their mobile phones, or less commonly, with the provided iPads. Students and tutors took photographs and completed the activities included in the interventions without any major technical difficulties. Students' late contributions close to the practical examination

were highlighted, as well as those of students who excelled in comparison to their peers in terms of online contributions. These were used as a guide for those students who were working behind schedule.

The results obtained by students on their assessments (6.6), both theoretically and practically suggested that the evaluations need to be rethought in order to assess their validity. This is because the grades obtained by students in relation to the scale utilised were very low.

The next chapter moves on to discuss the quality of contributions, and how they are related to the learning and teaching processed from the perspective and experiences of the students.

Chapter 7 Students' experiences and perceptions of the intervention

This chapter describes, in greater detail, the educational experiences of students within this study. It includes students' perceptions of the intervention with regard to the development of their knowledge and skills. Data are from students' and tutors' contributions online on OneNote, observations of dental preclinical practices, focus groups, interviews, final questionnaires, and final tasks.

OneNote provided information about the timings of when students created their contributions. Data from the observations (see 4.4.5) provided relevant information about real-life student interactions during their preclinical practices. During focus groups and interviews, the researcher's active inquiry facilitated more in-depth information about students' perceptions about the intervention, as well as how and when they used their and their peers' contributions. Ultimately, the questionnaire and the final task collected valuable information about students' perceptions concerning how they experienced their practices in the Clinical Skills Laboratory (CSL) with the designed intervention.

For this study, 'experiences' refers to the researcher's interpretations of students' actions, comments, and contributions. This contrasts with 'perceptions', which consider students' own interpretations in words. Therefore, this chapter seeks to answer the second Research Question, which is: **What are the students' experiences and perceptions about the impact of the educational intervention on the teaching and learning processes?** Additionally, it provides information to complement the answer to Research Question 1: **How does Design Based-Research inform the design and enactment of the educational intervention?**

7.1 Phantom head. Conceptions of simulated patients and practices.

According to the undergraduate Dental Programme at Concepción, students perform treatments for Restorative Dentistry and Fixed Prosthodontics using simulators (see 5.1.4 and 5.1.5). The work on phantom heads is presented as follows: "Students will execute practical work using simulators, applying restorative techniques leading to the preparation and fixation of temporary and/or definitive restorations ... by direct and

indirect methods, after practical demonstration" (Document: *Syllabus de Asignatura MDPI-IV*, 2018).

The data to understand students' perceptions about their work on the phantom heads mainly came from the final task[18] (see in 4.4.8), where nine students from cohort_1 and 14 students from cohort_2, giving a total of 23 students (41.07% of the participants), completed the task. The task required the students to think and deeply reflect on their work, including that on the phantom heads. While reflecting on the simulators' use, students acknowledged how much they appreciated the need to prepare for work with real patients. Independently they found some constraints, and they solved these in different 'creative[19]' manners. Interestingly, these creative solutions were not always connected with real scenarios and will be discussed later when the content of the contributions from OneNote is presented and analysed.

When asked about how they perceived their work with phantom heads, participants were unanimous in the view that this stage is essential for future patient treatment. Students indicated that they liked to work with simulators, in this case phantom heads. Additionally, simulated work in a safe environment seemed to help them in their first approach to clinical procedures and to development of the skills needed to become a dentist. Commenting on the approach to clinical procedures, one of the student respondents stated that: "The truth is, it is the only way to feel like I 'am being' a dentist. Most of the time, it is just theory, but working on teeth and pretending they [phantoms heads] are the patients is nice". (FT, S47-Ignacio)

This view was echoed by another student participant who commented:

> It (working on phantom heads) means being able to carry out a job focusing on what a patient will be like. It prepares me now by performing all the procedures in the mouth (phantom). It is crucial to reach the clinic with sufficient practical knowledge of what we should do and how to do it. (FT, S-55, Alvaro)

What follows is an account of the skills developed by students during these preclinical practices. From their perspectives, firstly, they developed skills due to their work with

[18] Final task: Series of questions designed to encourage students' reflections about their activities at the end of the intervention.
[19] Creative used to refer to the students' solutions to some problems which, in numerous cases, were very original.

phantom heads in CSL and, secondly, there were those skills associated with the intervention itself.

7.2 Developing skills through CSL during the intervention

Two main ideas emerged from the development of future skills through CSL training. Firstly, the students valued having opportunities to make mistakes in a safe environment; as they mentioned, it is extremely important that they can become confident about their work before treating a real patient. Secondly, a recurring theme was the sense among students that they developed improved ergonomic positions while practising on the phantom heads. In their own words:

> I think it is essential (working with phantom heads) because it helps us to get used to how to work, whether it is about the position we should take as operators or how to position our patients, which is comfortable for both. It is also a failproof practice to set our hands-free and perform procedures that will then be seen every day by us (Ema, S54, FT)

On the other hand, there were concerns about the difference with real scenarios. For example, Francisco mentioned:

> For obvious reasons, simulators do not include many of the factors that influence the development of dental actions on a 'flesh and blood' person. For these reasons, working using phantoms heads is a crucial step prior to contact with real patients but it is still a long way from reality. (Francisco, S25, FT)

Likewise, Andrea anticipated how different the scenario with real patients will become, stating:

> Next year will be very different, we will realise that (working with a real patient) it is not as easy as it is on an inanimate object, without saliva, without cheeks, without pain, without wanting to spit, without fear, etc (Andrea, S34, FT)

Despite these concerns, in general, the students like to imagine they are working with 'real humans', as it helps the development of their identity as a dentist. In the words of Claudia:

> For me, it is an approach and an important step towards work with a real patient, although the phantom does not ideally represent what it is to work in the clinic, it helps to visualise what we want to become and do (Claudia, S8,FT)

Summarising, it is essential to consider how students perceive their experiences in the CSL, thus providing a wider picture of the importance of the educational experiences they lived and the associated connections with their future practices. After having identified the significance of CSL for students, the next sections will discuss each of the skills the students recognised that the intervention helped them to develop. By analysing those skills, it was possible to distinguish interesting things, such as improving memory, developing critical thinking, emotions' management, working under time pressure. Each of these will be presented in the following sections. These things affected the development of students' skill and are an important aspect to consider when thinking about the programme, as they might contribute to students' future professional practice, beyond completing the requirements of the unit where the intervention was conducted.

7.2.1 Memory

Memory was one of the most frequent skills the students mentioned which the intervention helped them to improve. According to them, the intervention "served to boost learning in people with visual-kinetic memory, to have a fast and efficient memory helper" (Jorge, S10, gF, FQ)

Additionally, in the words of Antonia, with regard to the intervention:

> …you can go through everything you have done, because the memory is fragile and because many times you do not remember why you are doing the different steps.
>
> It is also a medium in which the teacher can feedback to us and upload information onto the platform (Antonia, S13, gF, FQ)

It is interesting to highlight this skill in relation to its applicability during their practical examination, as most of the times that memory was mentioned it was in relation to this instance in the students' schedule. As Paola commented: "(An advantage) …the ease of remembering the steps to be performed during the practical examination, in addition as one had written it, it served to remember and memorise it" (Paola, S33, gI, FQ)

The act of taking photographs appeared to help memory per se, as some students who did not share everything online also reported improvements in their memory skills. In the words of Isidora:

> The good thing was that, as I am really unfocussed sometimes, having this reminder with photos, comments and reflections proved very helpful. The bad thing was (more than anything) that as sometimes I forgot to put the photos and by the time I remembered, I no longer had such complete comments to put with each image (Isidora, S48, gJ, FT)

Additionally, in the Final Questionnaire Isidora declared that she used the photos to study for the practical examination, despite clearly stating: "Sometimes I forgot to upload the photos". The student also added that it was helpful for her, as: "[it] allowed me to easily remember the procedures".

7.2.2 Critical Thinking

Critical thinking was analysed from a number of different perspectives. Firstly, regarding the information that students provided with their contributions and consideration of when the students deeply reflect on their actions and were capable of connecting them with possible real scenarios and their future practices. Secondly, considering about how to access different experiences enhanced students' decision-making processes. Finally, how they used the intervention to evaluate their own progress closes the section.

7.2.2.1 Connecting with futures practices

When trying to see connections between the preclinical stage and their future practices, one essential stage was highlighted by the researcher while analysing students' contributions in OneNote. The stage selected was the beginning of the treatment studied. As mentioned, (see 5.1.5) the students were working on an extracted tooth adjusted in arcades and placed on the phantom heads. They were required to conduct an anterior post and core crown in order to retain porcelain fused to a metal crown. This treatment

needed a root-filled tooth, which due to the insufficient remaining tooth tissue to support a core, required a custom-made post and core to support the future crown. The need for this treatment depends on the clinical situation, and the judgement and knowledge of the clinician are both important factors in determining that this procedure is the appropriate treatment for the patient.

The beginning of procedures in the preclinical stage were considered an important moment to see how students described and reflected on the selected treatment. Furthermore, some students did not share all the procedures or all the stages on OneNote. Therefore, this earlier stage was selected as it was representative of most of the students who participated in the intervention. Furthermore, the stage analysed was considered as being an example of contributions. Thus, analysing the contributions, a connection could be discerned between the learning outcomes of the unit and the development of the competencies described in the study programme.

Table 19 shows an example where students' contributions reflected the connection between simulated practices and real clinical scenarios, connecting the theory from the theoretical sessions and the practical demonstrations working on the selected stages. Here, Valentina recognised the initial cut to the tooth as being a simulated fracture made by her tutor. She added that it was difficult to delimit the neck of the tooth. Closer inspection of the image shared by the student indicated that the irregular incisal edge of the tooth evidenced the described simulated fracture. This indicated that the decision to undertake a crown preparation was due to the fracture suffered by the simulated patient.

Table 19

Recognition of simulation and its connection with real possible scenarios

Original taken from Valentina's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
		Diente adaptado y con el corte simulando fractura que hizo la doctora. Para mí fue complicado delimitar el cuello del diente.	

Translation

Date dd/mm	Photographs	Comments	Reflections
{empty}	{irregular cut simulating a fracture}	Adapted tooth, with a cut simulating a fracture made by my tutor. It was hard for me to delimit the neck of the tooth.	{empty}

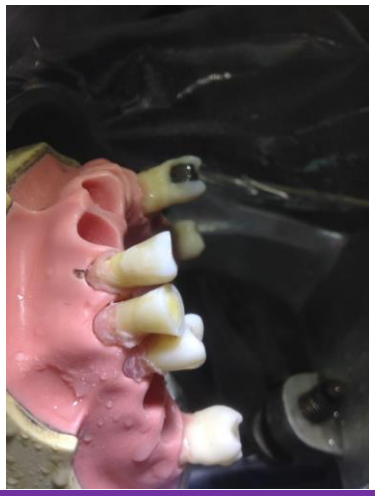
Note. The excerpt was taken from Valentina, S21, gH, OneNote Page

However, Isidora (in Table 20) shared the same stage as Valentina (in Table 19), describing it differently as follows "I cut the tooth with the 'high-speed wheel burr' until 2-3 mm were left proximally (M and D" (Isidora, S48, gJ, OnePage).

This suggests that Isidora shared her photographs and commented as a mechanical stage rather than as a clinical procedure. It was even reinforced with the picture she shared where it was possible to see a neat, straight cut, with no clear distinction of a simulated fracture, as presented in the previous example.

Table 20
Lack of connection of simulated practice with possible clinical scenarios

Original taken from Isidora's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
09/08		Corto el diente con fresa rueda de alta velocidad hasta que queden 2-3 mm por proximal (M y D).	Hay que cuidar que quede parejo el plano que está siendo cortado.

Translation

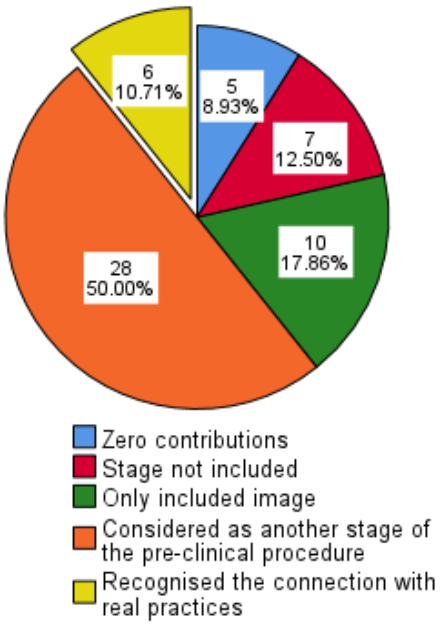
Date dd/mm	Photographs	Comments	Reflections
09/08	{canine straight worn}	I cut the tooth with a high-speed 'wheel' burr until 2-3 mm left per proximal (M and D).	We must be careful that the plane being cut is straight.

Note. The excerpt was taken from Isidora, S48, gJ, OneNote page.

To have a complete picture of how students critically connect their practices in CSL with their future practices with real patients, the example presented previously was considered to evaluate the same stage for all the participants. Therefore, Figure 37 shows the proportion of students' contributions placed within five different categories (i.e., Zero contributions, stage not included, only included photograph, considered as another stage of the preclinical procedure, recognised the connection with real practice). Closer inspection reveals that from 56 participants, five made zero contributions (blue), seven did not include the stage in their contributions (red), and ten only included photographs (green). Of the remaining 34 students who completed this stage, only 6 made a real connection between their preclinical practice and their future clinical procedures with patients (yellow). 28 students, who only considered it as a part of their preclinical procedures, described the stage in their contributions (i.e., comments and reflections) without expressing any deep connection with future real scenarios.

Figure 37

Students' OneNote Contributions regarding a beginning stage



Note. N=56

Summarising this, in relation to critical thinking, from the 34 students who completed the stage examined, it was possible to recognise two distinct groups of students. Firstly, a majority who recognised the procedure as another stage that needed to be followed to complete the requirements, not connecting it with real future practices. Secondly, students who connected preclinical practices with real scenarios. They clearly expressed and highlighted the simulated aspects of the actions they had conducted and justified the reasons for conducting such a treatment in the first place.

What was illustrated within this initial stage of the procedure was also found across all the students' contributions. Thus, there were cases where critical thinking was not clear or evident, as in the example in Table 20, and in other cases, where one could distinguish how students presented the theoretical or practical reasons behind their actions (example in Table 19). However, whether or not all the decisions should be based on theory, there are actions conducted by the students that facilitated their work on the phantom head but did not necessarily correspond to actions that could be conducted on real patients. Students described these actions as 'tips' or 'pointers', which whilst not corresponding exactly, were considered valuable. Table 21 illustrates an example of a tip shared by a student.

Table 21
Example of 'Tips' shared by Soledad

Original taken from Soledad's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
23.8		Para hacer el conducto, primero hago un acceso con fresa redonda mediana de carbide (estamos trabajando en dentina), hasta encontrar cámara.	Al principio me dio un poco de cosa porque no sabía si lo encontraría altiro, entre eso me di cuenta de que no estaba por buen camino (estaba lejos del centro)... pero no importa si no queda centrado avanza hacia donde crees que está, luego se elimina esto, al ingresar las fresas peeso; si esto no ocurre podría hacer ahí mi surco de inserción.

Translation

Date dd/mm	Photographs	Comments	Reflections
23.8	{Indirect vision showing the canal entrance}	The root canal is first prepared with a medium round carbide burr (working in dentine) until you find the pulp chamber.	At the beginning, I was a bit afraid because I didn't know if I would find it (the root canal) right away. I realised I was not on the right path (I was far from the centre). However, it doesn't matter if you are not centred. Push forward where you think it is, and then remove it when you prepare the canal with the peeso reamers. If it doesn't happen, you can place an anti-rotation grove there.

Note. Excerpt taken from Soledad, S28, gH, OneNote page.

It is noteworthy that some 'tips', such as the one shared in the previous example, could jeopardise real patients' treatments. Here, Soledad decided to carry out an action without a clear knowledge of what she was doing (i.e., knowing the root anatomy to know where to start preparing the root canal). She indicated this in her reflection: "Push forward where you think it is, and then remove it when you prepare the canal with the peeso reamers" (Soledad, S28, GH, OneNote page)

According to Soledad, if you get things wrong you can remedy it at the next stage or by doing the insertion groove there. The insertion groove needs to be planned based on the dentin remanent width, not where you remove more tissue because of a misunderstanding of the location of the root canal. Additionally, the anatomy of root canals will be seen by the students in their 4th year, in endodontics, which is an element

included in the unit: Integrated Adolescent, Adult and Older Adult Clinic I (see in Appendix Q). For this reason, Soledad assertion suggested that she conducted the stage without fully considering the further implications of her actions, which could be due to the fact she did not have the knowledge to do so. This problem will likely continue until the chronological order of the theoretical and practical curriculum's content is reassessed and duly revised. Additionally, as stated before, a root-filled tooth was needed to conduct the treatment simulated in CSL. However, this was not considered for this simulation. Further implications about the order of curricular content and the influence of preclinical practices will be included in detail within the Discussion chapter (see Chapter 9).

Notably, the intervention, in some cases, helped students to recognise those tips and provide further evidence that made them reflect and understand that some actions are carried out in the CSL aiming to ease the development of their motor' skills more generally, but not necessarily be replicated on real patients in exactly the same way, as in the description of the simulated fracture presented previously (see Table 19). This highlighted the role of the tutor to moderate not just tips, but students' learning process and cognition of it in general.

To end this section, it is also important to consider that when comments and reflections are referred to as descriptive, they included actions students had mentioned without considering the stage itself with deeper reflections. They talked about a stage or all of a procedure as if it were part of a recipe. For example, Jorge in Table 22, described the end of the third stage (i.e., pattern ready to be sent to the laboratory) with an image of the stage finished. In his reflection he added information about how to distinguish it from the others sent by their colleagues, but there was no comment about the process itself or an assessment of what was obtained as a result. The latter will be presented within the next section.

Table 22
Stage described as a cooking recipe

Original taken from Jorge's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
23-08		Término de tallado	Por recomendación para ser enviado al Lab, agregar una distinción en la forma del muñón, es decir, agregar una pelota de acrílico por ejemplo, cosa que se pueda (diferenciar).

Translation

Date dd/mm	Photographs	Comments	Reflections
23-08	{Indirect Duralay® custom made post, ready to be sent to the laboratory for casting}	Post finished	For recommendation: to send the pattern to the Lab add a distinction to it. That is, for example an acrylic ball. Something that differentiates it.

Note. The excerpt was taken from Jorge, S10, gF, OneNote page.

7.2.2.2 Developing self-assessment

Another aspect related with critical thinking is the development of the capacity to self-assess the product obtained. Therefore, by accessing their photographs, and those of their peers, students mentioned they could evaluate their work at each stage, complementing it with the feedback received from their tutors.

For example, Ana (see Table 23), presented a photograph where the contact point between the neighbouring tooth was lost. Additionally, she explained what was seen on the image and how to prevent it in future.

Table 23
Reference to photo for own work assessment

Original taken from Ana's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
23/08		Una vez ahuecado el diente de stock, se debe aplicar vaselina liquida en la preparación dentaria luego colocar el pin metálico previamente ajustado al conducto radicular, preparar acrílico para coronas Alike, colocar en estado arenoso en el diente de stock y posicionarlo sobre el pin metálico que se encuentra dentro del conducto radicular.	Esperar a que comience a polimerizar y llegue al estado plástico para poder remover y evitar que comience la reacción exotérmica sobre el diente del paciente. Como recomendación, no dejar el acrílico muy fluido ya que este escurre, por lo que se pierde (como en esta foto) los puntos de contactos proximales y desalineación en el arco dentario.

Translation

Date dd/mm	Photographs	Comments	Reflections
23/08	{temporary restoration of the canine without contact point}	Once the stock tooth has been hollowed out, liquid petroleum-jelly should be applied to the dental preparation, then place the metal pin previously adjusted to the root canal. Prepare 'Alike' acrylic for crowns, put it in a sandy stage on the stock tooth and then position it over the metal pin located inside the root canal.	Wait for it to begin to polymerize and reach the rubbery/elastic stage to remove it and prevent the exothermic reaction from starting on the patient's tooth. As a recommendation, do not leave the acrylic very fluid as it would run off, thus losing (as in this photo) the proximal contact points and there might be a misalignment in the dental arch.

Note. The excerpt was taken from Ana, S04, gJ, OneNote page, OneNote page.
Highlighted in grey is where Ana referred to sharing of the image ('photo').

In the example presented above, Ana shared an image and highlighted what was done incorrectly and how she solved it. Additionally, when students self-assessed their practical work at any stage, they could decide what to do next, thus improving their capability for decision making, which is beneficial to their clinical skills, as will be discussed further later in this document (see 9.3.2.2).

The focus will now be on the collaborative space created by the intervention.

7.2.3 Peer learning

According to the literature about peer learning (see 2.5), when consolidating learning, there is an important element of what we learn which is actually facilitated by friends and colleagues. Most of the time it is considered informal learning, however, it could be incorporated as a more formal reinforcement or support mechanism within the learning process in a safe place. This principle was applied during the design of the intervention (see 5.2). The intervention provided a shared environment where students created a repository of their experiences, including photographs, comments, and reflections. Therefore, during the analysis evidence of peer learning during the intervention was evident when students wrote, talked about, or discussed the use they gave to the contributions of their peers.

For example, the student Daniela mentioned that: "I reviewed them (peer's contributions) when revising for the practical examination I compared what I had done with (what my peers did); thus, I had more references" (Daniela, S17, FQ)

Additionally, during the focus groups, it was possible to distinguish how the students felt they had a commitment in terms of what their peers will see of them online. Continuing with the example from the student Daniela, she mentioned the importance of: "worrying about if [her work in CSL] looks good", when discussing with her peers about the influence of the intervention on their work in CSL, as can be seen in the following excerpt:

> **Gloria:** 'I think we took the specific job we did more seriously (during the intervention)'
> **Researcher:** 'In what sense more seriously?'
> **Gloria:** 'You have to achieve a certain standard so that your tutor accepts it, but you always tried to go one better than that, because your classmates would also review what you have done, so you are not going to show them 'anything half-hearted'.
> **All:** (laughs)
> **Paola:** 'That's it!'
> **Daniela:** You worried about it if looks 'good'
> (Excerpt from Group I Focus Group)

It was commonly observed that the students asked for help from those students who were more advanced with their work (as described later in 8.4). These informal explanations were registered in a formal way through the platform by students' contributions (i.e., photographs, comments, and reflections). The images helped students communicate their actions directly on OneNote or when one colleague asked for help during the sessions as seen in Figure 38.

Figure 38
Peer to peer explanation using OneNote contributions to ease the communication

Note: Source: researcher fieldnotes.
Comments added: student using her contributions, especially the photographs to explain to another student a procedure that was already demonstrated by the tutor previously achieved by her.

This situation could suggest that the use of photographs facilitates communication among peers. It is also supported by what Igor stated: "Also, speaking about feedback, perhaps some peers do not know how to express themselves very well, and the photographs helped to some extent to see some characteristics, which the student did not write there when they reflected" (Igor, S24,gF, FG)

Learning from peers is also associated with the next topic: visualisation. Students working behind their peers, used their peers' contributions to learn from what their peers had done and observe the technique to obtain a better result.

7.2.4 Visualisation

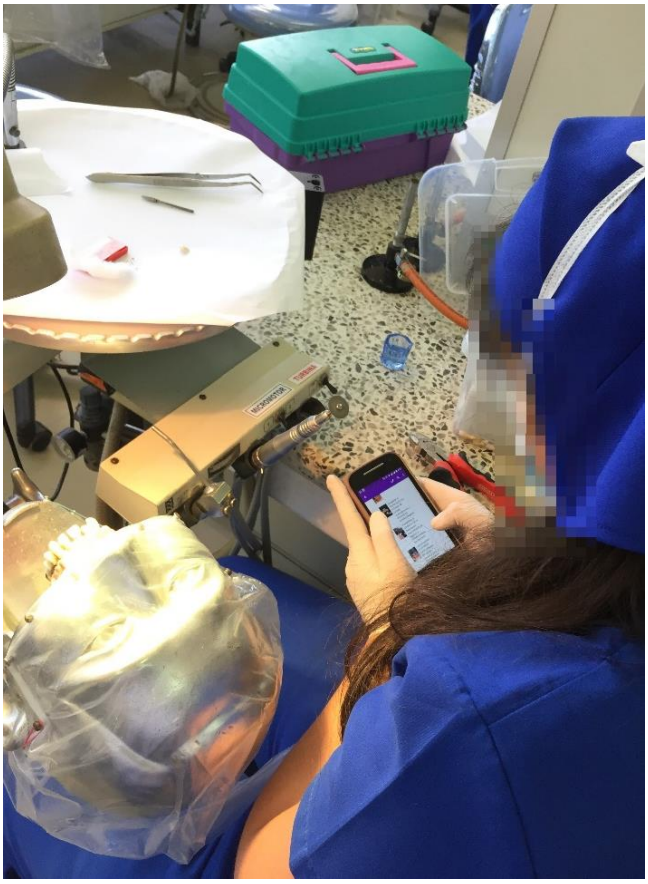
From the data it is possible to identify moments when students recognised visualisation during the intervention. Firstly, in a direct sense when the students were working and needed to check how the work should be achieved. Secondly, in studying for the practical examination.

7.2.4.1 Visualisation while working

It was described previously (see 5.1.6) that tutors provided demonstrations stage by stage to complete a procedure. These demonstrations were made to the entire group when the first student in a group finished a procedure and need to continue with the next one. This, is beneficial for the student who finished the procedure, as will be seen in the discussion performing a procedure soon thereafter was viewed as critical to mastery, however visual observation, contributes to the task acquisition.

For example, from the researcher's fieldnotes, a student was viewing the work of a peer to remember them what she needed to do to perform the first temporary post and core crown (see Figure 39).

Figure 39
A student reviewing a stage of the procedure from a peer's OneNote Page



Source: researcher fieldnotes

Additionally, Jorge mentioned: "It [the intervention] significantly reinforces our visual learning because some people are predominantly visual learners and therefore generate better learning" (Jorge, S10. FG). For Joaquin, a strength of the intervention was that: "I was able to review the material and visualise the steps that I should theoretically follow". (Joaquin, S31, FQ).

Thus far, it could be argued that students using photographs to share their experiences can lead to better communication and to promote deep rather than surface understanding of the studied procedures.

7.2.4.2 Visualisation while revising for practical and theoretical examinations.

This point is highly related with memory as described in 7.2.1. Students who mentioned reviewing their own contributions or the contribution of their peers referred to it together

with the capacity for remembering things while studying session-by-session or prior to their examinations.

For example, one participant stated: "It was easier and more effective to study for the practical and theoretical examinations because I have written it (OneNote contributions). Then I reread it, seeing the images as many times as was necessary" (Ema, S54, FQ).

Additional to the explanations to peers mentioned before (see 7.2.3), it is worth highlighting how the students used their contributions in OneNote or only their photographs on their devices to explain what they were doing to their family, friends, or other people in general. For example, Andrea mentioned that she used the images to "show it (her work) to her mom" (Andrea, S34, FQ). The possibility of explaining what they were doing, in a sense, meant the students taking ownership of their work.

7.2.5 Emotional management

As seen in the literature (see in 2.4), recognising one's own emotions within an experience helped improve the reflective process. Emotions could have a positive or negative impact on students' performance during their practices. Incorporating reflection into normal practices makes those emotions more visible and makes it possible to note how students perceive their emotions to affect their performance. However, noting student's recognition of their emotions was far from a straightforward process. As seen in the Pilot (see 5.3), in the Main study most of the contributions were descriptive and some examples were added to support students to recognise their emotions, with the final task (see 4.4.8) directly asking students to write about the role of their emotions in their practices. Even the completion rate of the final task was low (22 out of 56 participants). It was noteworthy that almost half of those students who completed the final task (10) sent it by email to the researcher instead of sharing it with their colleagues in OneNote, suggesting that sharing emotions was not always easy.

Emotions could be grouped as either positive or negative. The former are those emotions that students described as booster to their practical work which encourages them to continue working as they were. The latter are emotions than act in detriment to the students' work.

7.2.5.1 Positive emotions

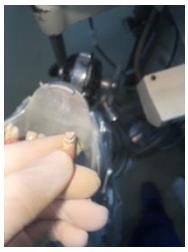
Positive emotions highlighted by the students are principally the confidence they felt to work and commit errors in a safe environment with the possibility to approach their tutors to clarify their doubts. For example, Tomas argued that:

> Practising using phantom heads is an essential part of our training as future clinicians since it allows us to develop what we have learned before direct practice on patients. Personally, to know that if I make a mistake in a procedure, it will not permanently damage a real patient. It has allowed me to develop my skills more calmly, always bearing in mind that this is a step before the clinic (Tomas, S38, FT).

The Milestone stages (seen in Table 10) are important in students' practices in CSL, they are mentioned many times by tutors and students. According to the tutors, students meeting their milestones on time make them feel proud of their work and it encouraged other students to conduct the rest of the procedures diligently. This had a positive impact on students' perceptions of their work and on their motivation to continue. An example of this is seen in Daniel's contributions in OneNote (see Table 24).

Table 24
Positive emotions described in student's reflections

Original taken from Daniel's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
09/08		Muñón terminado	Momento de satisfacción cuando termine, creo que me demore menos de lo que esperaba y eso me ayudó positivamente para tener confianza en mí mismo a lo largo del trabajo.

Translation

Date dd/mm	Photographs	Comments	Reflections
09/08	{crown preparation}	Crown preparation done.	Moment of satisfaction when I finished, I think it took me less than I expected, which positively helped me trust myself throughout the work.

Note. The excerpt was taken from Daniel, S44, gJ OneNote page.

7.2.5.2 Negative emotions

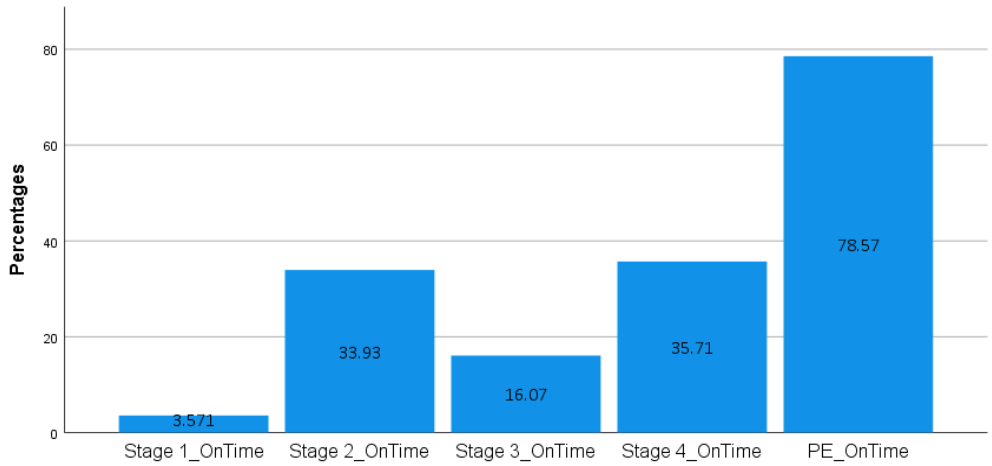
When students mentioned negative emotions (e.g., frustration, lack of confidence, anxiety) most participants associated the use of natural extracted teeth during their practices. Extracted teeth are difficult to obtain, and the studied procedures are conducted in CSL only on central incisors and canines, which reduces the possibility of obtaining those teeth, increasing the pressure on students to obtain them.

One participant commented: "At the beginning, I felt worried about what I would do because I was afraid of making a mistake and losing the tooth on which I was working. Those teeth are difficult to obtain" (Ema. S54, gJ, FQ).

7.2.6 Organisation and time management

A recurrent theme in the focus groups was a sense among those interviewed that time pressures caused distress to students and affected their participation in the intervention. Most students mentioned that they were working behind schedule. It was also a serious concern during the Pilot study (see 5.3). For this reason, in order to understand the pressure described by the students, the number of students who finished each milestone procedure (see Table 10) on time was evaluated. Figure 40 provides the results obtained from contrasting the percentage of students who finished each stage on time.

Figure 40
Timing evaluated during the procedure



Note. N=56
Each column represents the percentage of students who at the time considered on the timetable have finished the corresponded milestone procedure.
PE= Practical Examination.

From the data in Figure 40, it is apparent that 78.57% of the students (44) started their practical examinations on time. However, just 35.71% of the students (20) completed all of the stages before the examination. It is important to note that to be allowed to perform the practical examination (PE) students need to have completed the first 3 stages (milestone requirements, Table 10). The low proportion of the students who finished the different stages on time indicates that the time issues perceived by the students, were also an issue on the calculation of the time needed for students to complete each stage. For example, contrasting the 35.71% of the students who finished stage 4 on time with the 78.57% who started the practical examination indicates that this was a high number of students who started their examination having just completed the requirements but not the complete procedure.

It is worth noting that the time pressure was a negative emotion for most students, but there were a few that mentioned that they worked better under pressure. For example, Isidora alluded to the beneficial aspect of working under pressure, saying "it makes me concentrate 100% on the work to be done, avoiding a mistake., I work much more confidently too" (Isidora, S48, FT).

7.3 Two groups as cases to understand different students' experiences within the intervention.

Two detailed cases will now be presented to show the students' lived experience of working in the CSL showing how the intervention ran into their practices. A comprehensive description of the groups selected as cases is presented. It includes the general characteristics of each group (e.g., gender, age, results on the reflective questionnaire) which provides background information to facilitate an understanding of group development during the intervention. Following this, an analysis of the contributions was conducted to understand the ways participation varied and the impact it had on participants' practices. To illustrate this part of the analysis, two cases were selected based on their participation. Firstly, a highly active group and secondly a rather non-participatory one. The intention was to investigate and understand the differences that emerge from them, contributing to an understanding of these differences to answer the defined research questions.

During data analysis (see 4.5) seven main themes were identified and were integrated into the interpretation of the participants experiences. Table 25 provides a definition of

the theme and some examples. Appendix H shows how the theme and codes were applied within the data, and the analytical notes for those groups are presented. Moreover, this evidences how the case for each group was constructed, analysed, and interpreted.

Table 25
Summary of the themes

Theme	Definition	Codes examples.
1. Ability and skills of the students involved in the intervention.	It considers the skills and ability of the students developed by the intervention.	Learning experience, memory, concentration on the activity, the value of previous knowledge and experiences, Self-assessment, Motivation, Reflection, Critical Thinking, Handling emotions.
2. Recording of the experience	Photographs, comments, and reflections as a tool to record the experience, complemented with traditional pen and paper notes.	Type, classification, and the content of contributions. Use of the recorded procedures.
3. Technology	Technical considerations and characteristics which affects the learning process. Considering photographs.	Access, ubiquity, visualisation.
4. Tutor's role	Role of tutors was recognised throughout the intervention.	Connection with real practice. Role modelling.
5. Time concerns	Considerations of time in relation to skills development.	Pressure Affecting emotions and performance.

Theme	Definition	Codes examples.
6. Intervention issues	Value of the activity and how students recognise their performance in the intervention.	Assessment, evaluation, grades.
7. Learning Environment	Characteristics of the program and learning environment that affects students' performance.	Trust on tutor, peers, and role of phantoms heads.

7.4 The case of a highly participative group

Group F included seven students tutored by Dr Fuentes. The students engaged in a variety of different ways with the process (e.g., sharing photographs, adding comments and reflections, using other contributions to improve their own work). Most of the members of the group engaged and contributed frequently and in depth with the activity. As shown previously (see 6.5.1), the number of photographs shared by the students varied greatly. However, in Group F, half of the participants shared an amount above the median (i.e., *Mdn* = 8.5 photographs), the other three shared over six photographs (see Figure 29). Thus, presenting this case, a wide range of experiences were captured, starting from students who shared more photographs, comments, and reflections than their peers, to those who adopted a more passive role of following them.

7.4.1 Group 'F' generalities

Dr Fuentes guided this group, composed of seven students who all agreed to participate in the intervention. All these students took and shared photographs, and four of them completed the final task[20]. The group shared a total of 82 photographs, 69 comments and 52 reflections online (see Table 26). According to the final questionnaire, they took approximately 92 photographs as a group. Three students took more than they shared, indicating some filtering of what they shared online, the others shared all the photographs they took. According to the group calendar, they worked to the required schedule. They

[20] The final task corresponded to the final activity where the students were asked to complete eight questions designed to make them reflect on the activity (for details see 4.4.8)

had two sessions each week, one of three hours, and one of four hours which took place two consecutive days.

Table 26
General characteristics of Group F students and its participation in the intervention

Participant Pseudonym	Characteristics [a]			Self-Reported [b]					ON Contributions [c]				
	Gdr	Age	1st	Tkn	Shrd	Rflc	Own	Peers	P_ON	C_ON	R_ON	All	PE_c
Jorge	M	20	yes	16	9	yes	yes	yes	15	15	7	no	yes
Belen	F	20	no	8	6	yes	yes	yes	6	3	3	no	no
Antonia	F	21	yes	23	23	yes	yes	no	23	16	14	yes	yes
Igor	M	23	no	10	10	yes	yes	yes	9	9	7	No	yes
Tomas	M	21	yes	13	13	yes	yes	no	13	10	10	yes	yes
Natalia	F	21	yes	10	10	yes	yes	yes	8	8	3	No	no
Vivian	F	21	yes	12	8	yes	yes	yes	8	8	8	No	yes
Totals	-	-	-	92	79	-	-	-	82	69	52	-	-

Note. (n=7 in this group). ON = OneNote.
a. General characteristics of Group F participants (i.e., Ggr = Gender, Age, 1st= answering if it was the first time a student took the unit).
b. Self-reported answers from the Final Questionnaire (i.e., Tkn = number of photographs taken, Shrd = number of photographs shared, Rflc = the answer to: Did you reflect on your photographs? Own = the response to: Did you check your contributions on OneNote after uploaded them? Peers = the answer to: Did you check your classmates' contributions on OneNote?
c. ON Contributions, P_ON = number of photographs shared, C_ON = number of comments shared, R_ON= number of reflections shared, All = indicating if all the procedures for the studied treatment were shared on ON, PE_c = indicating if the procedures evaluated on the Practical Examination (PE) were completed on ON.

A closer inspection of Table 26 does not show a clear correlation of the number of photographs the students reported on the final questionnaire with those they actually posted online. However, no significant difference was found when the self-reported numbers of photographs were contrasted with the observed numbers of photographs on OneNote considering all the participants who answered the item on the final questionnaire (T=301.0, p=.496, r=0.09, Wilcoxon signed rank test - for details see 6.5.1). This result is somewhat intuitive, one would expect a committed participant to report data as accurately as possible and one possible action could be to actually count the number of contributions, which they do by opening the application and providing

accurate information. In this way, the difference between what was reported and what was actually there on OneNote, despite not being significant for the entire cohort of participants, could be an interesting point of analysis as those students who considerably differ on what they reported with what they actually did. In this group, Jorge reported sharing 15 photographs, however he shared 9. It is interesting that when closely analysing his case the difference could be related to his relatively low engagement with the activity, as despite the high number of photographs shared, he did not consistently show work and only uploaded the steps evaluated for the practical exam after the last session. Moreover, Jorge was working to the schedule and finished all procedures before the practical examination, but only shared the steps considered in the evaluation. In addition, he made some grammatical errors and provided descriptions and solutions to his problems that were ambiguous and disconnected with real practice, as seen in Table 27.

Table 27
Jorge's ambiguities with future practices connection

Original taken from Jorge's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
29-08		Búsqueda de provisorio de stock de acuerdo a anatomía del paciente.	Nótese que se debe reajustar las piezas vecinas para así asegurar el contacto entre piezas, se hará posteriormente.

Translation

Date dd/mm	Photographs	Comments	Reflections
29-08	{empty}	Looking for a stock tooth that suits) the patient's anatomy.	Note that the neighbouring teeth need to be readjusted to guarantee the contact point between pieces. It will be done later.

Note. The excerpt was taken from Jorge, S10, gF, OneNote page.

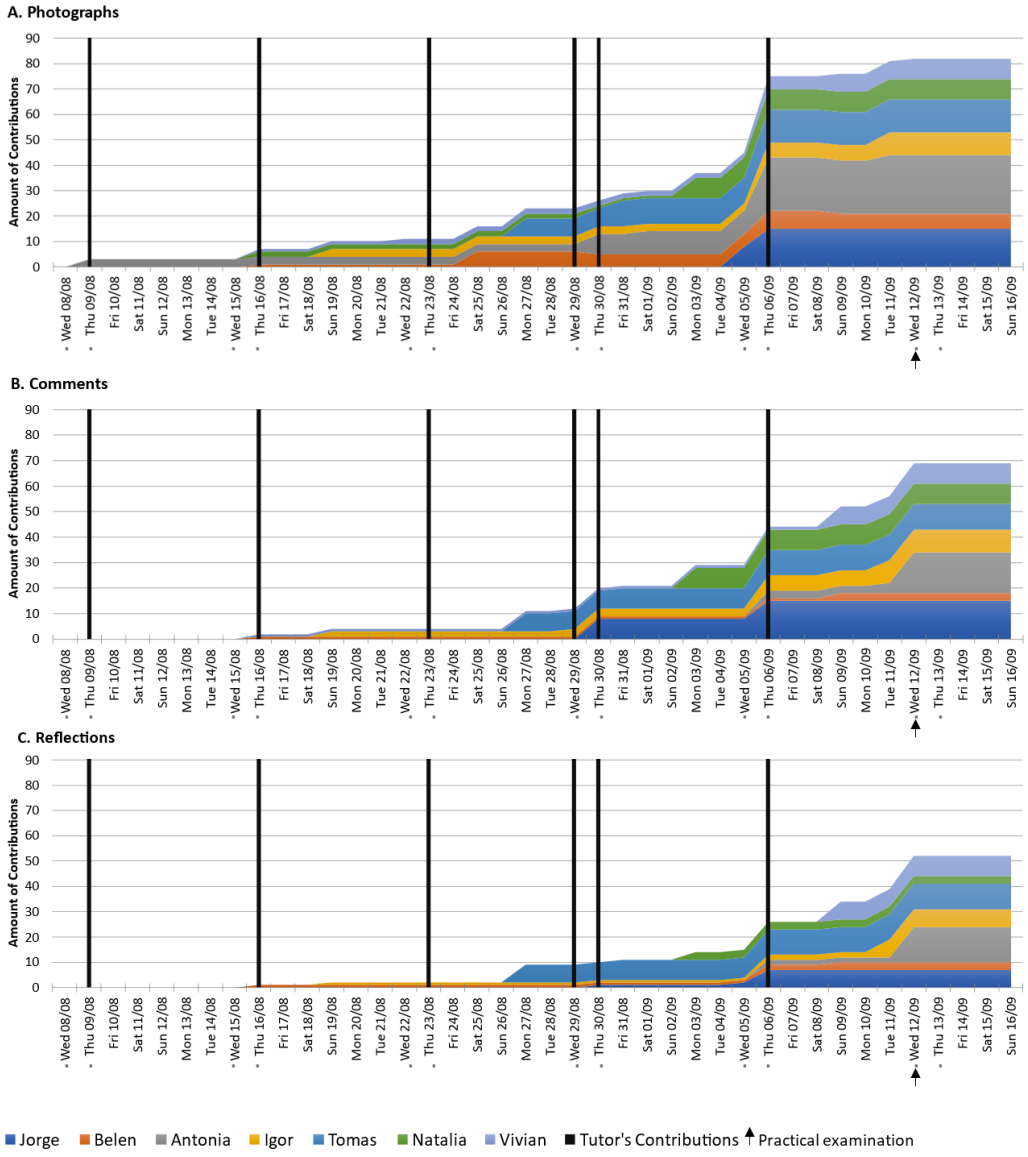
The connection with future clinical and professional practices was considered ambiguous as Jorge selected the stock tooth to do the provisional (part of milestone procedures, see Table 10) and considered the patient's anatomy, an action that it is in concordance with what will be done in clinics later. On the other hand, he mentioned in the reflection entry that in order to adjust the lack of contact point, instead of repairing what he had done he was going to re-adapt the neighbouring teeth. The solution he suggested is not possible in a clinic and reveals unprofessional practice. To start the

procedure, students were taught to adapt the teeth considering the contact point, so re-adapting them at this stage reveals that the provisional obtained was not sufficient, the right solution would have been to re-shape the provisional obtained, instead of adjusting the sounding tissues to the provisional done. In a clinic situation, it is equivalent to the dentist adding an extra treatment (e.g., orthodontics) to remedy what he or she did wrong in the first instance.

7.4.2 Contributions as a group. What is it available online each time?

Figure 41 shows how the contributions of the group progressed over time. It is an indicator of the type of information shared each day by participants (i.e., photographs, comments, and reflections). Students' participation, as described previously (see 6.5.2), was influenced by three external factors which related to the peaks of the students' contributions (i.e., practical examination, email sent to all the students, and one-to-one demonstrations). In the figure (indicated with a black arrow) the proximity of the practical examination is associated with increased students' contributions. In this way, when compared with the tutor's contributions, we can see how the tutor's activity was observed to go along with contributions of her tutees over time (see Figure 41). Thus, to understand how the contributions of the tutor (i.e., Dr Fuentes) were related to the contribution of the students it is necessary to first to describe the content of Dr Fuentes' Corner and subsequently to explore the connections with the content shared by the students.

Figure 41
Contributions over time of Group F



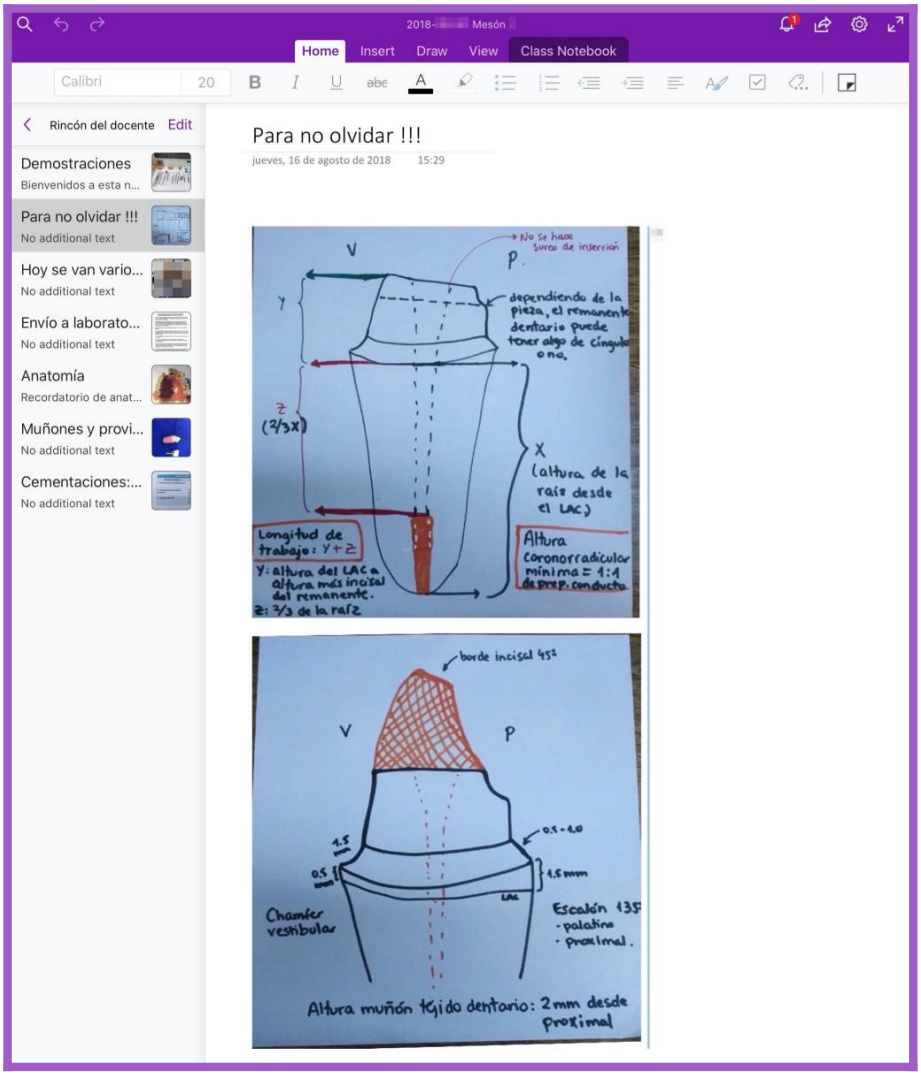
Note. (Students n=7, represented by different colours), Tutor n=1 (Dr Fuentes)
The chart shows the number of photographs(A), comments (B) and reflections (C) on OneNote each day.
The days when Dr Fuentes posted items online were highlighted as well as the day the students had practical sessions along with when they started their practical examination.
Note that it is not possible to determine at what time during the day the contributions were made. Thus, when the students had practice sessions, it was not possible to distinguish if the contributions were done during the practices or later the same day.

7.4.3 Dr Fuentes' corner

Dr Fuentes' Corner contained all the procedures needed to accomplish the requirements for the unit of prosthodontics (see 5.1.5). Those procedures were mainly presented using images rather than as an entire written description, as seen in Figure 42. The screenshot

shows a scheme indicating the parameters concerned with wear to the teeth and the requirements for reconstruction. The scheme was shared by the main tutor with their colleagues. Some of the tutors, such as Dr Fuentes in this group, shared it with their students on her tutor's corners on OneNote. Others drew something similar and took a picture of it and shared it later with their students. One drew it on the iPad directly during the demonstration, using the iPad as a whiteboard.

Figure 42
The use of images to describe procedures



Note. This figure presents an excerpt from Dr Fuentes's corner in group F. It was named: 'Para no olvidar !!! (English translation: Don't forget it!).
Top picture: shows a buccolingual view explaining the requirements of the root to support a reconstruction using a PFM.
Bottom picture: shows the shape of the pin-stump made with acrylic and details of the finishing line of the preparation.

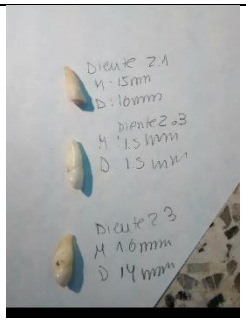
As discussed previously, student activity was intrinsically related to the participation of their tutor. It revealed how something that the tutor highlighted was then incorporated into descriptions and the reflections of the students. For example, an important part of the procedure is to register a measurement of the root then start the process. This simulates information extracted from an x-ray in clinic. If the students adapt the tooth with acrylic without measuring it first, the procedure would be compromised, or it would not be possible to estimate the length of it, as no x-rays are taken during the preclinical practice. On the other hand, within clinical practices, the measurement is required to estimate how much of the root canal needs to be prepared. It is essential to know how long the root is before adapting the tooth. Therefore, this is an action that all tutors explain to their students (as in Figure 42).

Consequently, six of the students in group F started their contributions on OneNote with an extensive description of the measures and requirements for their tooth in relation to the required procedures. As shown in Table 28, Antonia shared a picture of the dental pieces before adapting them, adding in her reflection the sentence 'as suggested by our tutor, it is very important…' (Antonia, gF, ON[21]), as validating the importance of carrying out this step because of the strong recommendation from her tutor. Interestingly, her reasoning for the importance of the described procedure is because their tutor told them to rather than due to the clinical importance of the act.

[21] (Student pseudonym, group, source). g = group, FG = Focus Group, FT= Final Task, I = Interview, FQ = Final Questionnaire)

Table 28
Details of the preparation shared by Antonia

Original taken from Antonia's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
08/08/18		Datos correspondientes a Mediciones de las piezas a trabajar este semestre.	Por indicación de nuestra docente guía, es muy importante hacer las mediciones de las raíces de las piezas dentarias previo a la adaptación con acrílico, con el fin de preparar el conducto, en las proporciones adecuadas.

Translation

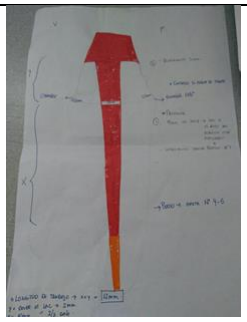
Date dd/mm	Photographs	Comments	Reflections
08/08/18	{teeth previous adaptation with acrylic into the arcade with all the measures written on their right side}	Data corresponding to measurements of the pieces to work this semester.	As suggested by our tutor, it is essential to take the measurements of the teeth roots before the adaptation with acrylic in order to prepare the canal, using the appropriate proportions.

Note. The purple outside line indicates that the table is an excerpt from the OneNote application.
Top panel: The original version of Antonia's first entrance in her OneNote page.
Bottom panel: a description of the image followed by the translation into English of the comments and reflection.

Further analysis reveals that the same level of importance was given by the tutor to the acrylic model of the pin-stump that needs to be accomplished as a milestone (see in 5.1.5, Table 10) that facilitates progression with regard to the final requirement before the practical examination (i.e., construction of a pin-retained provisional). An example highlighting the importance of this milestone was Vivian, who shared a diagram where she analysed all the procedures during the construction of her custom-made core and post, as shown in Table 29.

Table 29
Post and core details shared by Vivian in OneNote

Original taken from Vivian's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
11 Septiembre		Medidas a considerar	Cuando se quebró el primer pinjet, este trajo una serie de problemas consigo, por lo que trate de evaluar los posibles fallos en los procedimientos realizados anteriormente a través de un dibujo.

Translation

Date dd/mm	Photographs	Comments	Reflections
September 11th	{diagram explaining the solutions to the problem she encountered during her practices}. For example, when the length of the post was not sufficient: *'problem: 9 mm post length→ see if the acrylic is stuck, introduce Peeso reamer nº1'*	Measures to consider	When the first pinjet was broken, it brought a series of problems with it, so I tried to evaluate possible failures in the procedures previously performed through a drawing.

Note. The purple outside line indicates that the table is an excerpt from the OneNote application.
Top panel: The original version of Vivian's entrance in her OneNote page.
Bottom panel: description of the image followed by the translation into English of the comments and reflection.
Notice she used a Peeso reamer nº1 to solve her problem. However, the appropriate instrument to inspect the root canal is actually an endodontic file.

Of interest, as discussed later, is the connection between the actions carried out on a phantom head with what it is done clinically. As discussed previously, the role of tutors in guiding the students through an appropriate understanding of the actions is invaluable. For example, a theoretical understanding of endodontics (root canal treatments) is required in order to accomplish the crown and root preparation successfully. However, the procedures studied within the topic of Fixed Prosthodontics (see 5.1.5) did not considered the taught component (either practical or theoretical) of root canal treatment Therefore, the students conducted the root preparation for the post and core (milestone 1, in Table 10) without sufficient previous knowledge about endodontic treatment. The

theoretical and practical content of root canal treatments is located later in the curriculum (Facultad de Odontologia, 2014). Thus far, in order have a complete picture of the simulated treatment considered within the intervened procedure, students needed the appropriate explanations from their tutors in order to understand fully the simulated practice in a broader professional context.

In the same vein, the role of the tutor in evaluating if the students are capable of projecting their preclinical practices to a clinical scenario becomes crucial. Contrary to this situation we could find students repeat a procedure mechanically without connecting it at all with future clinical practice. An example of this situation was Vivian who used the wrong instrument to solve a problem and described it on her page as being good practice. As seen previously in Table 29, she used a Peeso reamer nº1 to solve her problem. However, the appropriate instrument to inspect the root canal is an endodontic file. Thus, it raises intriguing questions about the role the tutor plays in bridging the preclinical to clinical training gap. This idea was reinforced with what Antonia noted during the Focus Group, where she stated: "Many things in preclinical (training)... are done differently than how one will do in clinic in future" (Antonia, gF, FG)

Then it was again reinforced by Natalia, who added: "We have… a version for pre-clinic, and a version for clinic (referring to the procedures done during the preclinical training)" (Natalia, gF, FG).

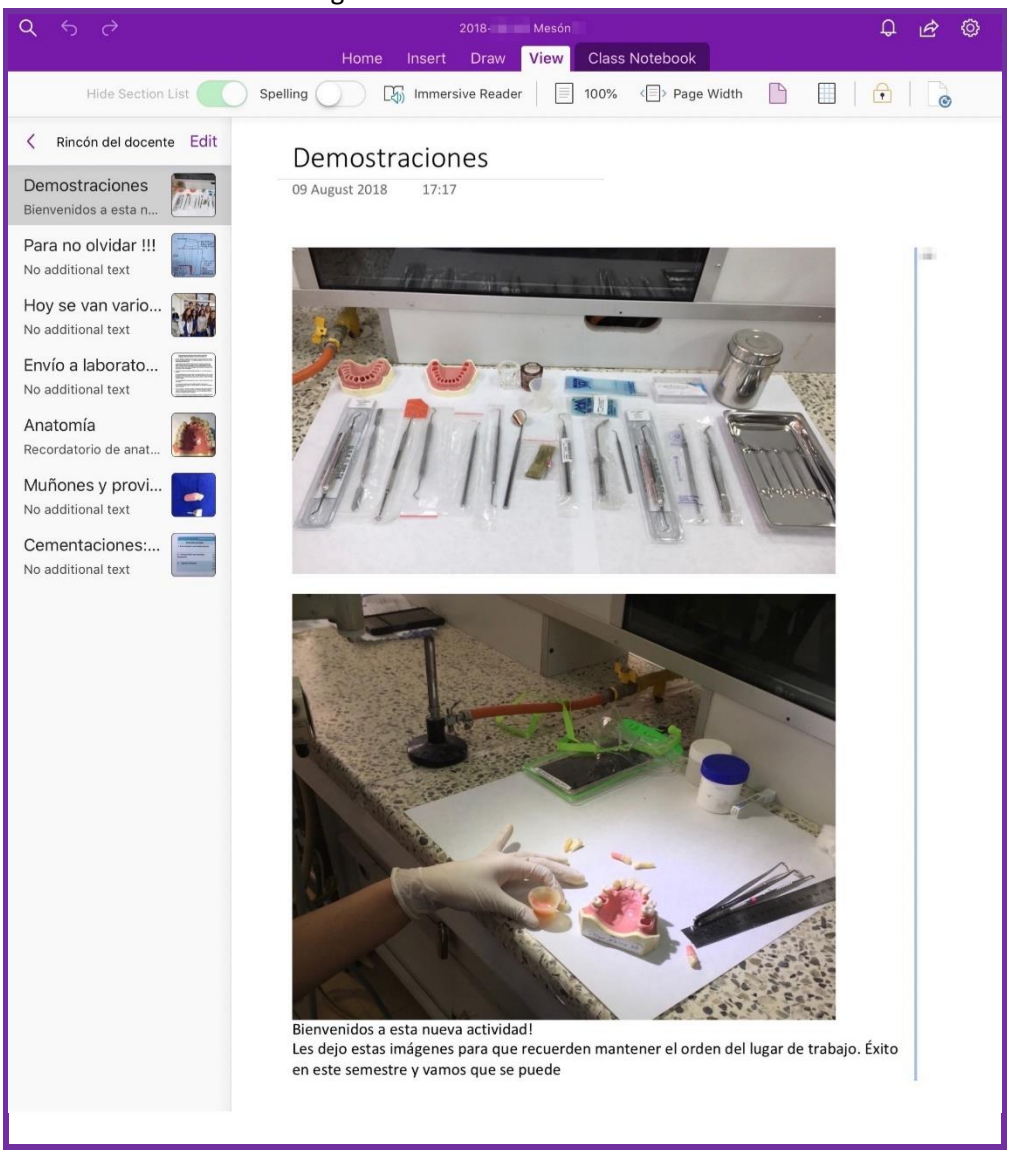
Thus, the role of the tutors become crucial to make those things perceived by the students as being 'different' from what they were told in preclinical to what they actually do in clinical practice to be as similar as possible to the future scenarios that they will face.

Continuing with Dr Fuentes' analysis, what stands out are the messages which she published on her 'corner' in order to motivate her tutees to be on track with the development of their procedures, as seen at the beginning of the intervention in Table 30.

Table 30

Dr Fuentes's corner extract from group F

Original taken from Dr Fuente's corner



Translation

'Welcome to this new activity!
I share with you these images to let you remember to keep your station tidy.
All the best for this semester. You can do it!

Note. The purple outside line indicates that the table is an excerpt from OneNote application.
Top picture: shows the instruments needed by students during the semester.
Bottom picture: shows the adaptation of the natural extracted teeth to an artificial arcade that is subsequently fitted on the phantom head.

The same behaviour of publishing motivational messages was observed during the accomplishment of a milestone, as shown in Table 31. There, the tutor included a picture of the participants of the group from the day they accomplished it and sent the acrylic

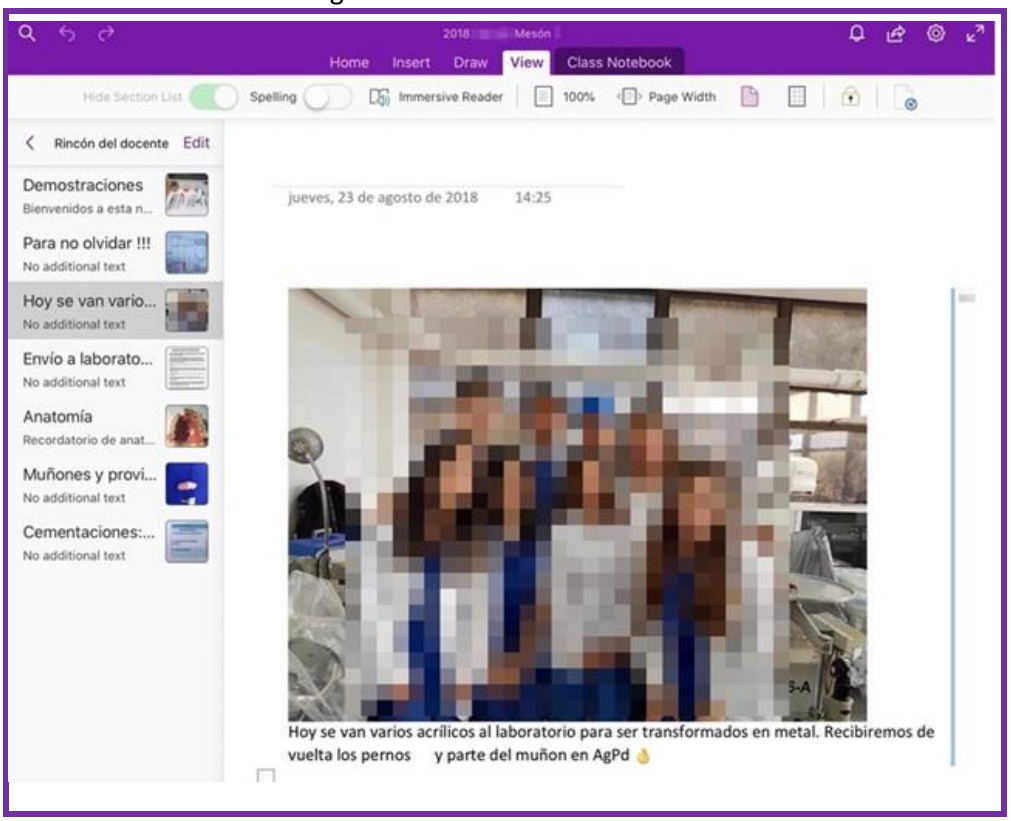
custom-made post to the laboratory. To have an idea how the comments of the tutor influenced her tutees Vivian provided some insight when she expressed the following: "The opinion of my tutor when she reviewed my work was fundamental to my progress" (Vivian, gF, FT).

It is significant how students consider the guidance of their tutor, even mentioning her during their descriptions and reflections. Thus, it suggests a constructive effect of the contributions of the tutor over the contributions made online by her tutees.

Table 31

Dr Fuentes contribution when a milestone was accomplished by her tutees

Original taken from Dr Fuente's corner



Translation

'Today some acrylics (patters) were sent to the laboratory to be transformed into metal. We will receive the custom-made post back in Ag-Pd (alloy) 👌'

7.4.4 Following a peer as a guide

As discussed above, the development of some student's contributions in the intervention followed that of their tutors. In addition, this activity could be seen as being an indicator

of the progression of the group in relation to the programme requirements. For some students, their peers' contributions were a complement to information shared by the tutor and served as a guide for them to perform the procedures. It is noteworthy how this group (F) adopted Antonia as a guide, referring to her OneNote page as 'Antonia's Corner' thus emulating their tutor's corner. The concept came to life during the focus group when they were asked about the role of their peers. One individual generated the concept: "Antonia's corner" (Igor, gF, FG), referring to the benefit and importance he attributed to the page, and the other participants laughed, in a sense expressing agreement with what he just said. Another commented: "Antonia shared what the tutor does, with a picture and a description" (Belen, gF, FG).

Following the same idea, what happened with Antonia's page is clearly illustrated in Table 32. Clear and detailed information about the procedure undertaken by the tutor is shown using many photographs and supported by an extensive description. Dr Fuentes encouraged Antonia to register her demonstrations, and Antonia adopted an enthusiastic role by registering and sharing together with plenty of additional details. She became a guide for her peers later, who valued her contributions during their practices and their studies for the practical examination.

Table 32

Antonia's contribution to OneNote based on her tutor's demonstration

Original taken from Antonia's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
05/09/18	 	Este es el procedimiento para preparar el Cemento Fosfato Zinc, cuyo objetivo es cementar el perno muñón de plata paladio de manera definitiva al diente. Vertimos 4 gotas y 1 cucharada del polvo, el cual dividimos en 16 partes y vamos agregando de a poco a la mezcla, pues la reacción es por saturación. Mezclamos en una loseta de vidrio con una espátula de cemento (no de plástico) por un minutos aproximadamente. Debemos asegurarnos de formar la textura adecuada y debemos formar UN HILO DE 2-3 CM levantando la espátula con parte de la mezcla. (Imagen 5) Posteriormente llevamos al perno muñón y cementamos en boca retirando excesos.	

Translation

Date dd/mm	Photographs	Comments	Reflections
05/09/18	{tutor doing the demonstration}	This is the procedure to prepare the Zinc Phosphate cement, whose objective is to cement the palladium silver custom-made post permanently to the tooth. We pour 4 drops and 1 spoon of the powder, which we divide into 16 parts and add little by little to the mixture, since the reaction is by saturation. Mix in a glass pot with a cement spatula (not plastic) for approximately one minute. We must make sure to form the appropriate texture and we must form A THREAD OF 2-3 CM by lifting the spatula with part of the mixture. (Image 5) Later we take the post and cemented it on the mouth removing excesses.	{empty}

On the other hand, Antonia commented that she did not review her peers' contributions. However, she thought the intervention was a good project to share experiences with her colleagues. During the focus group, she mentioned the following: "I

look at mine and what the tutor posted, but there are people that always look at other's contributions to compare" (Antonia, gF, FG).

In that sense, she was reflecting on her own work and comparing it to the tutors rather than her peers, and classmates adopting her as a guide. As a consequence of this behaviour, tutors may need to be cautious about the attitudes of their tutees, as will be discussed later. Vivian and Igor recognised that they followed Antonia's as a guide. Looking at their performance, they both finished the required procedures, but they both were behind their peers during the practical sessions, and this could be the reason why they adopted Antonia and other peers as a guide. They did not receive demonstrations simultaneous to learning a procedure, so it seems significant that they both mentioned that they review their peers' pages session-by-session to complement their experiences. In the words of Vivian:

> I reviewed the photographs of my peers before every session. When I progressed, I compared my results with them … It was a great activity; thanks to doing that, I was able to see my performance and reflect on my mistakes. It is an application that was available whenever you had doubts, so it was essential in my preclinical progression (Vivian, gF, FQ).

The point was clear again when she highlighted four advantages of the activity for her, she listed: "Reviewing each point; not making the same mistakes; remembering the materials to use, measures and procedures; comparing my performance with others" (Vivian, gF, FQ).

Another student, Igor, mentioned that he checked his peers' pages "in my routine studies on the unit, complementing my experiences with the ones of my peers" (Igor, gF, FQ).

7.5 The case of a low participating group

Group G was composed of six students tutored by Dr Reyes, who also guided group B, which also registered a low level of participation. As a group, group G demonstrated a low level of engagement with the intervention showing low participation online and not engaging with the use of technology provided (i.e., iPad) during the practical sessions (e.g., not taking photos, complaining about the use of technology and time availability). Some evidence suggested this group of students was rather more focussed on merely

completing the requirement, with little effort made to engage with the additional activities associated with the intervention, including taking and sharing photographs, commenting on them, and engaging in reflection. Additionally, most of the comments were orientated towards obtaining a better grade on the practical examination.

In this group, three out of six students shared a number below the median for all participants (i.e., *Mdn* = 8.5 photographs). There was one student who shared 19 photographs, and it was this participant who was followed as a guide by her peers. Therefore, it become interesting to analyse the content of those contributions.

Presenting this case aims to cover more experiences to complement the already presented ones in the previous case with engaged students. This will provide a deeper understanding of the dynamics among the entire cohort of students who agreed to participate in the intervention.

7.5.1 Group 'G' Generalities

Dr Reyes guided this group, composed of six students, who all agreed to participate in the intervention. According to the group calendar, they worked to the required schedule, and regarding the intervention, all these students took and shared photographs, and two of them completed the final task[22]. The group shared a total of 49 photographs, 20 comments and 11 reflections online (see Table 33).

[22] The final task corresponds to the final activity where the students were asked to complete eight questions designed to make them to reflect on the activity (see 4.4.8)

Table 33
General characteristics of group G

Participant Pseudonym	Characteristics [a]			Self-Reported [b]					ON Contributions [c]				
	Gdr	Age	1st	Tkn	Shrd	Rflc	Own	Peers	P_ON	C_ON	R_ON	All	PE_c
Elena	F	22	yes	8	8	yes	yes	yes	8	0	0	no	yes
Carlos	M	20	yes	8	8	yes	yes	no	10	10	0	no	yes
Claudia	F	21	yes	30	19	yes	yes	yes	19	18	11	no	yes
Cristian	M	20	yes	6	3	no	no	yes	c2	0	0	no	no
Pedro	M	27	yes	8	1	no	yes	yes	1	1	0	no	no
Paula	F	20	yes	7	7	no	no	yes	9	0	0	no	yes
Totals	-	-	-	67	49	-	-	-	49	20	11	-	-

Note. (n=6 in this group). ON = OneNote
a. General characteristics of Group F participants (i.e., Ggr = Gender, Age, 1st= answering if it was the first time a student took the unit).
b. Self-reported answers from the Final Questionnaire (i.e., Tkn = number of photographs taken, Shrd = number of photographs shared, Rflc = the answer to: Did you reflect on your photographs? Own = the response to: Did you check your contributions on OneNote after uploaded them? Peers = the answer to: Did you check your classmates' contributions on OneNote?
c. ON Contributions, P_ON = number of photographs shared, C_ON = number of comments shared, R_ON= number of reflections shared, All = indicating if all the procedures for the studied treatment were shared on ON, PE_c = indicating if the procedures evaluated on the Practical Examination (PE) were completed on ON.

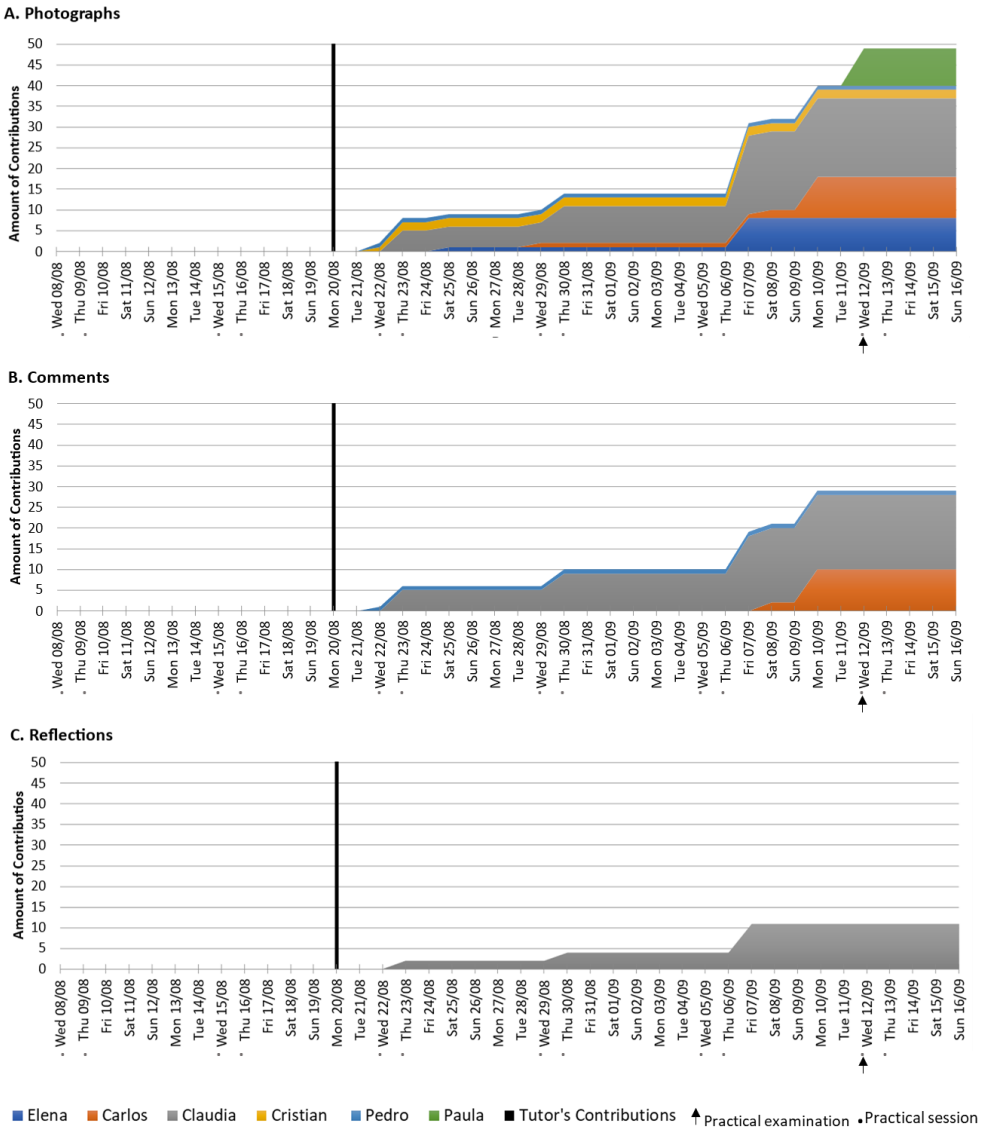
As a group they took approximately 67 photographs. Most of the photographs were shared by just three participants, Claudia, Carlos, and Elena. Comments were only added by Carlos and Claudia, and reflections only from Claudia. Thus, it was not surprising that during the focus groups all of the students in the group said that they used those tree students' contributions (mostly Claudia's) as a guide. Being in this situation disadvantaged Claudia, who noted she also tried to use her peers as a guide, but mentioned: "I try, but there was nothing there" (Claudia, gG, FG)

7.5.2 Contributions as a group

As mentioned previously, comments from the tutor were reduced to one contribution which consisted of the general guidelines to the procedure produced by the main tutor. The photographs were the same shared by Dr Fuentes in Group F and described in the previous section (see 7.4).

Displayed in Figure 43 is an overview of the number of contributions by participants each day. It is not possible to determine at what time during the day the contributions were done. Therefore, when the students had practical sessions, it was not possible to distinguish if the contributions were done during the practices or later the same day. What is striking about the figures is that we can see the higher quantity of contributions that Claudia (in grey) provided over the period. Additionally, Dr Reyes made only one contribution online, and did not use the application regularly during the practices. Consequently, as seen in Figure 43, the contribution previously mentioned was made on a day when students did not have practices.

Figure 43
Contributions over time group G



Note. (Students n=6, represented by different colours; Tutor, n=1, Dr Reyes)
The charts show the number of photographs (A), comments (B), and reflections (C) shared on OneNote each day by each participant.
The days when Dr Reyes posted items online were highlighted as well as the day the students have practical sessions and when they started their practical examinations.
Note that it is not possible to determine at what time during the day the contributions were made. Thus, when the students had practice sessions, it was not possible to distinguish if the contributions were done during the practices or later on the same day.

7.6 Summary of the chapter

The results in this chapter highlight views students had of their work on phantom heads and how the intervention helped them in the development of skills they would need later for their practices. Generally, the experience was positive, although impacted by

constraints the students had in relation to time and scheduled activities. The positive aspects are the described utility of the intervention as a memory aid, the development of critical thinking connecting with future practices, and self-assessment. This was followed by an evaluation of peer learning within the intervention, highlighting how students compared and complemented their own work with that of their peers. Furthermore, it the use of OneNote for contributions (i.e., photographs, comments, and reflections) was presented, with special attention given to the use of photographs in improving students' communication about their practices. It was not surprising that communication improved with their peers. However, the engagement to communicate and explain their work to non-dental people (e.g., relatives), showed unexpected positive results from the intervention.

A detailed visual review of contributions, and especially photographs resulted in improved performance in undertaking practical procedures. This beneficial aspect of the intervention was used by students during their practices, as some of them reported studying them session-by-session. Similarly, OneNote contributions helped students to study and revise for the practical and theoretical assessments. This could relate to the memory aid described previously. Improvements in recognising and managing emotions, as well as handling the work under time pressures, have also been reported through this intervention.

The chapter also presented contrasting cases relating to the engagement of student groups with the intervention. In this vein, more details were presented to understand how the students lived their practices and how the intervention influenced them. Therefore, a highly participative group and a rather non-participative one, were presented. It is interesting to highlight that within the highly participative group, students worked along with their tutor. In both cases it was possible to identify: the proximity to the practical examination provoked increased student participation; the milestones were given more attention than other stages by students and tutors; the students who worked behind used their more advanced peers.

Interestingly, in the highly participative group all the students benefitted from their peers and tutors. On the other hand, in the lower participating one, it was clear that some students who did not contribute to OneNote benefitted from those who did. This is important, as the availability of resources in a highly participative group was superior to

the other group. These results suggest that the companionship of the tutor and their motivation towards the intervention duly influenced student participation in it.

Chapter 8 Tutor experiences and perceptions of the intervention

This chapter is an account of the experiences and perceptions of tutors during the intervention. It describes how tutors participated, how they understood their role and how their experiences and perceptions can be linked with findings presented in the previous chapters.

The data presented and analysed in this chapter was derived from observations of tutors' practices during practical sessions in the Clinical Skills Laboratory (CSL); from tutor's contributions to the 'tutor's corner' in OneNote; from a post-intervention focus group conducted with all (seven) participating tutors; and from screenshots which tutors brought to focus groups as an elicitation tool to encourage discussion about what stands out from their students' contributions.

The chapter begins with a broad description of tutors' participation, highlighting the interactions that they have had with their students during demonstrations. Recognition of their roles in students' learning will then be presented. This will be followed by an analysis that tutors carried out of their students' emotions and their considerations of the assessment in relation to the intervention. Finally, tutors' perceptions of the work of their students and how the intervention helped their practices will be considered.

This chapter addresses Research Question 3: What are the experiences and perceptions of the tutors about the impact of the educational intervention/ reflective practice on the teaching and learning process? Additionally, it provides additional information to complement the answer to Research Question 1: How does Design Based-Research inform the design and enactment of the educational intervention?

8.1 Tutor participation

The tutor's contributions online varied significantly, making it possible to identify two distinct groups (see Table 34) of tutors, in relation to the student groups described in the previous chapter (see Chapter 7). The first consisted of tutors who actively participated in the activity, sharing examples online, using photographs to explain different procedures, helping students, and encouraging their students to participate. There were five tutors in this group. They presided over five of the ten student groups. The second group was made up of two teachers who tutored four student groups in total (i.e., two in cohort_1 and two

in cohort_2). In their teacher's corner [23], on OneNote, one tutor only shared one drawing and the other shared the image produced by the course director. In both cases, the contributions were made at the beginning of the intervention, while individual demonstrations about OneNote usage were carried out by the researcher.

Table 34
Tutor's participation within their groups of students

Highly participative group of students (HP)	**Low participating groups of students (LP)**
Tutors	
Dr Araya (A) Dr Silva[iii] (H) Dr Soto (E) Dr Fuentes[i] (F) Dr Lopez (J)	Dr Reyes (B & G[ii]) [Dr Silva [iii] (C)] Dr Diaz (D & I)
General characteristics of tutors within groups	
- Actively participated in the activity. - Shared examples online. - Used photographs to explain different procedures. - Helped and encouraged their students to participate in the intervention. - Interacted with other tutors about the use of OneNote.	- Rarely used the shared platform, just a few uploads at the beginning of the intervention. - Did not change their practices in relation to the intervention.

Note.
i. Dr Fuentes group F was presented as a highly participative group of students in 7.4.
ii Dr Reyes group G was presented as a low participating group of students in 7.5.
iii. Dr Silva characteristics are the ones listed under high participative groups of students.

It is noteworthy that Dr Silva had two group of students, one of which was highly participative and the other low. Independently she shows the same general characteristics for both groups. Therefore, it was not surprising she recognised the difference between her two groups saying:

[23] Tutor's corner: a special space designed for each tutor. There they freely share content with their students.

> It was very noticeable the difference between groups C and H... Too noticeable, and I don't know why. Students from my group H were very participative; for example, they took photos alone and asked questions. Even at the end of the activity, they insisted on continuing taking (photos) ... I mean, they were super motivated. But with group C, I don't know what happened which meant that they simply did not engage in the same way (Dr Silva, FG)

Furthermore, the other two tutors with low participating groups had both been assigned two groups. Whereas four of the tutors only had one group and these were all highly participative. The data was viewed and did not provide any additional explanations for this, rather than the low engagement with the activity showed by tutors. However, the case of Dr Silva, suggested that there were other associative factors attached to students' (non-)participation rather merely the influence from tutors mentioned here. However, is interesting to highlight that those highly participative groups shared a tutor who is also highly active and engaging online. Additionally, the contributions on OneNote as a group are more homogeneous over time in highly participative groups (see in *7.4*) than the ones in the low participative groups (see in *7.5*), where one or two students excelled the rest of their peers participation.

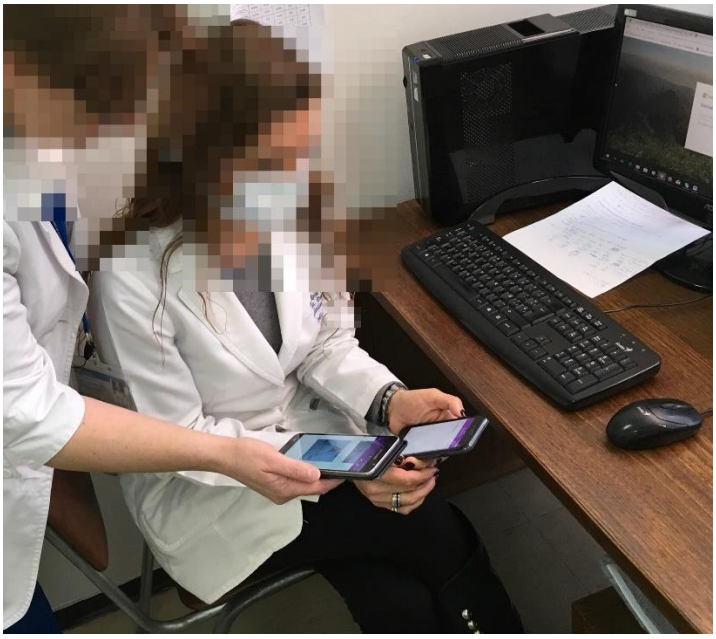
The first group of tutors (HP) provided contributions throughout the development of all the practical sessions included within the current intervention, reinforcing the ideas presented during their typical demonstrations, and encouraging or helping students to take photographs of their procedures to complete their OneNote pages, as seen in Figure 44 .

Figure 44
Tutor helping a student taking photographs

Note. Use of iPad to register student's action.

Furthermore, this group of tutors questioned the researcher regularly about the technical use of the platform, during group-by-group demonstrations carried out by the researcher, or whenever the researcher was available. The tutors in this particular group (HP) demonstrated how to use the application to each other (see Figure 45). These tutors also discussed issues related to the use of OneNote and their students' participation, while interacting with their colleagues online through a social media platform (i.e., WhatsApp).

Figure 45
Tutors' peer demonstration



Note. Tutors sharing material generated on OneNote though their mobile phones.

The popularity of WhatsApp among tutors to inform one another of issues related to the unit was often noted. There, photographs of procedures, and general guidelines, were regularly shared by tutors. Additionally, as the intervention developed, WhatsApp was used by the researcher to inform tutors about students' participation on OneNote and to ask them to encourage their tutees' participation, as shown in Figure 46. Additional to the typical unit chat conversations, there were comments highlighting students' participation and contributions of materials that could be shared online. Within WhatsApp a general description of the procedure was shared by the course director using photographs. This was used by the researcher as a prompt to encourage tutor participations on the platform, asking them to share those images with their tutees via OneNote 'tutor's corner'.

Figure 46

Recreation of WhatsApp conversation

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- **Researcher:** Hi! I encourage tutors participating in the intervention with third year students to be a little bit more active on the platform. See you later!

- **Dr Lopez:** Can we provide feedback on the students' reflections? Or should they reflect alone?

- Researcher: Alone, but you can encourage them to write something… such as to remind them to check the example (online). Or suggest them to do something.

- Dr Lopez: Ok perfect!

- **Dr Araya:** [thumbs up]

[…]

- **Dr Silva:** [screenshot of a student's contributions (photograph, comment, and reflection) in OneNote] Look!

- **Dr Lopez:** [smiles]

- Researcher: yes, I saw it…great!

- Dr Silva: I like it too

- Researcher: You can comment something on the 'tutor's corner'.

- Dr Silva: … Can I share this with the other group as an example? Without telling them who said that?...

- Researcher: Yes, of course. You can share it with them but keep it anonymous.

- **Course Director:** Well done, Dr Silva!

[…]

27 Aug 2018

- **Dr Lopez:** [photographs a form needed to send the Duralay® pattern to the laboratory for casting] -to share with your students in OneNote.

Note. Data from field notes translated into English.
[x]= bracket descriptions of shared images and emoticons included within the chat conversation.
Duralay® pattern correspond to milestone 2 (seen previously in *Table 10*).

Besides this informal conversation through WhatsApp, where tutors shared part of the intervention, during the focus group they were also engaging with other tutors. They

brought screenshots to the focus group and generously shared their experiences and perceptions of the intervention with one another.

The actions of tutors in relation to the use of the online platform influenced the perceptions of students about the use of the it. As one student, part of Dr Reyes' group, said:

> According to me what my tutor was doing trying to upload things to the platform, it was very difficult, because in fact, at least our tutor made us drawings and at one point, then she tried to draw us something on the iPad, but she couldn't manage it (Carlos, S07, gG, FG[24])

This comment suggests that if the tutor found it difficult to use OneNote this 'barrier' was transmitted to and felt by the students. This offers a possible explanation of the association between a low participation group of students (see in 7.5) with a low activity showed by their tutor as described here. However, it is noteworthy that the tutor's contributions to OneNote, or the use of the platform, did not influence the demonstrations they provided to their students. Tutors used traditional drawings with pen and paper, models, jaws, and previous work to demonstrate procedures to their groups of students. However, their groups did not have access to the benefits described for other groups of students, whom all had additional support from the content that tutors shared online.

8.2 Tutor demonstrations

Before starting a new stage of the procedure, each tutor conducted a demonstration for their tutees. Whenever possible, tutors conducted the procedure directly on the phantom head and sometimes they used models and drawings to aid their explanations. Each demonstration was conducted once when the first student in the group finished a stage of the procedure, meaning that the student who worked fastest got the demonstration on demand. The other students needed to stop their work and see the demonstration in advance of their subsequent work. In a demonstration, the tutor asked their students to

[24] (Student pseudonym, group, source). g = group, FG = Focus Group, FT= Final Task, I = Interview, FQ = Final Questionnaire)

get closer to her and to attend her explanations, as shown in Figure 47. When the demonstration finished the students continued with their work.

Figure 47
A tutor giving a demonstration

Note. Tutor demonstrating the use of the acrylic to fabricate a custom-made post and core. (Milestone procedure number 2, see Table 10).
Tutor wearing a white scrub, and students in blue.

The intervention provides the opportunity to record part of the demonstration (i.e., photographing or drawing with the Apple pencil directly in OneNote) and make it available for later review. An example of a tutor using the App on the iPad to complement her demonstrations is shown in Figure 48.

Figure 48
A tutor given a demonstration using photographs on the iPad

Note Tutor using OneNote through the iPad provided for the intervention. Photographs that are shown to explain are immediately available on students' own devices after the demonstration.

8.3 Tutor role within the intervention

As mentioned earlier (see in 6.2), tutors considered within the present research all possessed a background in education. This was based on the training offered by the institution or the postgraduate programmes they had followed. This is an interesting point to have in mind when considering the richness of the discussion about the learning and teaching process during the focus group.

Additionally, the language they used to refer to their students indicated that they took ownership and duly engaged with their students' achievements. This was also evidenced with what Dr Fuentes shared online when all her students accomplished the acrylic pattern and sent it to the laboratory (see 7.4.3, Figure 42) and the way all of the tutors referred to students in their group (i.e., my students, my group, mine) showing a sense of belonging and responsibility to the work the students had undertaken.

Talking about the role of the tutor on the use of the application during the focus group with other tutors, Dr Reyes, who did not participate actively online, mentioned:

> …I do not know if I understood it well; I felt that the idea was that we did not intervene much; thus, it (the intervention) would flow naturally. However, as the

> activity developed, as Dr Silva said, I thought our intervention became substantial (Dr Reyes, FG).

Then she highlighted what she thought their role should be to prompt the functioning of the educational intervention, saying:

> I think it is crucial that we participate, that we take the time (to participate). I even believe that that this time should be included within the session because sometimes we are fixed on time within the sessions and doing many different things (simultaneously). Thus, it was then when one put aside this tool, despite believing it is beneficial (Dr Reyes, FG).

Interestingly, even though Dr Reyes did not actively contribute to her 'corner' in OneNote, her comments suggested she was aware of the contributions made by her students and the possible benefits they had. She argued:

> ...However, as I said (referring to a previous opinion), I think we are achieving something that, as Dr Lopez said, we are forcing them (the students) to reflect. Therefore, we are getting them to reflect on a procedure, and we never asked them to reflect before, (usually) they went to the clinic and were mechanics... (Dr Reyes, FG).

Thus far, Dr Reyes recognised her role as a tutor promoting students' reflections through the intervention. However, she did not act accordingly as she believed it was not required. In her comments, Dr Reyes agreed with Dr Silva, and Dr Lopez, who are tutors from HP groups (see 8.1), and they described their actions in relation to the benefits their students could obtain. For example, Dr Silva described how her role as a tutor determined how the intervention worked within her groups of students. She mentioned that in one group she had a student who did not participate in the intervention. However, during demonstrations Dr Silva recognised she should integrate this student, allowing him to see her drawings and the photographs she selected in order to provide feedback to the entire group. She stated:

> …whether [the intervention] is individual or not will depend on our actions (as tutors) because I tried to review all the photographs the students uploaded, sharing them with the group. Additionally, I let them know that I had made a summary with photos from different students. It was not the sequence of a single case, but I used ideas from various students to highlight both good and bad things, sharing mistakes committed and their solutions. Therefore, all students could access the same information.
>
> In this way, during the practical examination, students would have more resources to solve any problem alone and not with our guidance (Dr Silva, FG).

8.4 Teaching and learning processes in relation to the intervention

8.4.1 General overview of teaching and learning affected by the intervention

Tutors recognised that students engaged with the activity, and according to them, moving from the mechanical work to having an understanding of what they were doing was the main shift in students' practices because of the intervention. In their own words: "Students understand what they did, and they will apply it differently" (Dr Reyes, FG).

And Dr Silva complemented: "Students understand what they are doing. Because, without this (intervention), students could have excellent motor skills and do it (the procedure) mechanically without really understanding what they were doing" (Dr Silva, FG).

Additionally, even if the student only took photographs, tutors agreed that the activity was beneficial for them. They mentioned that they commonly observed their students taking and using photographs during their preclinical practices. Tutors highlighted that their students' used photographs to improve their memory, to be more critical about their own work, to guide their procedural development and to share experiences with their peers. This suggested that the action of taking photographs triggers students' reflection, independently of the additional part of the activity (i.e., sharing photographs, comments, and reflections). The following excerpt from the focus group clearly evidenced this:

> **Dr Fuentes:** - 'When I was reviewing the contributions of all my students, they mostly took and shared photos. I already think they took photographs to have a record, a memory aid. I believe that this is also what I saw in the comments they shared.'
>
> **Dr Lopez:** - 'Yes (agreeing to what Dr Fuentes mentioned), the students supported their work from the photographs and became more perfectionist when it came to the clinical procedure itself. They focused on obtaining good photographs with the right angles and the right preparation width'.
>
> **Dr Silva:** 'Students tried to show good work ...so that the width could be seen and ... It made them observe their preparations with a more critical eye. (For example, one student mentioned) - No, I can see the inclination on this side, ah ... maybe I'm missing something"- and they went (back to their workstation) and retouched their work to make it look better for the photo.'

Then, the conversation turns to how they perceived the students used the activity; Dr Lopez focused on peer motivation, mentioning: "Deep down, if they saw a peer participating in the activity, there was automatically a kind of group motivation to contribute to that. And basically, to express their own experience within the clinical procedure (Dr Lopez, FG).

This was complemented with a view from Dr Diaz, from a low participative group, who nevertheless mentioned that:

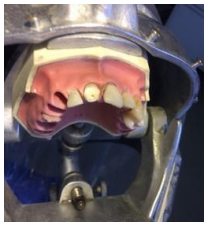
> My students participated sufficiently in the first part, taking photographs. Later they made very few comments, almost none in fact. But then I observed what they said to each other; it was very private for them, as they took their photographs and showed them to some peers. They heavily supported their work on their photos.
>
> There were very few reflections, but a situation caught my attention when we finished the intervention and continued with the following procedure next session. One student arrived, and when she was going to start working, she mentioned: "I missed OneNote, I had used it as a guide (Dr Diaz, FG).

8.4.2 Tutor's perceptions of their roles in students learning

A common view among tutors was that students attributed value to the tutor's actions and comments. Dr Araya had selected a couple of her own examples, but she decided to share one of Cristina's. She then proceeded to read what was on Cristina's One note page (see Table 35).

Table 35
Dr Araya´s screenshot

Original taken from Cristina's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
20/08		Preparación de conducto con fresas pesso previo desgaste periférico.	Se puede observar una caja por vestibular debido a que dentro del conducto se rompió una fresa redonda. En esta etapa para procedimientos futuros tendré en consideración el mejor manejo de las fresas gracias a la retroalimentación de la doctora quien me recalcó que debo entrar y salir del diente con la turbina encendida.

Translation

Date dd/mm	Photographs	Comments	Reflections
20/08	{entrance of root canal prepared in the right central incisor}	Root canal prepared with Peeso Reamers, before undertaking the crown reduction.	It is possible to observe a vestibular box because a round bur was broken inside the canal. At this stage and in future I will consider the best handling of the burs. Thanks to the feedback from my tutor who emphasised that I must enter and leave the tooth with the turbine on.

Note. The excerpt was taken from Cristina, S36, gA, OneNote page.

Finally, Dr Araya added:

> She [the student] made a reflection about what was going on. Because what I did in fact, was to take photographs and upload them there [Tutor's corner] and commented on the reasons behind what the picture showed [as in this case] (Dr Araya, FG)

The reflection shared by the student revealed how she was using the information shared by Dr Araya (in her corner) to prevent future situations such as the one she had

experienced during her practices as described in her reflection (in Table 35). Dr Araya highlighted how her comments online influenced her students' reflections by adding to the screenshot when she sent it later to the researcher:

> I sent this reflection because I like that the student has learned from another student's mistake. This situation was raised through OneNote (tutor's corner) with the corresponding advice to prevent it from happening again, and the student took it on board as if it were her own reflection (Dr Araya, commenting on her screenshot)

Another example was shared by Dr Silva, who selected a screenshot from Soledad (see Table 36).

Table 36
Dr Silva´s screenshot

Original taken from Soledad's OneNote Page

Fecha dd/mm	Fotografías	Comentarios	Reflexiones
16.8		La Dra. realizó un desgaste en la pieza a trabajar simulando un "trauma recibido" por el "paciente".	Esto lo hace más parecido a lo que podría pasar en clínica, eso me gusta.

Translation

Date dd/mm	Photographs	Comments	Reflections
16.8	{irregular cut simulating a fracture}	The tutor wore the tooth simulating a "trauma suffered by a patient".	This makes it more like what could happen in a clinic; I like that.

Note. The excerpt was taken from Soledad, S28, gH, OneNote page.

When explaining it during the focus group, Dr Silva said:

> The point that stands out for me is to see whether things we usually do and get used to doing impact upon our students. For example, a very simple act I think we

all do … [which is within the reflection in Soledad's OneNote page (see Table 36)] (Dr Silva, FG)

Dr Silva spotlighted the sentence "a trauma received by the patient", and added: "Surely, we always comment that it is positive feedback… We sometimes forget that we are in a simulated environment, and it is not merely a preclinical work. Therefore, it is our role to bring students close to the clinic" (Dr Silva, FG).

8.4.3 Recognizing the role of the students' emotions in their performance and understandings

As mentioned before, because of the low and active participation from tutors identified during the intervention, a screenshot of one of their student's contributions was requested from each tutor to prompt discussion during the focus group (see 4.4.6). To obtain the screenshot, tutors were requested to read through their students' pages in OneNote and to select one that grabbed their attention and that they would like to discuss with their fellow tutors.

While reading their students' comments, tutors valued the emotions that students had expressed. Tutors then discussed how student reflections emerged from their experiences and how emotions play a particular role in determining student understandings. From the focus group conducted with tutors, it was possible to recognise how students mentioned negative emotions (i.e., frustration, distress, fear, lack of self-confidence, anxiety) and moreover recognised how their work was affected by them. It also represented how students controlled these emotions and the role of tutors in helping them to understand what had happened and thus reduce the negative feelings.

Dr Fuentes suggested that there are students who considered and managed their emotions while others ignored them. However, according to her, tutors do not normally take them into account. Dr Fuentes particularly highlighted examples from two of her students, a male and a female. In her own words: "I want to contribute to the discussion about reflection, mentioning that when talking about our students' emotions, we did not do too much" (Dr Fuentes, FG).

The first example she selected was: "One of my students… a male wrote: 'I do not consider my emotions; they are complicated for me'…" (Dr Fuentes, FG)

And the second example:

> Other female student, when writing about her emotions, added:
> [My emotions often played against me, often failures prevented us from moving forward, because they generated moments of anguish, insecurity, and anger among us. As well as joy, trust, passion for the profession, the approval of our teacher and the way she treated us, it made us move faster, we put more effort into it (the practices), etc… and I think in these practices I have been involved in both situations]
> …So, I believe that emotions are a topic which we need to consider when dealing with our students (Dr Fuentes, FG).

Dr Reyes commented further by adding:

> Their reflections started from their emotions. I think it is an important aspect to consider. It is like when you ask them for a reflection, they talk a lot about their emotions, and that connects them to the learning itself (Dr Reyes, FG).

Dr Silva noted that if students were able to explain what happened, they could control their emotions. She exemplified this by quoting one of her students "who failed to perform an antirotating groove, who wrote: [Even though I did not get the groove, I was not disappointed by what I had done, because clinically it is something that can happen, for example, because of caries]" (Dr Silva, FG).

Dr Lopez selected another example that complements Dr Silva's observation. She mentioned: "I had one student in my group that always mentioned [on OneNote] how he arrives to the session" (Dr Lopez, FG). She summarised what her student shared: "[I'm in good spirits today, but I'm stressed, I am tired, etc.]' (Dr Lopez, summarising how her student shared and described how he arrived to the session)

After presenting the example, Dr Lopez highlighted how the student described his emotions and how they felt when finishing the procedure.

> [the finished work was quite rewarding, seeing that I was able to move forward and not be late, although I should have improved regarding the attention to the instructions and not let myself be carried away so much by my moods. Adopting

a more positive attitude when working] (Dr Lopez reading the screenshot she took, FG)

Then she added her opinion about that: “What is important here [in the example presented] is that their motivation to work depends on their state of mind and their willingness to work” (Dr Lopez, FG).

8.4.4 Instances of checking and correcting student understandings.

Each page in OneNote was developed as a personal space, albeit accessible to be read by peers and tutors. Dr Lopez mentioned that she missed being: “Allowed to comment on my students’ contributions, because you sometimes saw things they wrote that were not totally right” (Dr Lopez, FG).

As an example of these situations, she mentioned a quote from one of her student’s contributions, and Dr Silva reacted, agreeing that the situation described would be disgusting for a patient: “Next time, to avoid a foggy mirror, you can add soap and water to it and then avoid drying it each 5 seconds” [Dr Silva: Yuck!]” (Dr Lopez, FG).

Following the topic, Dr Lopez mentioned that she used those tips to have a conversation with her students. However, she had concerns about students leaving these comments online without correcting them as they could be referred to later (and taken as best practice if not challenged). For this reason, she suggested that it could be beneficial that tutors be allowed to comment on students’ contributions to amend possible mistakes. As was mentioned before and evoked by Dr Araya: “Whoever arrives late might read this and believe that's how it's done” (Dr Araya, FG).

However, when tutors discussed the possibility of providing feedback for each student’s comments during the session, concerns were raised about the time available for this. Additionally, they considered this regularity of feedback could be controversial as it would also mean making the activity compulsory. They suggested that doing so may affect the quality of the reflections as they started from being out of personal experience influenced by students’ emotions. Therefore, having regular interventions from tutors and the pressure of a compulsory activity could affect the richness and candidness of students’ reflections.

Tutors agreed, therefore, that the best approach was to comment in the tutors’ corner instead of invading the students’ personal contributions. However, they also mentioned

that tutors need to constantly read their students contributions so they could understand how their students understood the process. Finally, all agreed that it would be beneficial to talk to them personally when they understand something incorrectly and encourage them to edit it, instead of reviewing and commenting on them one by one. Additionally, they mentioned that leaving those comments on the tutor's corner will help the student to correctly remember the details.

8.4.5 Considerations about assessment

Assessment was a controversial issue when tutors discussed their practices. They all agreed that with the intervention higher order thinking processes were activated. However, they recognised that students' practices were focused largely on memorisation. They identified that both theoretical and practical assessments are based on memorisation. For theoretical assessment, students need to recall and repeat what they have memorised to answer the questions. Likewise, for the practical one, they need to mechanically repeat what they have practised during their practical sessions (for details, see 6.6).

In words from Dr Soto:

> ...Where I see we have not changed is in the way we ask the questions. We continue asking questions that are solely based on memorisation… On the one hand, we are teaching at a higher level, but deep down, at the time of evaluating, we are at a basic level. Because, if you analyse… in the theoretical examination 80% or so of the questions required a recall in memory... We have been changing the questions, but the level (of assessment) is not consistent with what/how we are teaching (Dr Soto, FG).

Additionally, it was suggested that what is needed is a change in the ways students are assessed and how tutors understand assessment. For example, they mention that they need to value the assessment of the process. Commenting on this, Dr Reyes and Dr Araya had the following conversation during the focus group:

> **Dr Reyes -** Sometimes, we may not give as much validity to the theoretical examination and other evaluations. What happens is that we have established that we evaluate with the theoretical examination, and it is not necessary -

Dr Araya: -We also evaluate the process-

Dr Reyes: -Maybe this (the intervention) is an assessment too-

According to tutors, students in their practical assessment repeat what was explained to them mechanically. Tutors recognised that this kind of assessment encouraged students to learn in a way that is mostly orientated towards grades. They explicitly noted that "it is something we owed to our students" (FG, Dr Lopez). This suggested that further improvements in the assessment process would be beneficial for the approach students take during their practices.

8.4.6 Feedback through the platform enhanced by the intervention

Tutors highlighted that in their practices providing students with appropriate feedback was an essential element of their role. They shared the common practice of providing group feedback to their students, in addition to the initial demonstrations which had already been presented. The frequency of this group feedback varied between tutors and depended on what they considered pertinent to be shared according to the experiences of their students.

While they mentioned that they did not notice a big change in their practices, the technological enhancement provided students with further resources. When talking about the feedback provided, Dr Araya said:

> It also makes everything easier, leaving the mistakes recorded. Sometimes, students forget (what they did). Instead, there (OneNote), I wrote them the reasons behind things or highlighted what they needed to avoid. At the bottom, the reflections include that…things in which they were wrong (Dr Araya, FG).

Dr Silva complemented this as follows: "That is what we regularly do, but that they have the possibility to repeat it, reassess it, and review it again is valuable to them" (Dr Silva, FG).

8.4.7 Visualisation

Apart from the use of photographs to communicate among peers, tutors found that the use of photographs also improved the quality of the image they used to explain to their students. They recognize that they usually draw to explain things, but that

photographs improve the level of detail of what they want to communicate. In their own words:

> I see the intervention as it is, and it is invaluable. Because we all do different drawings and diagrams (to explain the procedures to the students). It is different to see it (the details) in photographic form, and there are some really good photos, which show it even in three-dimensional form. They (the students) took different angles, so we can show a lot more (than a drawing or diagram). It was really enlightening! (Dr Soto, FG).

8.4.8 Perception of time

As mentioned previously for students (see in 7.2.6), time concerns affected the development of students' practical sessions.

Tutors recognised the issue of doing the demonstrations on demand according to the first student who finished an action. This situation impacts upon the students who are behind, who need to stop what they are doing, and listen to instructions that are not yet familiar or immediately relevant to them and then go back to continue with their work. Later, when the student needs to perform, they had already seen the demonstrated action, needed to recall the demonstration given to them when their peers were ready to proceed. This situation was overcome partially with the intervention, as the students who were behind had retrospective access to the content. However, some tutors pointed out that it is needed to create a methodology where all the students work at the same rate/time, as time is a serious concern for students left behind.

Dr Soto pointed out that they did not know if the students would have time to check the content. However, all agreed that the possibility of register demonstrations was valuable for their tutees' work. It is the role of the students to study, analyse and learn from the content shared by their tutors and peers.

Another point of discussion was the possibility of reviewing the stages and rethinking the scheduled actions for each taught session the students experienced. All tutors agreed that time was a concern and that it was not always possible to anticipate whether the students who was late would have read or even accessed OneNote later.

8.5 Summary of the chapter

This chapter presented the experiences and perceptions the tutors had with the intervention. Those experiences and perceptions varied among tutors similar to those of the students described in the previous chapter. Two groups of tutors were distinguished. Firstly, five tutors actively participated in the activity by:

1. Sharing examples in their corners (e.g., sharing photographs of the procedures and commenting about them).
2. Encouraging their students: to participate
3. Interacting with other members of the staff, supporting the use of OneNote, and sharing experiences.

On the other hand, the second group of tutors rarely used the application and did not alter their practices because of the intervention. However, tutors agreed on the benefits the intervention had on their students and on the fact that having some students working behind schedule was an issue that needed to be considered when evaluating the unit design. They highlighted that when students engaged with reflection and the activities included within the educational intervention, they **moved on from the mechanical repetition** of procedures, focusing on understanding what they were doing. Additionally, tutors highlighted the use of photographs: **improving students' memory,** helping students to be more critical toward the procedures, and guiding students' work. In the same vein, tutors later highlighted access to the content (i.e., students' and peers' contributions and tutors' contributions) for those who worked behind schedule. According to them, the visual record of the procedures allowed students to reassess and review the content whenever they needed.

Additionally, the intervention served tutors as a tool to **check their students' understandings** and to **value their own practice and role** as tutors in developing their student skills. They emphasized their role in **connecting the preclinical work with possible real scenarios**, considering their students' emotions and how their behaviour influenced them.

Finally, while the benefits were clear, it was not recommended to make the activity compulsory; as according to the tutors, it could affect the richness and candidness of the students' reflections.

Chapter 9 Discussion

This research acknowledged the theory and practice gap in dental education, especially in the transition from pre-clinical to clinical courses, and difficulties acquiring reflection skills in the early stages of trainees' development (see 1.1). Consequently, an educational intervention using photographs taken with mobile devices to encourage reflection in dental education and its impact on developing professional knowledge and skills in future dentists was investigated. The objectives were:

1. To design an intervention that promotes reflection in dental pre-clinical practices based on previous experience of the researcher and the available literature.
2. To study the impact of the designed intervention on the learning and teaching process in relation to the theory and practice gap.

To accomplish the objectives, this research followed Design-Based Research (DBR) which allowed the study of an educational intervention from a social perspective, providing deeper understandings of learning situations and relationships between participants. Consequently, this approach helped explain how the educational intervention worked, for which students it worked, and under which conditions it worked (see 4.2.2). DBR implemented within this research considered three phases (see Figure 10). The first phase determined the preliminary design framework (see in 5.2), based on the researcher's previous experiences and interactions with students and colleagues, the context, and the literature. This was followed by a prototyping phase which consisted of two cycles, i.e., Pilot Study (see 5.3) and the Main Study (see Chapter 6, Chapter 7, and Chapter 8). The final assessment reflective phase was conducted to answer the research questions, which will be presented in this chapter.

The research questions considered were:

RQ1: How does Design Based-Research inform the design and enactment of the educational intervention?

RQ2: What are the students' experiences and perceptions about the impact of the educational intervention on the teaching and learning processes?

RQ3: What are the experiences and perceptions of the tutors about the impact of the educational intervention/ reflective practice on the teaching and learning process?

This chapter summarises the key findings, followed by a detailed discussion concerning the research questions they addressed. First, general aspects of the intervention design, implementation, participants' profiles, and general contributions are discussed to respond to the research question 1. Following this is a broad examination of students' experiences and perceptions, considering the skills developed during the intervention, the issues that affected their skills development, as expressed in research question 2. Third, a discussion about tutors' participation and their role within the teaching and learning process considered by the educational intervention, which delineates the answer to research question 3. This chapter ends with a proposed model integrating the benefits of the designed intervention into the teaching and learning process of dental students.

9.1 Key findings

The results of this study indicate that the design of the intervention using Design-Based Research was plausible and allowed improvements during the cycles (i.e., insights from the Pilot Study to be applied during the Main Study). The Pilot study firstly corroborated the feasibility to apply the designed intervention. This first stage provided evidence to support the idea that dental students are capable of engaging with reflection when progressing in their programme. In the same way, students collaborate with their peers and learn from them. However, the programme did not provide appropriate opportunities to encourage reflection explicitly, and therefore the pedagogical potential of integrating theory and practice was not as visible as one might have expected. Secondly, this first cycle of implementation valued the role of tutors in preclinical practices, allowing improvements in the intervention design by adding a dedicated space for tutors to support their students' practices (i.e., tutors' corner). Additionally, preliminary evidence of the impact of the intervention in student learning allowed the researcher to obtain institutional funding for the acquisition of mobile devices (iPads) to support the implementation of the intervention. Finally, the Pilot Study provided evidence to support the use of OneNote in mobile phones and iPads. These devices provided an accessible platform to develop the collaborative aspect of the intervention, as their usage did not require specialised technical support or the development of additional skills, rather than following general instructions provided by the researcher.

In the main study, the participation of students and tutors varied, but nearly all reported benefits from it. Tutors' participation influenced how students perceived the intervention and used it accordingly. Furthermore, it was found that students focused

their motivation and involvement in the intervention in relation to obtaining better grades (see in 6.5.2). Thus, this observation motivated a deeper analysis of the programme and instruments used to assess students' skills acquisition. It is not surprising that this analysis showed a focus on summative assessment in many opportunities (i.e., unit syllabus, introductory practical and theoretical sessions) and pointed out the need to review the order of curriculum content in order to facilitate students' connections with future clinical practices (see in 7.4.3).

According to tutors and students, encouraging students' reflection during their practical experiences was perceived as beneficial to their understanding of the studied procedures. In the same way, tutors anticipated that the skills students developed through the intervention, such as improved memorisation, critical thinking, self-assessment, communication, and management of emotions and time, could help them transition into their clinical practices (for details, see Chapter 7 and Chapter 8).

Understandings of students' simulated practices in the Clinical Skills Laboratory provided evidence for strategies to offer subsequent cohorts enhanced training. For example, concerns about time pressures were identified among students and tutors and analysed in detail, providing a starting point to suggest improvement in the unit first and in the programme afterwards, such as improvements to sequencing content and evaluate the session's timetabling.

Tutors perceived their role in the intervention as valuable through considering students reflections in OneNote (see in 8.4.2). Additionally, tutors showed commitment to their group's development and collaborated with colleagues to get the most from the intervention.

Incorporating the views of the participants and the understandings gained through the research helped improve the design of the educational intervention and suggested even further refinements for future use.

The following sections address each of the research questions in turn.

9.2 RQ1: How does Design Based-Research inform the design and enactment of the educational z?

In this section, the evidence presented in Chapter 5, regarding the prototype (5.2) and results from the implementation of the pilot study (5.3), will be integrated with results

from the main study presented within Chapter 6, Chapter 7, and Chapter 8, in response to research question 1.

DBR was a valuable approach to follow within this research, as it allowed the development of the decision-making process (Abdallah & Wegerif, 2014; Barab & Squire, 2004; Herrington et al., 2007). The cyclical processes involved within this research (i.e., design, implementation, evaluation within the pilot and main study) allowed for modifications to best fit the research context, and making these modifications for each cycle improved validity and reliability (Barab & Squire, 2004).

The intervention design took a multiple theory perspective allowing different theories to complement and justify the design and implementation of educational interventions (Mukhalalati & Taylor, 2019). Similarly, a study in the area of Health Professions Education reflected on the use of DBR in the "development of a teaching portfolio for stimulating teachers professional development within the context of higher education" (Dolmans & Tigelaar, 2012, p. 3), considering the importance of theory to inform decisions within an intervention.

The theoretical framework allowed explanations, which are complemented with detailed considerations of the context, interactions, and analysis of the findings to inform and redefine the design of the intervention. Thus, andragogy (see 2.2) contributed to portraying dental students as adult learners and applying some characteristics attributed to them into the intervention design. In general terms, adult learners are self-directed human beings, using their experiences as a source of learning, and orienting their efforts to developing their social roles and performances. Social constructivism (see 2.3) provided the lens for understanding learning as a social construction influenced by the sociocultural context and as an activity centred on the student. Consequently, the theory behind reflective practice definition (see 2.4) and peer learning (see 2.5) considered the social aspect of learning and were applied to the design of the educational intervention. For example, as will be discussed later (see 9.2.3), assessment culture within the institution (sociocultural context) affected how participant students used the product of the intervention (i.e., contributions in OneNote), highlighting active participation and access to the application close to their practical evaluation.

The development of the pilot study itself contributed to the value of education as a social enterprise rather than as a biomedical subject. This is an important aspect pointed out by Ringsted et al. (2011), who highlighted that research in Health Professions

Education orientated toward highly standardised interventions and dominated for positivistic philosophies. The latter are found, for example, in studies of the efficiency of drugs or technical procedures common in medical fields (Dolmans & Tigelaar, 2012; Ringsted et al., 2011) as familiar to the researcher. Therefore, insights from the first cycle contributed to the development of the research underpinnings and moreover provided evidence to support the intervention design under a socio-constructivist approach (see in 2.3). This approach helped design an intervention which promoted strategies of communication and memory, considering that learning does not occur in isolation (Andrews, 2012; Watson, 2001)

9.2.1 Improvement throughout the cycles

Based on experiences from the pilot study, the design was improved by adding more significance to the tutor's role in developing the intervention. This decision was because the observation of the practices did not provide enough evidence to support the response to research question 3 regarding the tutor's experiences and perceptions. Therefore, a more profound consideration of tutors' role as mediators of students' environments (Brooks & Brooks, 1999) was taken into account. Thus, 'tutors' corners' were incorporated as part of the design and became part of the data collection methods (see 4.4.7). They provide evidence about tutors' engagements with the activity and allowed further analysis into the development of the intervention online. Additionally, this action considered one of the recommendations from student participants about improving the integration of tutors into the intervention (see 5.3.4.3). Consequently, this change in the intervention design positioned the intervention within normal preclinical activities rather than as a complement to them. It is noteworthy how this change turned the focus of the intervention into a teaching and learning process rather than an isolated activity with new technology from a group of students. This issue supports the idea of 'technology invisible' (Cobo & Moravec, 2011; Sanchez, 2000), which focused on the learning and teaching process and the development of pedagogical activities rather than using technological devices. In this case, the use of mobile devices to produce photographs of different procedures promoting reflection in dental students.

Furthermore, actively incorporating tutors in the educational activity resonated better with the socio-constructivist approach (see 2.3) under which the intervention was designed. Tutors actively being part of the intervention allowed for more social interactions that ultimately contributed to the teaching and learning process and the

researcher's understanding about how, why and for whom the intervention worked as it did.

In the same vein, a new approach to gathering data and constructing the narratives (see 4.5 and 5.4) was developed as a result of the pilot study. This allowed the researcher to focus interest on previous results and improve data collection methods. For example, as students concentrate on using the intervention through benefits related to the practical examination (see 5.3.3), an alternative way to collect information from students' accesses and contributions to their pages was developed (described in 4.4.7). Consequently, the data collected provided richer evidence during the main study, allowing evaluation of the influences of the existing assessment culture within the institution through the development of the intervention (further discussed in 9.2.3).

Summarising, when considering the results from the pilot study (5.3.3), there were technical and theoretical aspects that were improved. Firstly, the development of new strategies to collect and analyse data contributed to a better understanding of the teaching and learning process, as described previously. Secondly, the researcher's interpretations of the intervention were developed, which is a clear application of the reflexivity (see 4.6.3) needed to improve the design of the intervention through the cycles. What follows is an account of each of the research foci of interest, meaning that insight from the pilot study was incorporated into the main study and contributed to the development of the intervention.

9.2.2 Student's engagement with reflective practice

The intervention considered third year dental students and their tutors. Third year students were the appropriate participants as they had previous experiences to reflect on and are close to the transition to clinical practice, so oriented their reflections toward this process. Similarly, Jonas-Dwyer et al. (2013) found it worthwhile to introduce reflective practice to third year students, based on the quality of the comments they shared when reflecting about their first clinical encounters. Furthermore, considering the benefits of reflective practice described by students and tutors (discussed later in 9.3 and 9.4), its application seems worthwhile in the earlier stages of the education of dental students as suggested by previous research (Boyd, 2002; Koole et al., 2013). For example, Boyd (2002) conducted a pilot study with sixty-nine first-year dental students reflecting on their early didactic and clinical experiences. She found that through reflective practice, students connected the didactic material with their clinical experience, viewed themselves as

future clinicians, and expanded their understandings about the nature of dentist-patient interactions. Additionally, as a result of reflective practice, the educators had an additional opportunity to identify students' misconceptions about concepts (ibid), as this current research also did.

This research investigated the level of engagement with the reflective thinking the students had in order to contribute to the understanding of the profile of the students. For this purpose, the Reflective Thinking Questionnaire (RTQ) (Kember et al., 2000), which incorporates four subscales (i.e., Habitual Action, Understandings, Reflection and Critical Reflection), was utilised (see in 4.4.4). According to result scales from the questionnaire from the pilot study and main study, higher levels were obtained in Understanding and Reflection, followed by Critical Reflection and Habitual Action (see 5.3.3 and 6.3). Moreover, there was low variability among students in the four scales, expressed in terms of the standard deviation. These results reflect those of Tricio et al. (2015) with dental students from different cohorts and those of Kember et al. (2000) with students from different health science professions (i.e., occupational therapy, physiotherapy, and radiography nursing). These findings were not surprising considering the conceptual descriptions of the RTQ, as students are not yet sufficiently expert to perform at the habitual action dimension, and critical reflection is sometimes defined as complex and as being a 'difficult, lengthy and often painful process' (Kember et al., 2000, p. 391). Correspondingly, Schön (1983) suggested that an expert in any discipline performs some actions like 'riding a bike'. In these cases, repetition of the same action leads to the expert being able to master an action and perform it without thinking. In the same vein, the reaction expected by a nurse when confronting a patient in cardiac arrest, where the immediate response "would be to call a code, without conscious thought" (Lethbridge et al., 2013, p. 321) is indicative of habitual action. In the case of dentistry, this happens with the development of motor skills, for example, an expert dentist using the handpiece to prepare a tooth.

The results showed that students engage with reflection (see 6.3) and that reflective practice integrated into preclinical practice was beneficial (discussed in the following sections). These results confirmed that the intervention contributed to the solution of the research problem (see 1.1). That is: current educational practices underutilised reflection as a teaching strategy in dental education (Boyd, 2002; Woldt & Nenad, 2021) which suggested deeper consideration of the advances in education in other health professions, especially in nurse education. When clinical skills are considered, simulated practices have

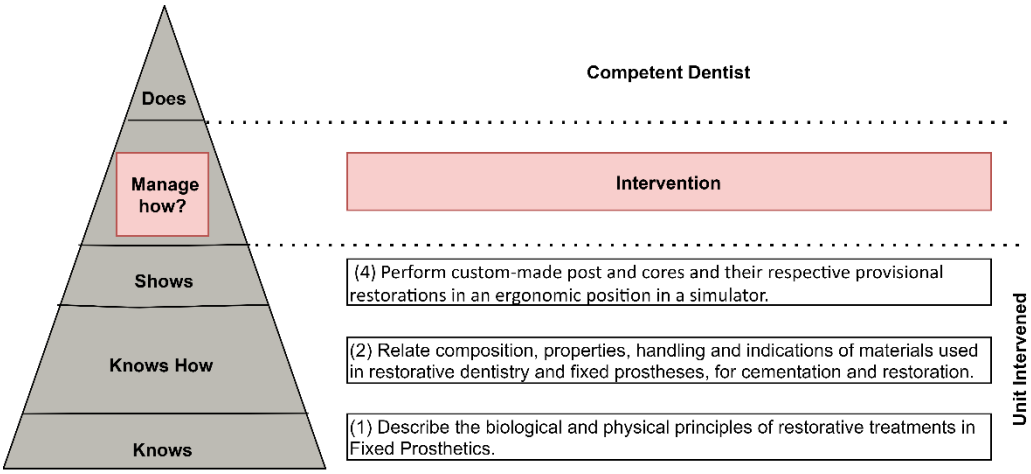
been widely studied in nursing and have considered reflection as an important constituted stage of the learning process from simulated practices (Higgins et al., 2020; INACSL Standards Committee, 2016), as the preclinical practices considered within this current research. However, as discussed later, tutors recognised that third year dental students are trained to reproduce a clinical procedure mechanically. This action seems to be acceptable for the first stage of motor skills acquisition in the previous year of training. However, based on the evidence provided by this study and previous research (Bosse et al., 2015; Issenberg et al., 2005; Kobus, 2011), continuing with this approach in students who are close to the transition from preclinical practice to clinical training wasted a valuable opportunity for them to benefit from reflective practice, with which they showed they are capable of engaging.

9.2.3 Influences of assessment practices in learning and teaching

Figure 49 illustrates the learning outcomes in relation to the intervention and locates the intervention as a connector for future performance of students as competent professionals. As was presented in the literature (see 2.7), the acquisition competencies are at different levels (i.e., cognitive, affective, and psychomotor). In the case of the intervened unit the learning outcomes (LOs) were presented in 5.1.4. There, the cognitive domain is stated as: Students describe (LO1) what they need to do and relate this to previous knowledge (LO2). The affective and psychomotor could be found in the LO3 and LO4, which mentioned that students need to conduct determined procedures in a simulated environment in an ergonomic position. However, if students repeat what they do without reflecting on their practices, they obtain only a mechanical repetition of actions without connecting with future scenarios (as discussed later in 9.4). This is reflected in the assessment procedures considered within the unit (see 6.6). Based on Miller's pyramid (Miller, 1990), it could be argued that students were assessed on the repetition of facts (see 6.6.1) and actions (see 6.6.2) which are not necessarily transferred to the clinical environment (Does, the top of the pyramid in Figure 49). This transference of knowledge requires further skills, like the ones improved within this educational intervention, such as memory (see 7.2.1), critical thinking (see 7.2.2), and emotional management (see 7.2.5). It is therefore argued that an intervention based on reflective practice contributed to the integration of different elements of the curriculum (i.e., disciplinary content, disciplinary skills, generic skills, workplace awareness, and later workplace experience (Barnett & Coate, 2005)), which could result in a better transition between 'theory and practice'.

Figure 49

The intervention contributing to the development of a competent dentist



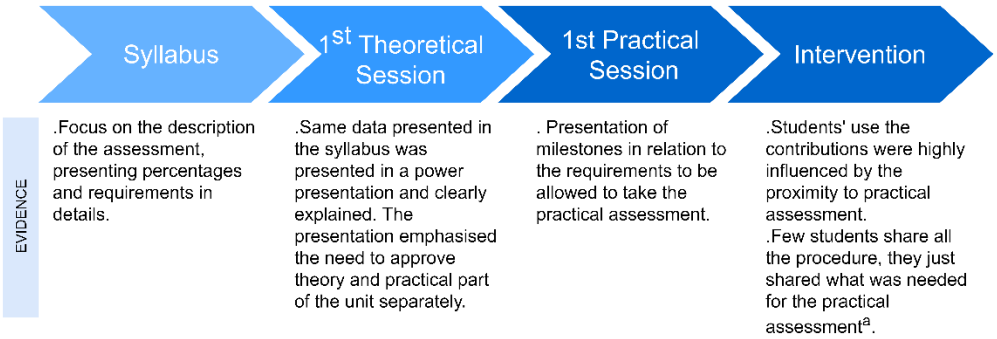
Note. Source: Miller's (1990) revised pyramid by Michael Botelho, presented in the ADEETECH Talk 2020, Presentation: Supporting clinical skills learning online and in-class. Adapted with permission.
(1)(2)(3) represented the Learning outcomes within the intervened unit.
The location of the intervention benefits based on the results of this research.

Results in relation to quantity and type of contributions (see 6.5.1), as well as their development over time (see 6.5.2.1), showed that students engage more with the activity in relation to the proximity of their summative assessments, either practical (Shows, in Figure 49) or theoretical (Knows, Knows how, in Figure 49). Therefore, in the case of theoretical assessment, it was not surprising that the number of photographs the students took correlates with the grades the students obtained in the Mini_Test_1 (see 6.6.3.1). In the same way, previous studies suggest that when teaching focuses on the acquisition of facts, students tend to be more strategic toward learning, adopting mechanical methods of learning (Kobus, 2011), focusing their attention of what they believe is going to be assessed (Gibbs, 2006). Similarly, a retrospective study found that when medical students were allowed to voluntarily attend skills laboratory training sessions they dedicated more time practicing skills they anticipated would be evaluated during their subsequent clinical skills assessments (Buss et al., 2012).

Considering further assessment practices of the dental programme where the intervention was developed, it is noteworthy to highlight the attention given to summative assessment. The study programme presented a description of the undergraduate dental degree, including a general description of all the constituent units. An extensive description of the unit where the intervention was applied (i.e., DMPI-IV) was found in the unit syllabus. Interestingly, the importance of the results obtained by

students, in terms of the grades awarded, was emphasised. The same significance was given to grades during the first theoretical and practical sessions, as illustrated in Figure 50.

Figure 50
Importance given to the grades among unit and intervention development



Note. Summary of the evidence found in different components of the subject (i.e., syllabus, 1st practical and 1st theoretical sessions) and during the intervention.
[a] presented in 6.5.

These observations suggest that the importance given to the grades by students affected their performance and, therefore, their approaches to their practices and the intervention. It seems possible that these results are related to the timing of their contributions (see 6.5.2), where the proximity of the practical examination coincided with the observed increase in the contributions the students made online those days. Therefore, it is important to consider the organisation of the intervened unit and its relationship with students' progression in their curriculum.

In addition, in relation to what was available online (see 6.5.2.2), some highly participative students (HP) suggested making the intervention an obligatory activity by adding an associated summative assessment to it. According to these students, the summative grade could motivate their less engaged peers to participate in the intervention (see 6.5.3 and 7.5.2). These findings reinforce the idea that assessment drives students' motivation to learn. Contrary to the principles assumed by andragogy (see in 2.2), the focus on passing the unit rather than making the most of the learning experiences questions the self-directed attitudes adults have to learn.

In the same vein, Boyd (2002) encouraged the completion of reflective writing by first-year dental students by offering an optional extra credit assignment. This idea differs from other authors, who considered the collaborative construction of knowledge through

social negotiation, not by encouraging competition for obtaining better grades (Kolb, 2015; Nihra et al., 2018). Similarly, Pee (Pee et al., 2002) suggested that formal assessment could even be counterproductive, inhibiting the development of students' qualities and skills required for reflection. Likewise, Curtis et al. (2017), when assessing and appraising written reflection from General Practitioners (GPs) and GP trainees (GPTs), found that summative assessment of reflections resulted in self-censorship, as a consequence for the fear of being judged. The author suggested that GP or GPTs wrote the reflection to meet the assessment criteria rather than to engage with the learning process associated with it (Curtis et al., 2017).

In contrast to those low participative students, it is interesting to consider the case of one student from a group that were not considered in the Pilot Study who asked voluntarily to participate in the full intervention (see in 5.3.1). She thought that the activity she observed on the participating groups seemed beneficial for her learning process. Similarly, a systematic review (Ahmed, 2018) about the usefulness of portfolios to promote reflection in undergraduate medical students highlighted the importance of the students' perceived usefulness of the tool to their later use of it.

9.2.4 Curriculum considerations highlighted by the intervention

Analysing students' contributions in OneNote showed a gap in the organisation of curriculum content. It could be argued that the content included within the unit affected the students' learning process, as they do not have a complete picture of the theory to support their actions. Specifically, third year students did not have the knowledge about root canal anatomy, and root canal treatment is crucial for the preparation needed to conduct the studied procedures (see in 7.4.3). Thus, lack of integration of the curriculum could explain effects on the learning process, and one might anticipate that this could interfere with the transference to real future scenarios (Bugaj & Nikendei, 2016). Therefore, oversimplification (Kneebone, 2009), such as the absence of endodontic treatments to facilitate students' acquisition to motors skills, could lead to superficial understandings in the learner that could affect the cognitive and affective domains.

In the same vein, Bugaj and Nikendei (2016) stated that integration within the curriculum is important to maximise the learning effect of training periods. Consequently, the curriculum must have a sequence that tells the story and represents the learning trajectory for the growth of the student during the education programme, establishing connectivity and interdependence of the courses (Harden & Laidlaw, 2021, p. 67).

9.3 RQ2: What are the students' experiences and perceptions about the impact of the educational intervention on the teaching and learning processes?

9.3.1 The importance of the phantom head conceived as a patient

The phantom head (or mannequin or simulator) was the centrepiece of the teaching and learning activities undertaken in the Clinical Skills Laboratory (CSL). As described previously (see 5.1.6), mannequins hold acrylic jaws within which teeth are placed, simulating possible scenarios to develop students' motor skills and the procedural knowledge required to treat real patients. Therefore, phantom heads are a critical part of the curriculum when preparing students to provide safe treatments on actual patients.

The present study has found that students unanimously recognised that working with phantom heads is essential for their future treatments of patients. These results further support the value that students in Health Professions Education place in these experiential practices without the danger of damaging a real person. Training within the CSL is more than simply practising motor skills; it is also about familiarising students with the future clinical environment (Bugaj & Nikendei, 2016; Dutã et al., 2011; El-kishawi et al., 2021; Schwibbe et al., 2016; Takayesu et al., 2006; Vann et al., 1981; Velayo et al., 2014).

In the same vein, in the CSL, students were expected to behave professionally while developing expertise in pre-determined techniques and at the same time cultivating their identity as dentists. Thus, acquiring and demonstrating reflective skills at this stage of training is essential, contributing to students' future reflections of their clinical skills and capabilities.

9.3.2 Skills development

The findings presented in Chapter 7 showed that students developed memory, critical thinking, the ability to learn from their peers' experiences and to visualise what they are doing and what they want to achieve. Additionally, while reflecting on their own experiences, students highlighted their emotions and concerns about time pressures that affected skills development. Therefore, emotions and time pressures are possible factors that act to the detriment of students' development as future dental professionals. For example, the requirement for a natural extracted tooth, which increased the negative

effects of stress; the need to remember procedures that are not demonstrated to them on demand (for students that are behind).

What follows is a discussion about each of these students' skills that were developed in relation to the intervention and how they improved the teaching and learning process.

9.3.2.1 Memory

Students reported they used photographs principally, and other contributions secondarily, as memory support while completing the procedures during their practical sessions and to study for their practical examination. Similarly, Schwibbe et al. (2016), when studying the acquisition of dental skills in preclinical techniques courses, used Ackerman's Theory (Ackerman, 1988) to support the cognitive workload which is demanded when students are developing new skills (explained previously in 3.3). The use of the intervention, in the same way, could be attributed to the complex procedures studied, which requires the memorisation of different procedural stages in order to perform them accordingly.

Learning involves changes in memory to apply the acquired knowledge in future scenarios (de Bruin et al., 2019; Young et al., 2014). Interestingly, at the cognitive level, a positive correlation was found between the number of photographs students took with the grades they obtained in the first mini_test (see in 6.6.3.1), which mainly required them to recall and enumerate the stages to conduct the procedure.

9.3.2.2 Critical thinking

The literature suggests that the development of critical thinking is required to facilitate the convergence between practical and academic knowledge (Chutinan et al., 2021). This can be facilitated by open-ended questions that help students understand the procedure's outcomes (Bartle & McGowan, 2021). The current research results demonstrated the development of critical thinking by allowing students to connect their preclinical practices with future clinical scenarios (see in 7.2.2.1) and helping them develop the ability to self-assess their work (see in 7.2.2.2). Thus, the incorporation of reflection during preclinical practice helped students to integrate what they are doing with the underpinning theory that supports their actions, but additionally with an understanding of possible real scenarios.

Similarly, a recent systematic review (Woldt & Nenad, 2021) supported incorporating reflective writing as a technique to improve students' critical thinking. They found that reflective writing had a positive impact on student's critical thinking, judgment, and

learning. Additionally, while students develop their capacity to reflect, they improve their problem-solving abilities and increase their motivation for learning, which in conjunction with reflective skills, contributes to their ability to navigate future clinical situations (Woldt & Nenad, 2021).

9.3.2.3 Peer learning

Peer learning (see 2.5) was incorporated within the prototype of the intervention (see 5.2), providing a formalisation of the interactions between students that influenced their learning processes (Boud, 2001). One Note pages were conceived to achieve this purpose. The results posited OneNote as a shared environment where students created a repository of their experiences (see 7.2.3). It was found that students compare their work with the work of others, and they show commitment to their peers by being more perfectionist with their own work (see 8.4.1). Additionally, they benefited from the intervention by feeling engaged and having ownership of the procedures they conducted and receiving feedback from their peers (see 5.3.4.1). Previous research has also reported these benefits from peer learning (Biltucci, 2015; Harden & Laidlaw, 2021; Secomb, 2008; Topping, 2005).

Likewise, students developed their ability to communicate (see 7.2.3) with their peers while assisting them during the procedures and improved communication with non-dental related persons (see 7.2.4.2). This could be associated with the previously described usefulness of photography in the area of dental education presented in 3.5.2. The improvement in communication is also noteworthy because this is an ability that is required for future professional life and is highly encouraged by different dental programmes (see 3.2.1).

9.3.2.4 Visualisation

It was found that students visualise their work with more detail after conducting it and photographing the process, being more critical about their performance (see 7.2.4). These results corroborate the ideas of Partido and Wright (2018), who suggested the use of photographs as a practical method to improve self-assessment of own performance.

Additionally, it was found that students who worked more slowly used their peers' contributions and found them helpful to guide their work. This supports previous research that states that constant mental or physical observation of the processes helps the acquisition of motor skills (Horst et al., 2009).

9.3.2.5 Emotions

Emotions played an important role in reflective practice (see 2.4), however, students did not fully engage in sharing their emotions at the beginning of the intervention (see 5.3.3). For this reason, the final task (see 4.4.8) explicitly asked students to consider their emotions and how they affected them. It was found that either positive or negative emotions could impact positively or negatively on students' performance during practices, and conversely, students' performance impacted their emotions (see 7.2.5). For tutors (see 8.4.3), their students' emotions indicated some remedial actions needed or that the students were progressing well in developing their knowledge and skills (de Bruin et al., 2019).

As coping with emotions is not explicitly trained in the curriculum of medical students (Satterfield & Hughes, 2007), it could be suggested that explicitly questioning students about their emotions, as the current research did, could contribute to their training in how to manage them. Furthermore, this skill becomes especially important because students will face new and demanding scenarios and need to be capable to deal with their emotions.

9.3.2.6 Time pressure

Time pressure is among the most common emotional experiences medical students will face (McConnell & Eva, 2012). Time also concerns dental students, but when analysing the rigid structure of the curriculum, it reinforced the idea of time as a policy decision, as suggested by Vann et al. (1981).

Students (see 7.2.6) and tutors (see 8.4.8) both agreed that time caused them concern about their work, suggesting that it causes stress in the students while conducting their practices. Besides this, they mentioned that the intervention improved their memory. One could connect these ideas to what was discussed by McConnell and Eva (2012) about how stress influenced working memory. Stress caused students to remember better the emotional event instead of broad cognitive connection with it, thereby affecting their capabilities to "transfer the learned information to other clinical setting" (2012, p. 1321).

Although the time issue may cause concern to students and tutors, it could also be argued that learning to cope with time pressures prepares students further for life as practising dentists. Consequently, time management is considered under the competencies needed for newly graduated professionals, as presented previously in the contextual analysis for dental training regulation (see Table 2, in 3.2.1).

9.4 RQ3: What are the experiences and perceptions of the tutors about the impact of the educational intervention/ reflective practice on the teaching and learning process?

An interesting starting point to understand the perceptions and experiences of participant tutors within the intervention is their background in education. All of them have vast experience as supervisors, even some have postgraduate degrees in education-related topics (see 6.2). This is contrary to previous research, which stated that health profession educators often lacked a background in education (Bartle & McGowan, 2021; Hu et al., 2015; Mikkonen et al., 2018). Therefore, knowing their background helped to explain their understandings of their roles, and how, according to them, the intervention worked with their students (Jippes et al., 2013).

Based on their background, it could be expected that all participant tutors engaged highly with the intervention and actively participated on the activities required of them. Contrary to expectation, tutors' participations varied according to their group of students, distinguishing a highly participative group (HP) and a low participating group of tutors (LP) (for details, see Table 34, in 8.1).

However, this lack of participation was resolved during the focus group by promoting the discussion about the screenshots from their students' OneNote pages. To obtain the screenshot, tutors went through their students' pages and selected what caught their attention (see 4.4.6 and 8.1 for details). Consequently, to their understandings about teaching and learning, and the revision of their student content, they reflected on the intervention. Their perceptions were very similar to the perception of their students (discussed previously in 9.3). Furthermore, they acknowledged their role, became aware of their practices, and recognised their influences over their student participants. Similarly, Møystad et al. (2015) found a consequence of a training programme for faculty development in dental educator perceptions of their roles. Additionally, participant tutors recognised and talked about the drawbacks of the assessment process (discussed previously in 9.2.3), focused on memorisation and how the activities promoted by the intervention provide students with more opportunities to move beyond memorising stages of a procedure.

The perceptions and experiences about the learning process, according to tutors, could be summarised as students who participated in the intervention moved from the

mechanical repetition of practical and theoretical work to understand what they were doing. According to them, students used photographs beyond the activity in OneNote as a memory aid to assess their own work and to guide their work through the procedure. Those findings related to student skills have been discussed in conjunction with the students' experience and perceptions (see 9.3).

What follows is a discussion of the experience and perception of the tutors about their own teaching practices because of the intervention.

9.4.1 Tutor collaborating and sharing ideas with peers

Within the present study, tutors in the HP group shared their own experiences about their practices, valuing the role of reflection, and providing demonstrations to other tutors about the implementation of OneNote (see 8.1). Similarly, one study (Jippes et al., 2013) about the adoption of a medical education innovation (i.e., use of constructive feedback) found a positive influence of tutors networking (i.e., communication intensity with other supervisors in their department) within the adoption of the innovation. In the same vein, a systematic review about the competencies of health professions education highlighted collaboration and cooperation as essential aspects of successful educational strategies (Mikkonen et al., 2018).

9.4.2 Tutor role recognised within the intervention

Nowadays, the role of preclinical supervisors in the context of medical education is not as broadly described across the literature as it is for the role of clinical educators (Bartle & McGowan, 2021; Hu et al., 2015). This research recognised how, through an intervention that promotes student reflection, tutors could recognise their role during preclinical practices. This could contribute to understanding the usual 'invisible yet essential roles' (Hu et al., 2015, p. 1124) of health profession educators.

Considering their students' contributions, tutors valued their role in facilitating their students' understanding of future clinical scenarios (see 7.2.2.1 and 8.4.2). Additionally, tutors emphasised the importance of considering their students' emotions and how those influence their performance (see 8.4.3). They reconsidered their practices concerning the assessment processes highlighting these affect their student orientation to learning (8.4.5). These findings align with previous research that has positioned the role of educators in medical education in promoting learner construction of knowledge, beliefs, values, and behaviours within a community (Rostami & Khadjooi, 2010). Moreover, tutors

who become aware of their influences in how students learn could orientate their practices to become better supervisors (Møystad et al., 2015).

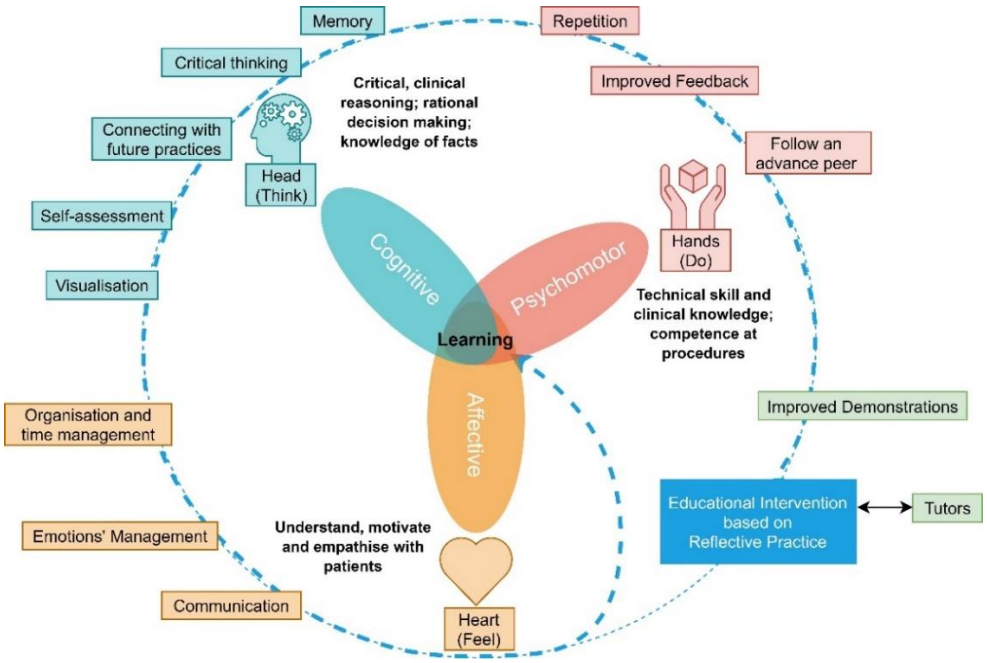
Additionally, the possibility to check their students' contributions allowed them to provide additional meaningful feedback (see 8.4), as they recognised their students' misunderstandings. This provides further evidence of the usefulness of reflective practice as an informative process to the teacher about their students' understandings (Ahmed, 2018; Forsythe & Johnson, 2016; A. Grant et al., 2006; R. Morgan, 2006).

9.5 Bridging theory and practice gap: It's not a cooking recipe

To finalise this discussion chapter, it is necessary to return to the cooking recipe analogy (see 1.3) and reflect on how this research moved away from this approach. Results from this research showed that reflecting during preclinical practices provided an opportunity for students to connect attainment of the learning outcomes (see 9.2.3), going beyond them by integrating and relating what they were doing in the simulated environment with possible real scenarios (see 7.2.2). Similarly, the need for health professions students to act and think professionally while progressing in their programmes with reflective practice has been acknowledged (Mann et al., 2009). These ideas connected reflection with the learning process, pointing out that without reflection, a learner tends to adopt a surface approach to learning, mainly memorising facts for the task at hand (Moon, 2004).

Moving beyond the mechanical repetitions of facts and actions, an integration of the cognitive, psychomotor, and affective domains of learning was previously discussed (see 2.7. To summarise the results of this research and provide a diagrammatic representation of them, the model previously presented (Figure 3) was updated adding the idea of spiral curriculum (Figure 4) and the benefits from the intervention. Each benefit was presented in relation the domains it contributed to develop and identified by different colours (Figure 51). Reflective practice within this current educational intervention allowed the development of skills, such as memory (see 7.2.1), critical thinking (see 7.2.2), visualisation (see 7.2.4), and management of emotions (see 7.2.5), that contributed to integration between the three domains of learning. It is, therefore, the integration of the three domains of learning that allowed student to go beyond the repetition of mechanical procedures.

Figure 51
A proposed model for Learning in Dental Education



Note. Source: author representation based on McHarg and Kay (2009) and Hoque (2016) The blue dashed arrow indicates the educative intervention allowing curriculum spiral development suggested by Harden and Stamper (1999). The blue dashed circle indicates that the integration of the cognitive, psychomotor, and affective domains is surrounded by reflective practice and the skills it develops. The skills developed through reflective practice in preclinical practice for dental students are highlighted. Red = psychomotor domain, Orange= affective domain, Turquoise – Cognitive domain. Green = represents tutors. Tutors feed into their student's reflective practice and the results of this feed on tutors' role.

It is arguable that the integration of reflective practice as a constitutive element of students training contributes to the integration of theory and practice in preclinical dental students, by allowing them to gain deeper understanding of their experiences. The model helps to understand how the interconnection between the cognitive, psychomotor, and affective domains impacts learning. For example, memory improvement (see 7.2.1) was among the most reported benefits from the intervention (cognitive skill). Thus, if memory retention increases, it could reduce working memory, allowing better performance of the psychomotor domain (see 3.3), affecting students' confidence in performing it and reflecting on better management and communication with patients (affective domain).

9.6 Summary of the chapter

In this chapter the results from this study were considered in relation to previous research literature and theories, the proposed model for learning in dental education is a summation of the work conducted throughout this dissertation. It suggests how we might

look at the integration of reflective practice in dental education. As a result of this process, the model integrates students (see 9.3) and tutors (see 9.4) experiences and perceptions, presenting the skills gained by students from reflective practice. This moves the field a step forward from measuring if students are engaging with reflection and considering the literature (see 5.2) to the design of an activity that makes them reflect on their practices. Thus, with the appropriate guidance from tutors, students start developing reflective skills while developing other associated abilities. Therefore, the skills obtained by students from reflective practice contribute to bridging the gap between theory and practice at a preclinical level of dental students by integrating the affective, psychomotor, and cognitive domains of learning.

Chapter 10 Conclusion

This dissertation describes the development of an educational intervention designed to address a gap between theory and clinical practice and the associated difficulties of dental students acquiring skills in reflection in the early stages of their undergraduate education (see 1.1). In Chapter 1, the research problem was outlined in conjunction with the rationale for conducting this research at both an academic (see 1.2.1) and a personal level (see 1.2.2). Chapter 2 positioned this research in the field of Health Professions Education, providing theories to understand how students learn and how teachers teach. This was followed by a focus on the teaching and learning process in dental education in Chapter 3.

Based on the initial chapters, Chapter 4 delineated the research aims, objectives and research questions, providing a detailed justification and discussion of the philosophical and methodological elements integrated within this study.

Design-Based Research (DBR) was the selected methodology and included three phases (see Figure 10). Firstly, a preliminary phase integrated the researcher's position and experiences, context, literature and interactions with students and colleges to formulate the research problem and develop a preliminary design framework. Secondly, a prototyping phase considered two iterative cycles, i.e., the pilot study (see 5.3) and the main study (Chapter 6, Chapter 7 and Chapter 8) of design, implementation and evaluation of an educational intervention. The prototype intervention considered reflection promoted by photographs taken by students during their practical sessions, and comments and reflections about them shared in a collaborative space designed for that purpose (i.e., OneNote, see 5.2.1). The Pilot Study provided valuable information to evaluate the intervention's feasibility and improve the design, both theoretically and technically, of the Main Study (see 5.4 and 9.2.1). Finally, the assessment and reflective phase was presented within Chapter 9.

This chapter completes this doctoral thesis by developing an overall conclusion and reflecting on the strengths and limitations of this work, together with recommendations and suggestions for further research.

10.1 Overall conclusion

DBR was an appropriate methodology to tackle the research problem (see 9.2), allowing for the continuous refinement of an educational intervention (see 9.2.1). The educational intervention, based on reflective practice, aided skills development of dental students in a preclinical unit (see 9.3) and contributed to the integration of theory and practice (see 9.5). Additionally, it helped tutors to value their own roles within the development of their students (see 9.4).

A social constructivist approach to reflection allowed its application throughout the design of an educational intervention. Thus, reflection as a way of being, seeing and understanding practice as well as conceiving it as a social activity (see 2.4.1) supported the intervention and helped the analysis of the obtained data. For example, the followed approach helped understand how the students' adoption of the intervention was shaped by the social culture within the institution (see 9.2.3). The social aspect of learning was formalized through a shared virtual environment which makes a vivid representation of how student learn from their peers (see 9.3.2.3) and by doing so, improving their own practices. Additionally, the role of tutors providing demonstrations which facilitate students' connection with future real scenarios was also viewed from the perspective of learning as a social construction. All the evidence obtained through socio constructivism lens worked in conjunction to understand the way students acquired the skills, knowledge, and attitudes in CSL. These understandings provided a straightforward intervention that allows evaluation of tutors own practices as well as tool for students to enhance their learning experiences. Ultimately, DBR was appropriate and suited the aims of this study and answered the research questions. In general words the research provides evidence to promote reflective practice among dental students in a collaborative environment and illustrate how the design, implementation and evaluation of an intervention was a reflective process for the researcher as well as for the participants.

Based on the sequential model followed for this research (see Figure 10), what follows are summary contributions to knowledge, considering methodological, theoretical, and practical aspects in turn.

10.1.1 Contributions to methodology

Contributions to methodology can be understood from two points of view. Firstly, DBR as a methodology to develop and study educational interventions in Dental Education.

Secondly, the intervention itself, as a pedagogical methodology to tackle the research problem.

This dissertation demonstrates that DBR was a useful methodology to design and implement this educational intervention. It allowed improvements to be made between cycles and, as a result, produced a pedagogical strategy which incorporates reflective practice into dental students' training. This strategy could be applied to other disciplines within the educational context of health professions, where reflection is key to integrate theory and practice.

Allowing students to take photographs, and comment and reflect on the procedures they were studying whilst also sharing them with their peers, was demonstrated to be beneficial for their learning process. Firstly, it provided a strategy to move beyond the mechanical repetition of procedures and facts in preclinical training. Secondly, it provided evidence for tutors to monitor the understandings of their tutees. Additionally, the use of photographs with a pedagogical intention within an online platform offers a plausible way to introduce a technological innovation in dental education. Consequently, the design was supported by the literature (see 5.2) and the empirical evidence produced by this current research. Particularly, OneNote (see 5.2.1) served as a tool to promote reflection, and despite relatively superficial reflections shared within OneNote, there was evidence from focus and reflective task of the intervention prompting deeper reflection.

10.1.2 Contributions to theory

This study contributes to the integration of theories of learning into the development of an educational intervention within dental education. That is, valuing the construction of knowledge through social interactions (Andrews, 2012; Bonk & Cunningham, 1998; Richardson, 1997; Watson, 2001) to theoretically conceptualise and create a collaborative space for sharing learning experiences (i.e., OneNote pages). Similarly, the design process considered reflection to be a metacognitive skill, as well as a social activity, that provided a better understanding of self and the situation, allowing knowledge to be applied in future scenarios (see 2.4.3). Reflective practice was conceived as a way to share experiences, promoting this through use of available technological tools including photographs, online platforms, mobile devices, and the internet.

Additionally, the intervention contributed to developing a range of necessary skills, e.g., memory, visualisation, self-assessment, communication, and critical thinking, all of which are essential for future dentists' performance. Furthermore, by developing these

skills the intervention demonstrated integration of psychomotor, affective, and cognitive learning domains, ultimately contributing to dental students' learning.

10.1.3 Contributions to practice

Contributions to practice refer to the educational intervention as a product of the research. The intervention was implemented in a naturalistic setting, and the design was strongly supported by theory (see 5.2). The evidence showed that deeper consideration is needed about where reflection can best be included in curriculum design and how to organise delivery of content. The content of students' contributions also provided possibilities for tutors to observe their students' understandings and provide additional feedback. In this sense, recording the studied procedures by taking photographs, making comments, and reflecting about them could act as a quality assurance step of the students' understanding and facilitate the tutors' roles.

Additionally, the results emphasised the role of tutors, which can contribute to their identity as a teacher in health professions education (Bartle & Thistlethwaite, 2014; van Lankveld et al., 2021). However, this topic was beyond the scope of this research.

The results from this research have been partially presented (See Appendix U for abstracts) at different conferences in health professions education, seeking to receive comments and questions and promote discussions with researcher colleagues. The last presentation involved an institutional project in Concepcion, within which an instructional strategy for remote training in Dental Education was developed during the current pandemic. The strategy incorporated the recommendation from this current research, and reflective practice was included in the same way as it was incorporated into this research.

10.2 Strengths of the study

The strengths of this research project include the methodology used to design an educational intervention and high-level involvement and insights from participants in the intervention.

10.2.1 Methodological strengths

The methodology (DBR) allowed the development of an innovative intervention at the preclinical stage of the education of dental students, and this was strongly supported by the literature (see 1.2.1), the researcher experience (see 1.2.2) and the contextual

elements of the dental programme (see 5.2). The intervention was refined through constant design, implementation and evaluation, and detailed consideration within the Pilot Study (see 5.3) and Main Study (see Chapters Chapter 6 Chapter 7 Chapter 8). The intervention not only successfully encouraged students to reflect, but to share those reflections demonstrating that seeing reflective practice through a socio-constructivist lens was possible and offered the possibility to develop informed educational practices. Additionally, using technology as a means to support the implementation was very innovative and considered the contemporary issues related to use of technology in dental education (see 3.4). In sum, the project clearly documented the context, the literature, the experience and perceptions of participants to develop an educational strategy that responded to the individual researcher's preferences, as well as to contextual possibilities and constraints (Barab & Squire, 2004; Ringsted et al., 2011).

Notwithstanding there was not a robust means to assess reflection (Ahmed, 2018; J. C. Williams et al., 2019), the use of the RTQ (Kember et al., 2000) as a validated questionnaire adapted for dental education (Tricio et al., 2015) provided evidence to compare with the reported literature about the ability of students to engage with reflective thinking (Ghanizadeh & Jahedizadeh, 2017; Kazemipoor & Hakimian, 2018; Sargent, 2015; Tricio et al., 2015).

Another strength of this study is the integration of different methods of data collection and analysis. These provided comprehensive information which complemented explanations of complex issues, e.g., the culture behind assessment practices, and participants' use of the educational intervention. Therefore, the consideration of multiple sources of data allowed triangulation of information (discussed further 10.3).

10.2.2 Involvement and insights from participants

Participants' involvement and their insights provided sufficient data to make clear conclusions. Showing, for example, that the timepoint of the intervention within the curriculum, transitioning from theory to practice of third year students was appropriate (see 9.2.2) and justified the use of OneNote as a stable and appropriate platform for the intervention.

The intervention was a totally new activity for students and tutors. They participated fully and opened up about things by taking photographs and sharing them, with comments and reflections with their peers. They also shared their views by completing the final questionnaire and attending the focus groups. Additionally, their use of

photographs went beyond the requested activity, expanding their understanding about how they can reflect on the photographs they and others produced concerning the procedures they were studying and how to manage and enhance their communication abilities by using them. This generates a valuable amount of novel data able to compare and contrast with related studies.

10.3 Limitations of the study

Every decision during this research was supported by careful consideration of the drawbacks and their strengths. However, some issues are important to acknowledge.

The Reflective Thinking Questionnaire (RTQ) (see 4.4.4), OneNote pages (see 4.4.7), Final task (see 4.4.8), and Final questionnaire (see 4.4.9), all provided self-reported data in general, and therefore are at risk of bias. People have selective memories and may get the timing of events wrong (Walentynowicz et al., 2018) or think their answer could affect their performance, or they could just answer what they think is appropriate or socially desirable (Andersen & Mayerl, 2017; Fisher & Katz, 2000). Although it is impossible to eliminate this issue, totally, , the approach taken with this research by gathering different and varied sources and type of data allowed triangulation of methods and analyses which minimise the limitation (Bazeley, 2013; Herrington et al., 2007; Punch & Oancea, 2014; Yin, 2018).

Another limitation was the lack of available data of OneNote application analytics (see 4.4.7) to deeply understand the usage and metrics of the interactions of participants within the application. This issue was partially solved by the recommendation from the application developers, which involved a time-consuming process of manual access to the participant pages. However, it would be desirable to have access to a platform that provides richer information about participants' interactions and usage of the application.

An additional consideration is that student and tutor participants were a self-selecting group. Therefore, it is difficult to anticipate if the results would be the same if the activity was compulsory and considered those students and tutors that might be less positive about engaging with the intervention. Similarly, this study was conducted in one institution in one unit of one programme; therefore, future research that involves other disciplines and students from other institutions will be necessary before it is possible to generalize the findings. In other words, this research was conducted within one institution, with a particular ethos for education, and with a particular cohort of students. However,

through the triangulation of data collection methods, multiple integrations of sources, and participants' views, a more robust substantiation of the interpretation and conclusions could be provided (Huberman & Miles, 2002; Tracy, 2010). Additionally, particular interest was given to the context, providing 'thick descriptions' (Geertz, 1983) of it, as well as the interactions "because any single behaviour or interaction, when divorced from its context, could mean any number of things" (Tracy, 2010, p. 843). Therefore, the approach taken within this research highlights trends towards the transferable aspects of the intervention to other contexts.

10.4 Recommendations

For researchers, based on results of this study, a methodology such as Design-Based Research is recommended when developing educational interventions, as it provides the resources to reflect and integrate the literature, the context, and the position of the researcher. Thus, developing educational strategies applicable in a chosen situation can be replicated in different contexts due to careful considerations involved within this methodology.

For professional development, it is recommended that reflective practice is incorporated in the early years of dental education and during training programmes of all students. Reflective practice was shown to not only benefit students and tutors, but also to highlight curricular issues that could be improved. Additionally, based on the benefits of taking photographs to support reflection, it is recommended that dental students are encouraged to take photographs of their practices, as they represent a record of their work and additionally function as a tool to promote self-assessment and communication of their work to others. Nevertheless, caution needs to be applied in order to ensure ethical considerations are made if this is ever used in a clinical (rather than clinical skills) learning environment.

For the institution, mapping the learning outcomes throughout the curriculum in order to enhance student navigation through the units and have a coherent story is recommended. The example highlighted within this intervention pointed out the specific content of endodontic treatment, but detail consideration of all the curriculum will provide better understandings of students' development. Particularly for the unit where the intervention was carried out, it is highly recommended to continue with the tasks included within the intervention and incorporated in previous year.

For teachers in general exploring creative solutions that are easily available and at a low cost is recommended. OneNote is a versatile tool that offered online support and a straightforward use. From this research OneNote could be suggested as an application which allows easy-to-access and easy-to-use collaborative work.

10.5 Future Research

This research has thrown up many questions in need of further investigation. What follows are four topics that will help to establish a greater degree of accuracy in understanding the role of reflective practice in closing the gap between theory and practice in dental education.

1. Escalate the study to understand the integration of reflective practice within the entire dental curriculum.

The study was conducted within a specific clinical procedure in one unit (see 5.1.5); it would be interesting to incorporate this pedagogical approach to reflective practice into the entire unit, to have a broader perspective of the benefits of reflective practice in the development of clinical skills in preclinical settings. Additionally, the designed intervention identified a gap in the organization of curriculum content and how this could influence the transference of developed skills into real scenarios (see 9.2.4). Further research might explore the level of curriculum integration and the role of reflective practice within this integration.

2. Further exploring the influence the development of reflective practice in preclinical courses has on clinical practices.

The skills developed through the educational intervention were summarised in a model (see in 9.5) which integrates theory and practice by promoting the integration of the affective, psychomotor, and affective domain of learning through reflective practice. Thus, a future connection with clinical practice at a theoretical level was hypothesised. Therefore, future research is needed that put those skills into practice and to evaluate the effectiveness of the designed intervention in helping the transition of students into clinical practice, and to become better clinicians as hypothesised from the results of this research.

3. Further exploring tutors' development through reflective practice and their role in developing students' interactions with reflective opportunities.

As discussed within the data collection methods (see 4.4.6), and when presenting the results related to tutors' experiences and perceptions about the intervention (see 8.4.2), the use of screenshots allowed interesting conversations with tutors. The exercise designed to promote tutors' discussion ended up being an interesting source of reflection on the tutor's own practices. Further exploration of tutor development and their role within their student learning process could offer a more holistic understanding of the development of educational interventions.

4. Expand the influence of assessment practices on the development of reflective practice within dental students.

Students orientated their participation in the intervention and their development through the practices for obtaining a pass qualification in the pilot (see 5.3.4) and in the main study (see 6.5). However, this current research did not report a relationship between the level of engagement with reflective practice (measured by the reflective thinking questionnaire (see 4.4.4) and the grades obtained by the students in their summative assessment. Therefore, the influence of assessment practices in the way students approach learning was thought-provoking (see 9.2.3) and drew attention to further research.

10.6 Final remarks

This research has shown that the ongoing literature discussion with respect to how to assess reflection needs to redirect focus into the development of activities that develop reflective practice in dental students. Thus, students and tutors could benefit from educational practices that considered reflection as an integrative part of the learning process rather than a construct to be assessed.

The novelty of this research was the successful integration of technology with a clear purpose in the development of an educational strategy. It resulted in a cost-effective strategy where students used their own devices, taking, selecting, and sharing photographs in conjunction with providing and obtaining comments and reflections with their peers. Because of the activity, students improved their learning processes, moving beyond the mechanical repetitions of facts and actions. Even more, just taking and reviewing photographs was reported as beneficial because students became more critical about their own work because of these specific activities prior to sharing in OneNote. These findings from this research act as justification for innovative practices that include use of technologies in a strategic way promoting learning.

Finally, Design-Based Research offered an approach to research that valued the researcher's role and experience and contributed to the development, implementation, and evaluation of educational interventions. Likewise, it facilitated the development of the researcher through interactions with the participants, the theory, and the context, which essentially is another application of reflective practice itself.

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Appendices

Appendix A
Concepcion location in South America

Note. Red arrow point Concepcion location.
Source: https://www.nationsonline.org/oneworld/map/south_america_map2.htm

Appendix B
Reflective Thinking Questionnaire (English Version)

University of BRISTOL

Reflection Questionnaire

(Kember et al., 2000, Modified by Tricio et al., 2015)

Project: Promoting reflection in preclinical dental students using mobile technologies: A mixed method study

Name: _____ Group: _____ Date: ___/___/_____

Date of birth: ___/___/_____ Sex: F / M Teacher in charge: _____

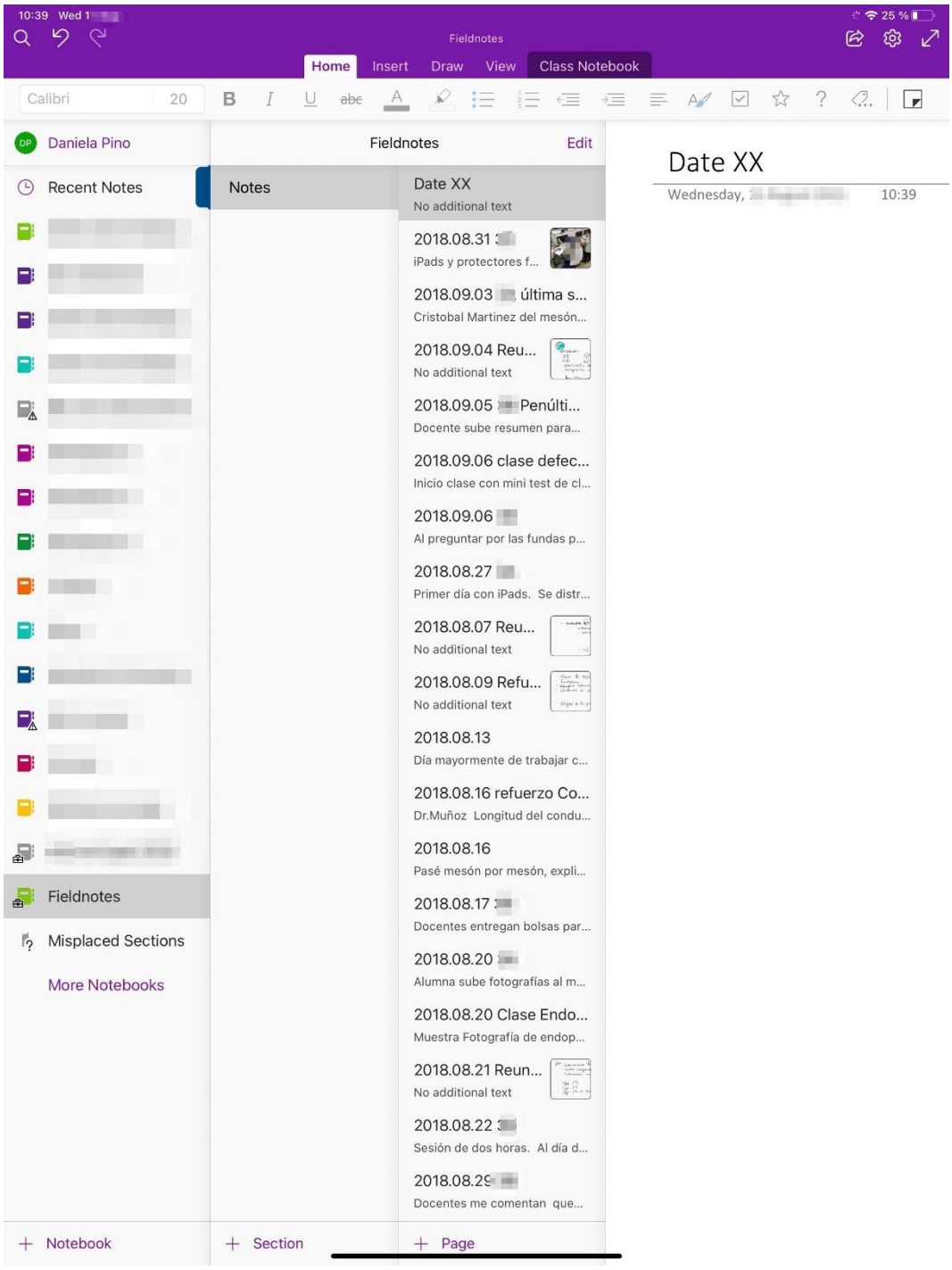
Instructions: Please mark (X) in the appropriate circle to indicate your level of agreement with statements about your actions and thinking in this course.

1 Definitely agree / **2** Agree with reservation / **3** Neutral / **4** Disagree with reservation / **5** Definitely disagree

Note: Only use neutral is a definite answer is not possible.

	Statements	1	2	3	4	5
1	When I am working on some activities, I can do them without thinking what I am doing.					
2	Dental training requires me to understand concepts taught by the lecturers.					
3	I sometimes question the way others do something and try to think of a better way.					
4	As a result of my dental training I have changed the way I look at myself.					
5	In dental training, I do things so many times that I have started doing them without thinking about it.					
6	To pass dental training examinations you need to understand the content you are studying.					
7	I like to think over what I have been doing and considerer alternative ways of doing it.					
8	Material learned during my dental training has challenged some of my firmly held ideas.					
9	As long as I can remember material presented in class for examinations I do not have to think too much.					
10	I need to understand the material taught by the teacher in order to perform practical tasks.					
11	I often reflect on my actions to see whether I could have improved on that I did.					
12	As a result of the material learned in dental training I have changed my normal way of doing things.					
13	If I follow what the lecturers say, I do not have to think too much about my dental training.					
14	In dental training you have to continually think about the material you are being taught.					
15	I often re-appraise my experience so I can learn from it and improve for my next performance.					
16	During dental training, I discovered faults in what I had previously believed to be right.					

Appendix C
Fieldnotes by date in OneNote



Appendix D
Focus Group (Tutors) Protocol (English Version)

University of BRISTOL

Focus Group Protocol (Tutors)

Project: Promoting reflection in dental preclinical students using mobile technologies: A mixed method study

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Researcher: Daniela Pino V

Instructions:

During this session we will conduct a focus group. I expect all of you could give your opinion related to the activity that you already lived in your preclinical practice with your students.

I will ask you some questions that will provide me important information related to the study. Please give answers as complete as you can.

Note: This activity will be audio and video recorded to facilitate the transcription.

Research Question 1: How do theories of teaching and learning and prior empirical studies inform design and enactment of the educational intervention?

Research Question 3: What are the experiences and perceptions of the tutors about the impact of the intervention/ reflective practice on the teaching and learning process?

Question 1: Do you perceive any difference in how students do their practices while they take pictures and write reflections?

Question 2: Does this activity have any influence in your role as a tutor?

Question 3: Can you share with us something that calls you attention of this activity?

Date: __/___/_____

Appendix E
Focus Group (Students) Protocol (English Version)

University of BRISTOL

Focus Group Protocol (Students)

Project: Promoting reflection in dental preclinical students using mobile technologies: A mixed method study

Researcher: Daniela Pino V

Instructions:

During this session we will conduct a focus group. I expect all of you could give your opinion related to the activity that you already lived in your preclinical practice.

I will ask you some questions that will provide me important information related to the study. Please give answers as complete as you can.

Note: This activity will be audio and video recorded to facilitate the transcription.

Research Question 1: How do theories of teaching and learning and prior empirical studies inform design and enactment of the educational intervention?

Research Question 2: What are the students' experiences and perceptions about the intervention's impact on the teaching and learning process.

Question 1: How can you describe the process of taking pictures during your practices?

Question 2: Did it influences the way you live your practices? …How?

Question 3: Does the photographs help you to reflect? When? … When you were taking the pictures or when you write the comments?

Question 4: Taking pictures and writing a reflection during your practices make any difference if you compare with previous practices you have?... Can you describe?

Question 5: Was the activity useful in your practice? Why?

Question 6: Do you think you will do something different in your before you do this activity? What? How?

To improve the design of the activity

Question 7: Do you have any suggestion? What could be better in the activity?

Date: __/___/_____

Appendix F
Guide for the Written Reflection Task (English Version)

Guide for the Written Reflection Task

The ability to reflect is an essential feature of a competent clinical practitioner. Reflection, among other things, involves the notion of learning and thinking, and comprises returning to experience and examining what has been learned and seeking a guide to incorporate it in our way of acting, thinking and feeling during our activities. We reflect to learn something or learn as a product of reflection.

Reflective writing is a representation of what happens in our mind and it is important to note that you will not only learn about what happens in your mind, but also about the writing process. Digital images were added to this activity to help you in the reflective writing phase.

You are requested to write a document considering the following question. Try to answer them, taking as a basis the photographs shared, as well as the comments and reflections in OneNote.

Questions to guide the written task:

1. What does the experience experienced in simulators (fantomas) mean to you?
2. How did you feel during your practices?
3. How did your emotions relate to your performance?
4. What were the good and bad parts of this unit and what implications did it have for you?
5. Was there any previous experience that guided your act during the practices? Which? Please describe them.
6. Did your tutors' and classmates' comments influence your practices?
7. What would you do differently the next time you face a similar situation? Please describe it.
8. In relation to the fixed prosthesis unit: What do you think you will use in your future practices? How do you think you'll use it with your patients?

The writing is free, and the questions listed above are to help you produce a deeper reflection on your practices and act as a guide for your future professional performance.

Based on:

Ashley, Gibson, Daly, Baker & Newton (2006) Undergraduate and postgraduate dental students' 'reflection on learning': a qualitative study.
Boud, Keogh, Walker (1985) Reflection: turning experience into learning.
Mann, Gordon & MacLeod (2009) Reflection and reflective practice in health professions education: a systematic review.
Moon (2004) A handbook of reflective and Experiential Learning. Theory and Practice.
Wald et al. (2010) Beyond the Margins: reflective writing and development of reflective capacity in medical education.

Appendix G
Final Questionnaire (English Version)

University of BRISTOL

INTERVENTION'S EVALUATION

Project: Promoting reflection in dental preclinical students using mobile technologies: A mixed method

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Date: ___/___/2018

Student Number: _____ **Group:** _____ **Pseudonym:** _____

Tutor: _____

Dear students: I will appreciate your answer to the following questions concerning the activities you undertake using OneNote.

1. Did you take photographs? ☐ YES. How many? ..... (approx.)
   ☐ NO

2. Did you upload photographs? ☐ YES. How many? ..... (approx.)
   ☐ NO

If your answer is yes; When did you upload photographs? For example, immediately after taking them, later, on your free time, when you study. Describe.

.....
.....
.....

3. Did you reflect on your photographs? ☐ SÍ
   ☐ NO

If your answer is yes; When did you reflect on your photographs? For example, immediately after taking them, later, on your free time, when you study. Describe.

.....
.....
.....

4. After you uploaded and/or reflected on your photographs.
   Did you use them again? ☐ SÍ
   ☐NO

If your answer is yes; When did you use them? For example, on your free time, when you study. Describe.

.....
.....
.....

5. Did you review the photographs, comments and/or reflections of your peers??

☐ SÍ

☐ NO

If your answer is yes; When did you review the photographs, comments, and reflection of your peers? For example, on your free time, when you study. Describe

.....

.....

.....

6. From your point of view, what are the advantages of the educational intervention?

.....

.....

.....

.....

.....

7. Did you have any drawbacks or difficulties with the educational intervention? Describe.

.....

.....

.....

.....

.....

8. Do you have any comments or suggestions on the educational intervention? Describe.

.....

.....

.....

.....

.....

.....

.....

.....

.....

Thank you for participating in this project!

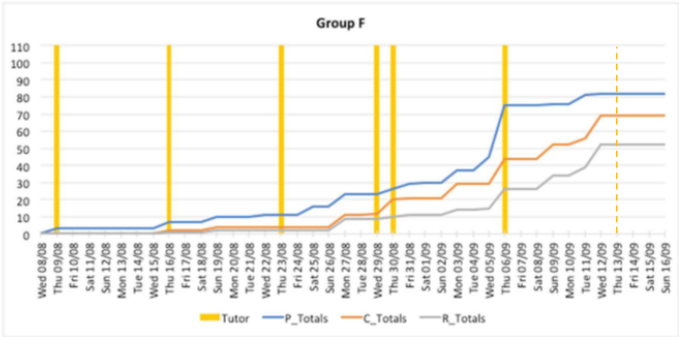
Appendix H
Integration of Data. Example Group and participant

1. Group F – The case of a highly participative group (Spanish Version)
2. Example Of Antonia (Spanish Version)

Grupo F

Tutor	Dr. Fuentes					
Participantes (n=7)	E-10 Jorge E-11 Belen	E-13 Antonia E-24 Igor	E-38 Tomas E-41 Natalia	E-49 Vivian	**Sesiones:**	Wednesdays 15:10 - 17:00 Thursdays 14-10 - 18:00

Descripción General:



Desde el calendario de B	
22.08	Ref. coronario
23.08	perno duralay
30.08	corona prov. total acrílica
06.09	Muñón colado + prov. periférico.
12.09	Pp Ref coronario y corona prov c/anclaje

Rincón del Docente	
09.08	Orden de material y adaptación dientes.
16.08	- Bienvenida y Motivación a participar -Apunte compartido por docente encargado de asignatura
23.08	Foto de grupo, mencionando envío a laboratorio (~Ref. coronario) (~perno duralay)
29.08	- Protocolo de envío a laboratorio - Recuerdo de anatomía en las restauraciones
30.08	- Muñones y provisorios (~corona prov. total acrílica) (~Muñón colado + prov. Periférico)
06.09	Cementaciones, explicación de ellas.

Participación total

-Participación del grupo completo.
-Activa participación de docente guía durante los días de las sesiones prácticas, lo que sigue el mismo comportamiento que los aportes de los estudiantes.
- Valoración del rincón del docente y rincón de Antonia
- Docente comparte en el rincón del docente todo el procedimiento.)lo que se requiere durante la pp está completo)
-

Grupo F

Participantes

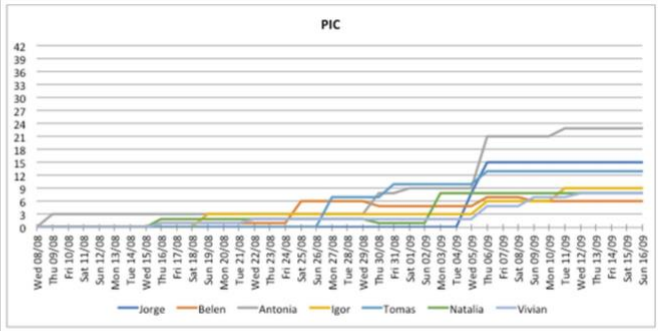
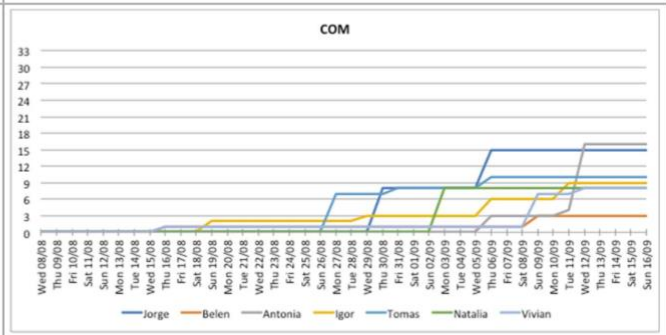
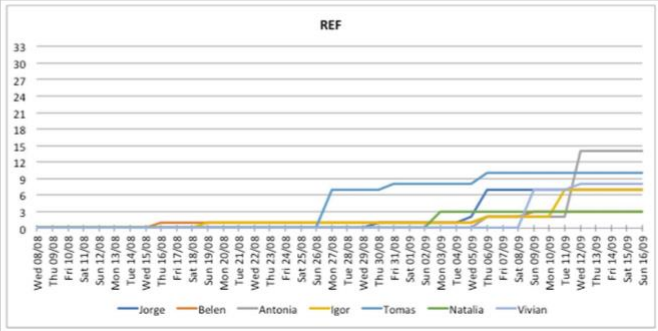
					RTQ				Selft Reported		Use of ON			ON Contributions			How?		Grades			
ID	Pseudonym	Gdr	Age	1st	HA	U	R	CR	Taken	Shared	Reflect	Own	Peers	P_ON	C_ON	R_ON	C	PP	Pract	Mtest	Theory	Final
10	Jorge	M	20	yes	16	17	18	19	16	9	yes	yes	yes	15	15	7	A	yes	5,3	5,3	3,0	5,3
11	Belen	F	20	no	15	14	16	14	8	6	yes	yes	yes	6	3	3	A	no	5,8	5,4	3,8	5,4
13	Antonia	F	20	yes	14	19	17	20	23	23	yes	yes	no	23	16	14	yes	yes	5,1	5,4	2,7	5,1
24	Igor	M	22	no	12	19	15	17	10	10	yes	yes	yes	9	9	7	A	yes	4,5	3,1	3,4	5,2
38	Tomas	M	21	yes	11	20	17	14	13	13	yes	yes	no	13	10	10	yes	yes	5,7	4,2	4,5	5,2
41	Natalia	F	21	yes	15	18	14	13	10	10	yes	yes	yes	8	8	3	A	no	5,3	6,4	4,2	5,3
49	Vivian	F	21	yes	10	20	20	20	12	8	yes	yes	yes	8	8	8	A	yes	4,2	3,4	3,6	5,0
	Sub-Total								92	79				82	69	52			5,1	4,7	3,6	5,2

A=Almost the entire procedure is complete. Missing the last provisional preparation in most of the cases

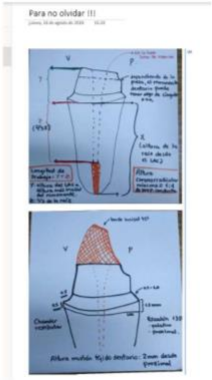
* Antonia dice no revisar el contenido de sus compañeros, sin embargo, le parece una buen proyecto para compartir experiencias con sus compañeros de mesón.

Durante el focus group señala que "miré lo mío y lo del docente, pero hay personas que siempre ven lo del resto para ir comparando"

--> En este sentido, Antonia ´"compara" lo de ella con lo del docente y sus compañeros por su parte adoptan a Antonia como el rincón de Antonia.

P		- Constante adición de fotografías
C		- Adición más tardía de comentarios
R		- Adición final de reflexiones

Grupo F

Dr Fuentes OneNote	  Bienvenidos a esta nueva actividad! Les dejo estas imágenes para que recuerden mantener el orden del lugar de trabajo. Éxito en este semestre y vamos que se puede	**Quote 1: Motivación inicial de docente con su actividad** "¡Bienvenidos a esta nueva actividad! Les dejo estas imágenes para que recuerden mantener el orden del lugar de trabajo. Éxito en este semestre y vamos que se puede"
	 Para no olvidar !!!	**Quote 2: Compartir apuntes compartidos por docente encargado** Docente comparte bajo el titulo de "no olvidar" las indicaciones de la preparación coronaria y el muñón acrílico.

		**Quote 3: Motivar a los estudiantes a actualizar sus intervenciones** "Recordatorio de anatomía para cuando tallamos nuestras restauraciones. ¡No olviden actualizar sus intervenciones!" Docente también comparte una imagen con los integrantes del grupo el día que enviaron varios a laboratorio el perno de acrilico. (23.08) Este día coincidentemente es el día en que debían entregar ese requisito, lo que da un indicio de un trabajo parejo de los estudiantes.

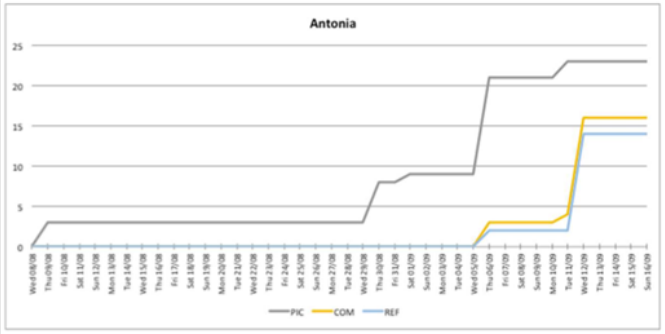
E-13 Antonia

Descripción General

					RTQ				Selft Reported		Use of ON			ON Contributions			How?		Grades			
ID	Pseudonym	Gdr	Age	1st	HA	U	R	CR	Taken	Shared	Reflect	Own	Peers	P_ON	C_ON	R_ON	C	PP	Pract	Mtest	Theory	Final
13	Antonia	F	20	yes	14	19	17	20	23	23	yes	yes	no	23	16	14	yes	yes	5,1	5,4	2,7	5,1

- Usa descripciones de los procedimientos y de los materiales empleados.
- Describe los errores y como los soluciona.
  - Autocrítica
- Da las razones de realizar determinadas acciones prácticas.
  - Conectándolo con lo que se haría en un paciente real.
- Conecta con experiencias previas y futuros posibles escenarios
  - Mención docente guía para solución de dificultades
- Primera vez que cursa el ramo
- Agrega comentarios t reflexiones después de entregar requisitos para pp.

Contribuciones en el tiempo:



--> pp 12.09 Comentarios y reflexiones aumentan considerablemente el día antes de la prueba práctica.
Con las fotografías se aprecia un crecimiento de acuerdo a las entregas de sus trabajos al docente encargado de asignatura.
Entregas:

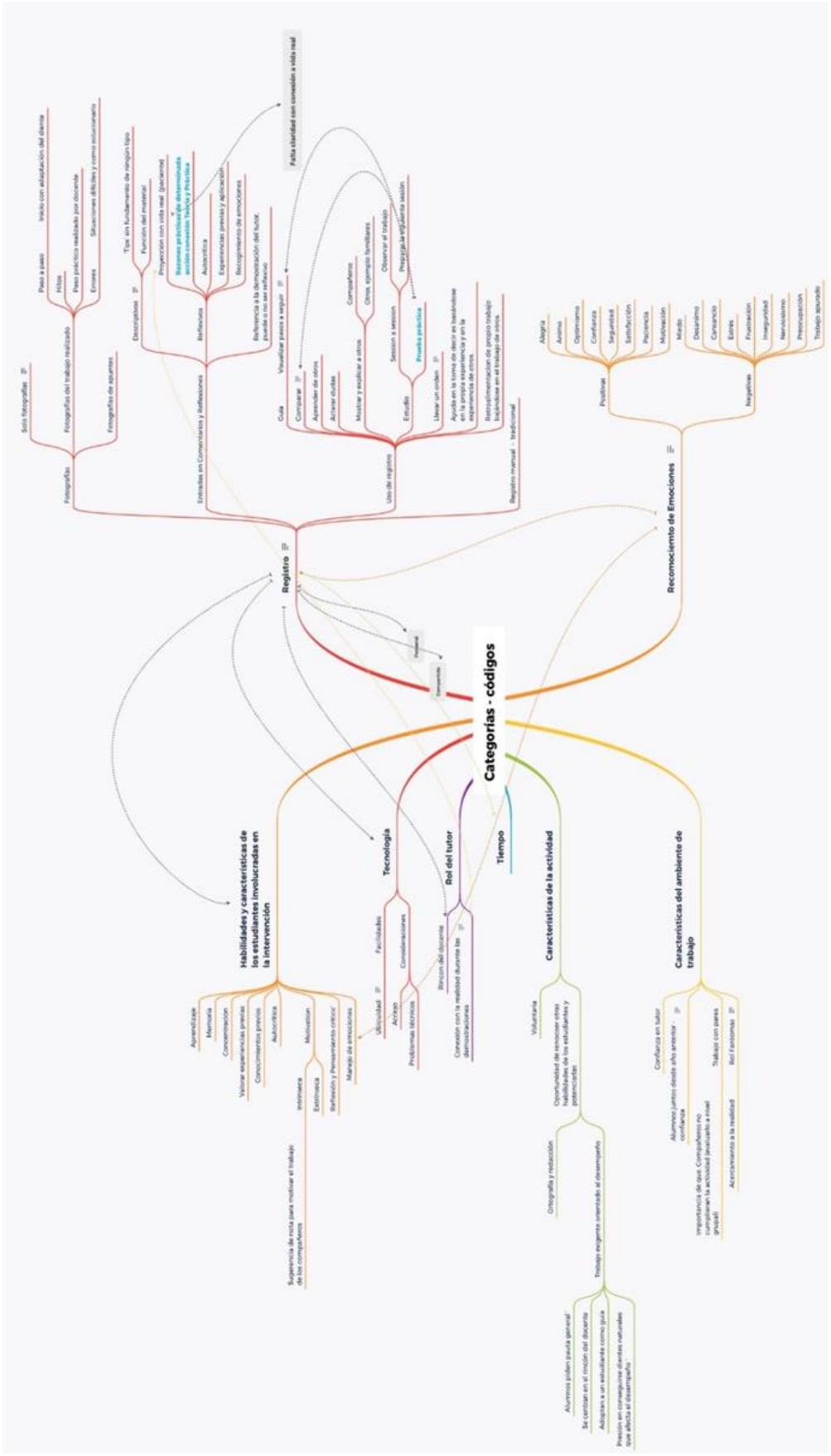
23.08	perno duralay
23.08	Ref. coronario
05.09	corona prov. total acrílica
24.09	Muñón colado + prov. periférico.

Desde el cuestionario final:

- Sube algunas al momento de realizada la acción y otras después en su casa.
- "Reflexione sobre ellas al estudiar para recordar en qué etapa había quedado y retomar la sesión siguiente" "para estudiar para la prueba practica"

<table>
<tr>
<td>Ejemplos clave</td>
<td>
Quote 1: Autocrítica
<table>
<tr>
<td>09/08/18</td>
<td>  </td>
<td>Adaptación del diente en arcada superior. Pieza dentaria a trabajar: 2.1. Inicialmente con desgaste incisal.</td>
<td>Es muy importante hacer una correcta adaptación del diente. La foto es de la primera adaptación que hice de la pieza; esta la considero no correcta, pues el cuello del diente no está al nivel del cuello de los dientes vecinos.
Esto se debe considerar para el momento en que hagamos el provisorio, pues si la altura del muñon está alterada, el provisorio tendrá una longitud diferente a la de las demás piezas.</td>
</tr>
</table>
</td>
<td>Fotografía de acción realizada, evaluando el resultado obtenido:
"Es muy importante hacer una correcta adaptación del diente. La foto es de la primera adaptación que hice de la pieza; esta la considero no correcta, pues el cuello del diente no está al nivel del cuello de los dientes vecinos."
• Consideraciones futuras:
"Esto se debe considerar para el momento en que hagamos el provisorio, pues si la altura del muñón está alterada, el provisorio tendrá una longitud diferente a la de las demás piezas"</td>
</tr>
<tr>
<td></td>
<td>
Quote 2: Reconocimiento y corrección de Errores
<table>
<tr>
<td>22/08/18</td>
<td>  </td>
<td>Mini muñon natural. De altura presenta:
• Vestibular: 0.5 mm aprox de cuello, y en profundidad hacia "adentro" 1.5 mm. Terminación. Chamfer
• Palatino y proximal: 1.5mm de altura en cuello y aprox 0.5-1 mm "hacia adentro". Terminación en 135°
Para disminuir la longitud del muñón utilicé una piedra diamante a/v tipo aguja. Para realizar el Chamfer, utilicé una piedra troncocónica y para la terminación en 135° una piedra torpedo.</td>
<td>Una vez realizado el muñón, se debe realizar la profundización a conducto. En primer lugar usamos una piedra diamante redonda para cavitar y llegar hasta la cámara pulpar. Luego, con una Fresa Peeso, profundizamos el conducto, con una medida correspondiente a 2/3 del conducto de la raíz del diente. En el caso de mi diente, el conducto estaba calcificado, por lo que solicité ayuda a mi docente, y entre intentos por trazar el conducto, se pasó a perforar la raíz y la corona perdió un pedazo. Para arreglar la situación se procedió a realizar una caja (con conformación) en vestibular, como se puede ver en la fotografía.</td>
</tr>
</table>
</td>
<td>Describe el problema:
Describe lo que se debe hacer:
"Una vez realizado el muñón, se debe realizar la profundización a conducto. En primer lugar, usamos una piedra diamante redonda para cavitar y llegar hasta la cámara pulpar. Luego, con una Fresa Peeso, profundizamos el conducto, con una medida correspondiente a 2/3 del conducto de la raíz del diente"
"En el caso de mi diente, el conducto estaba calcificado, por lo que solicité ayuda a mi docente, y entre intentos por trazar el conducto, se pasó a perforar la raíz y la corona perdió un pedazo"
Solución:
"Para arreglar la situación se procedió a realizar una caja (con conformación) en vestibular, como se puede ver en la fotografía"</td>
</tr>
</table>

Appendix I
Mind Map Codes references



Appendix J
Ethics Committee Certificate, Intervened University

UNIVERSIDAD DE CONCEPCION
FACULTAD DE ODONTOLOGIA

CERTIFICATE

C.I.Y.B. Nº050/17

The Bioethics Committee in the regular meeting considered the request for approval of the research project ***"Promoting reflection in preclinical dental students using mobile technologies: A mixed method study"*** *("Promoviendo la reflexión en estudiantes de preclínico de Odontología usando tecnologías móviles: Un estudio de enfoque mixto") presented by Daniela Pino.*

In the face of the preceding, the Committee declares:

1. *The research project has scientific value.*
2. *The study presents a theoretical basis, a methodology and objectives that reflect on being a significant contribution to knowledge.*
3. *The participating researcher is competent to carry out the research successfully.*
4. *Informed consent is clear, ensures the confidentiality of the information and the guarantee of voluntary withdrawal of participants.*
5. *That for all the previous this Bioethics Committee has no qualms or inconvenience attentive to our area.*

Consequently, the project is ***approved****.*

The present document is extended at the request of the interested party for the purposes she deems appropriate.

FACULTAD DE ODONTOLOGÍA U. DE CONCEPCIÓN PRESIDENTE COMISIÓN DE INVESTIGACIÓN

DRA. GABRIELA SÁNCHEZ SANHUEZA
Presidenta
Comisión de Investigación y Bioética
Facultad de Odontología
Universidad de Concepción

Concepción, September 29th, 2017

Roosevelt #1550, Casilla 160-C, Concepción-Chile
Fono 56-412204292

Appendix K
SoE Research Ethics form, University of Bristol

University of BRISTOL

SoE RESEARCH ETHICS FORM

Name: Daniela Pino Valenzuela

Proposed research project: Promoting reflection in preclinical dental students using mobile technologies: A mixed method study

Proposed funders: CONICYT and Universidad de Concepción

Discussant for the ethics meeting: Carolina Gordillo, year 3 PhD student

Name of supervisors: Professor Sally Barnes, Dr Kate Whittington, and Professor David Dymock

Has your supervisor seen this submitted draft of your ethics application? Y/N

Outline of the project:

This project considers the incorporation of reflective writing as an activity that complements the regular practice of preclinical dental students. It is during this training period when students must demonstrate the acquisition of knowledge and skills that make possible their future work as dentists.

In their future practice, students may face complex scenarios. Some of them might have not even been experienced while they were students, particularly in the preclinical practice which practices are far too standardised. It is here, where the capacity to reflect becomes an imperative element in their skills as dentists because it is related to the solution of these ill-structured problems. Furthermore, it helps with the gap between theory and practice described in the literature, and that is described as the problem faced by the practitioner when he has to perform something that has been previously theoretically seen.

Aim:

To learn more about the use of reflective writing in the development of dental professional skills in future dentists.

Research Question:

How can dental preclinical practice be enhanced using reflective writing?

To answer the research question is necessary to respond to the following secondary research questions:

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1. How does the use of photograph (taking and sharing) influence the reflective practice and performance of preclinical dental students?
2. What are the differences in the engagement with reflection (if any) when students perform a reflective writing activity during their preclinical practice?
3. What is the perception of the tutors about the impact of students' reflective practice on the teaching and learning process?

This study will follow a mixed method research approach from a pragmatic perspective. It will consider three phases: pre-intervention, intervention and post-intervention. During the pre-intervention phase, the students will complete a questionnaire developed by Kember et al. (2000) and modified by Tricio et al. (2015) to be used with dental students (see Appendix 1) to measure the engagement of the student with reflection.

During the intervention, the students must take pictures with a mobile device and upload them with a description and reflection in OneDrive application. As well the researcher will record the observation of students and tutors throughout their practices. Additionally, a rubric, developed by Wald et al. (2012) will be used to evaluate the student's reflective writing (see Appendix 2)

In the post-intervention phase, all the students will take the already mentioned questionnaire again. At least two focus groups will be carried out with eight students each. Depending on the quality of them, another focus group will be considered. The participants will be selected according to the quality of their writing reflections, three who achieve a level of reflection or critical reflection and three who meet habitual action or introspection.

Eight semi-structured interviews will be conducted with students, using the same criteria used to select the participants for the focus groups.

In the case of tutors, a focus group will be performed considering all of them (eight tutors in total). Besides, individual interviews will be conducted depending on the quality of the focus group.

Ethical issues discussed and decisions taken:

Following the SoE Research procedure, I include here all the suggestion done by the discussant and a description of what we conversed in the different points proposed by a guide delivered by the School of Education[1].

[1] http://www.bristol.ac.uk/education/research/networks/ethicscommittee/procedures/

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Discussed Points:

1. **Research Access/ Exit**

The research access is given due to one of my funders is the school where I will conduct the study. I had a meeting with the dean of the faculty of dentistry Dr Alex Bustos, who asked me to send all the documentation to the president of the Research and Bioethics at the Faculty of Dentistry at the Universidad de Concepción, Dr Gabriela Sánchez when I complete the procedures at the University of Bristol.

I also have been in contact with the main tutor of third-year dental preclinical students, Dr Muriel Mendoza, who coordinated the dates to be able to implement the activity that I have developed when I get the approval for this project.

Once, the corresponding permits are obtained I will be able to inform the tutors and students of the activity, and ask them if they want to participate in the study.

The research will be conducted during the unit of fixed prosthesis. When the students finish the unit, they also finish their participation in the study. As the tutors, as well.

2. **Information given to participants**

An information sheet was prepared for students (see Appendix 3) and tutors (see Appendix 4). There I provide all the information they need to know about the study.

3. **Participants right of withdrawal**

The information sheet expresses the right of participants to withdraw from the study whenever they consider pertinent. The activity will be incorporated into their practices, so they will need to follow it, but they may decide not to participate in the study. Therefore, their information will not be accounted for.

A limit of one week after the intervention starts and one week before it finishes will be given to the participants to decide to participate or to withdraw from the study.

4. **Informed Consent**

An informed consent form was designed for students (see Appendix 5) and tutors (see Appendix 6), they need to agree several points related to their understanding of the study before they consider taking part.

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5. Complaints procedures

The participants will be provided with the contact of the researcher and her supervisors to expose any possible complaint they have related to the study.

6. Safety and Well-being of participants/researchers

As the tutors and students, I will follow the regulation of the Universidad de Concepción to work in the preclinical laboratory, using a scrub, protection mask, and protection glasses and gloves when is required.

For taking pictures, the student will have a designed area, to no disrupt the regulation for the use of mobile devices in clinical environments.

The students under their preclinical practice, work with phantoms or mannequins, so extra consideration for patient's safety and well-being is not necessary.

7. Anonymity/ Confidentiality

Students will be asked to complete their names and last names in the questionnaires unique and exclusively to compare their results after and before the intervention and if they ask for advice from the researcher in the area of reflection, to identify their tests. They will be informed that this is the reason and that for the rest of the study this will be treated anonymity and confidentiality.

The only person that will have access to their results in the test will be the researcher. To analyze, storage and report it, those data will replace by a random number, the same will be done with the name of the tutors, to avoid that the students recognize their classmates and tutors. This transformation of information will be stored by the researcher and only she will have access to it.

In the case of pictures taken by the researcher while she conducts the observation, if any of the participants appears on the picture, their faced will be disseminated and their names erased from their uniforms.

8. Data Collection, Data Analysis and Storage

All participants (students and tutors) will be asked to consent being photographed and video recorded. Furthermore, they will consent any data collection at any stage this study. This data and other data related to the research will be stored on the university server, accessed remotely during the field work. The pictures taken by the students will be stored in the application, using their university's account, and protected under a password.

Member checking will be used when I think my view could interfere in the way I see results.

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9. Data Protection Act

The data collected will only be utilised for the purposes agreed with the participants in the consent form. It includes the thesis and possible publications.

10. Feedback

Participants will be informed that they can contact the researcher if they want to know their results and if they want advice on how to use reflection in their practices. I will share with them my availability, to give them the opportunity to book an appointment if they deem it appropriate.

At the end of the study, depending on the results, I will prepare a guide to improve reflective practices, for tutors and students.

11. Responsibilities to colleagues/ Academic community

The research is planned considering all the participants and based on the literature. It is innovative and it nor considering the fabrication of results or plagiarism of other colleagues. Furthermore, I attended different conferences related to the area to see what people are doing in different places and trying to incorporate concepts as updated as possible.

12. Reporting of research

The participants will be informed that results could be used for thesis purpose and possible publications. Anonymity and confidentiality will be assured to them.

Appendixes:

Appendix 1: Kember's questionnaire

Appendix 2: Rubric to evaluate the student work in the application

Appendix 3: Information Sheet for students

Appendix 4: Information Sheet for tutors

Appendix 5: Informed Consent for students

Appendix 6: Informed Consent for tutors

Signed: Daniela Pino Signed: Carolina Gordillo

Date: 20-09-2017

Note: The name of the student was changed by his/her student number.

Appendix L
Information Sheets for students

Information Sheet for students

Project: Promoting reflection in preclinical dental students using mobile technologies: A mixed method study

You are invited to take part voluntarily in a research project. It aims to learn more about the use of reflective writing in the development of dental professional skills in future dentists. The activity considers that you take pictures with a mobile device during your practices in the fixed prosthodontics unit, and use them to write a reflection about your practice. This will be shared with your classmates using OneNote Application.

The activity is required as another form of feedback from your practices; however, your partaking in this study is voluntary. You will have the right to withdraw from the study without a given justification and just by sending an email informing the decision during the period between a week after the study starts and a week before it ends.

What does the participation in this study mean?

The activity of reflective writing will be introduced in the unit of fixed prosthodontics. If you decide to participate in the study, you will take a test before starting the activity and after finished it. It describes your engagement with reflection in the dental training. You may ask for your results at any time as well as request advice related to the topic of the project. To do that, you could book an appointment with the researcher.

Furthermore, you will be observed meanwhile you conduct your practices, while you interact with your tutors and classmates, and at the end of the activity, some of you will be invited to participate in a focus group or a personal face-to-face interview to talk about the activity. The dates will be negotiated with you according to your time availability.

Some personal data will be requested in the questionnaire, including your name and last name to compare the results you obtain after and before the test. It will be replaced by a random number (known only by the researcher) to ensure anonymity, for the storage, analysis and report of the information. Besides, some pictures may be taken during the

observation period by the researcher, who will blur the face of any person that appears and erase their names from their scrubs

What will you gain from this project?

To reflect how you live your practices. This could also have an impact in next cohorts of students and future tutors.

If you have further questions or any complaint related to this, please do not hesitate to contact the researcher and /or her supervisors.

Researcher: **Daniela Pino Valenzuela** Daniela.Pino@bristol.ac.uk

Supervisors: **Prof Sally Barnes** Sally.Barnes@bristol.ac.uk

Dr Kate Whittington K.Whittington@bristol.ac.uk

Prof David Dymock D.Dymock@bristol.ac.uk

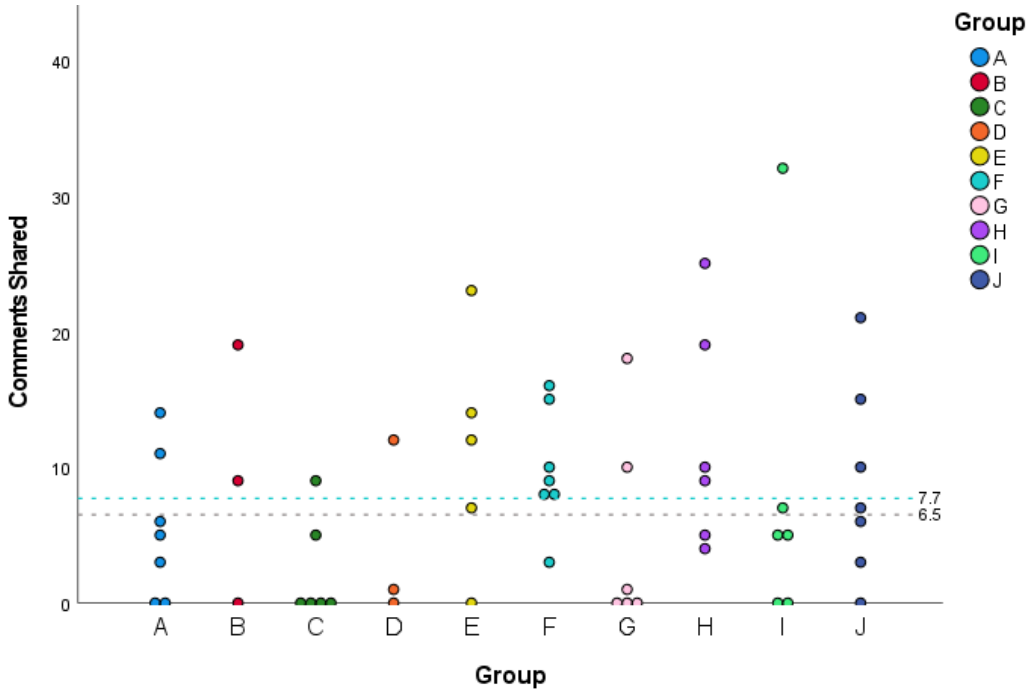
Thank you in advance, I appreciate the time you will take to contribute to my research.

Yours sincerely,

Daniela Pino Valenzuela
PhD Student, School of Education
University of Bristol

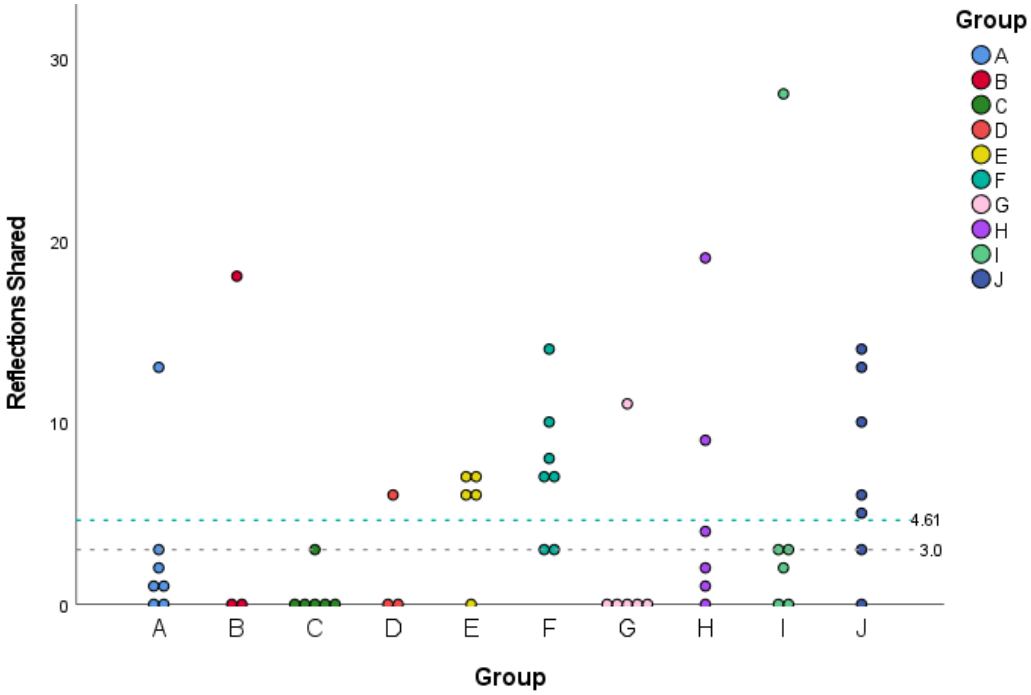
Appendix M
Comments and Reflections frequencies by participants.

Comments shared frequencies by participants in each group



Note. N=56. Each group of preclinical work received a letter from a to 'A' to 'J' (total= ten groups), colours differentiate the participants in each group. Cohort_1 includes subgroups from 'A' to 'E.' Cohort_2 includes sub-groups from 'F' to 'J.' The green dotted line represents the mean of comments shared on OneNote by the participants, M=7.70 (SD=7.5), and the grey dotted line the median, Mdn= 6.5.

Reflections shared frequencies by participants in each group



Note. N=56. Each group of preclinical work received a letter from a to 'A' to 'J' (total= ten groups), colours differentiate the participants in each group. Cohort_1 includes subgroups from 'A' to 'E.' Cohort_2 includes sub-groups from 'F' to 'J.' The green dotted line represents the mean of reflections shared on OneNote by the participants, M=4.61 (SD=5.93), and the grey dotted line the median, Mdn= 3.

Appendix N
Consent form for students

Informed Consent form for students

Project: Promoting reflection in preclinical dental students using mobile technologies: A mixed method study

Researcher: Daniela Pino V

Related to the study that you have been invited to, please read carefully the following affirmations to check your understanding, marking with a cross ☒:

☐ I read an information sheet related to the study and understand that it will be carried out during the regular practices in the fixed prosthodontics unit, where a new activity will be incorporated.

☐ I understand that I can have access to my results and I request advice in the field of reflection to the researcher.

☐ In case that I will be invited to participate in the interviews they will be audio-recorded, and focus groups audio and video-recorded to facilitate the transcriptions.

☐ I consent that the researcher, while she is doing her observation, take photos during my practices in different settings (e.g. doing a dental preparation), and then blur my face and my name on my scrub.

☐ I understand that the information collected during the study will be treated anonymously and I only provide my identification in the questionnaires to compare my results after and before the intervention, and then a random number will replace it.

☐ I consent the use of the information anonymously in further thesis or any subsequent publication (e.g. quote extracts from reflective writing)

☐ I understand that my participation in the study is voluntary and I can withdraw without further justification during the time established by the study.

☐ I was informed that I can address the researcher and her supervisors in case I have any question or complaint related to the study.

I, _ (name), e-mail: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _@udec.cl, consent to participate in the research. _____

Signature Date: __/___/_____

Appendix O
Information Sheets for Tutors

University of BRISTOL

Information Sheet for tutors

Project: Promoting reflection in preclinical dental students using mobile technologies: A mixed method study

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You are invited to take part voluntarily in a research project. Its aim is to learn more about the use of reflective writing in the development of dental professional skills in future dentists. The activity considers that the students take pictures with a mobile device during their practices in the fixed prosthodontics unit, and use them to write a reflection about their practice. This will be shared with their classmates using OneNote Application.

The activity is required for the students as another form of feedback of their work. As a tutor, you must give them feedback as in a regular practice.

Your partaking in this study is voluntary. You will have the right to withdraw from the study without a given justification and just by sending an email informing the decision during the period between a week after the study starts and a week before it ends.

What does the participation in this study means?

If you decide to participate in the study, you will be observed meanwhile you conduct your practices, while you interact with your students and colleagues. Some pictures may be taken by the researcher, who will blur the face of any person that appears and erase their names from their scrubs.

Please, during the observation session, try to not interact with the researcher to avoid the possible influence in students' perceptions of the activity.

At the end of the activity you will be invited to participate in a focus group or a personal face-to-face interview to talk about the activity. The dates will be negotiated with you according to your time availability.

What will you gain from this project?

To reflect on your role as tutor on preclinical dental students. This could have an impact in the next cohort of students and future tutors.

If you have further questions or any complaint related to this project, please do not hesitate to contact the researcher and /or her supervisors.

Researcher: **Daniela Pino Valenzuela** Daniela.Pino@bristol.ac.uk

Supervisors: **Prof Sally Barnes** Sally.Barnes@bristol.ac.uk

Dr Kate Whittington K.Whittington@bristol.ac.uk

Prof David Dymock D.Dymock@bristol.ac.uk

Thank you in advance, I appreciate the time you will take to contribute to my research.

Yours sincerely,

Daniela Pino Valenzuela

PhD Student, School of Education

University of Bristol

Appendix P
Consent form for tutors

Consent form for tutors

Project: Promoting reflection in preclinical dental students using mobile technologies: A mixed method study

Researcher: Daniela Pino V

Related to the study that you have been invited to, please read carefully the following affirmations to check your understanding marking with a cross ☒:

☐ I read an information sheet related to the study and understand that it will be carried out during the regular practices in the fixed prosthodontics unit, where a new activity will be incorporated.

☐ In case that I am invited to participate in the interviews, I understand they will be audio-recorded, and the focus groups will be audio and video-recorded to facilitate the transcriptions.

☐ I consent that the researcher while doing observations, takes photographs during my practices in different settings (e.g. while I interact with the students), and then blurs my face and my name on my scrub.

☐ I understand that the information collected during the study will be treated anonymously, and that my personal information will be associated to a random number known only by the researcher.

☐ I consent the use of the information anonymously in further dissertation or any subsequent publication (e.g. quote extracts from focus group)

☐ I understand that my participation in the study is voluntary and that I can withdraw without further justification during the time established by the study.

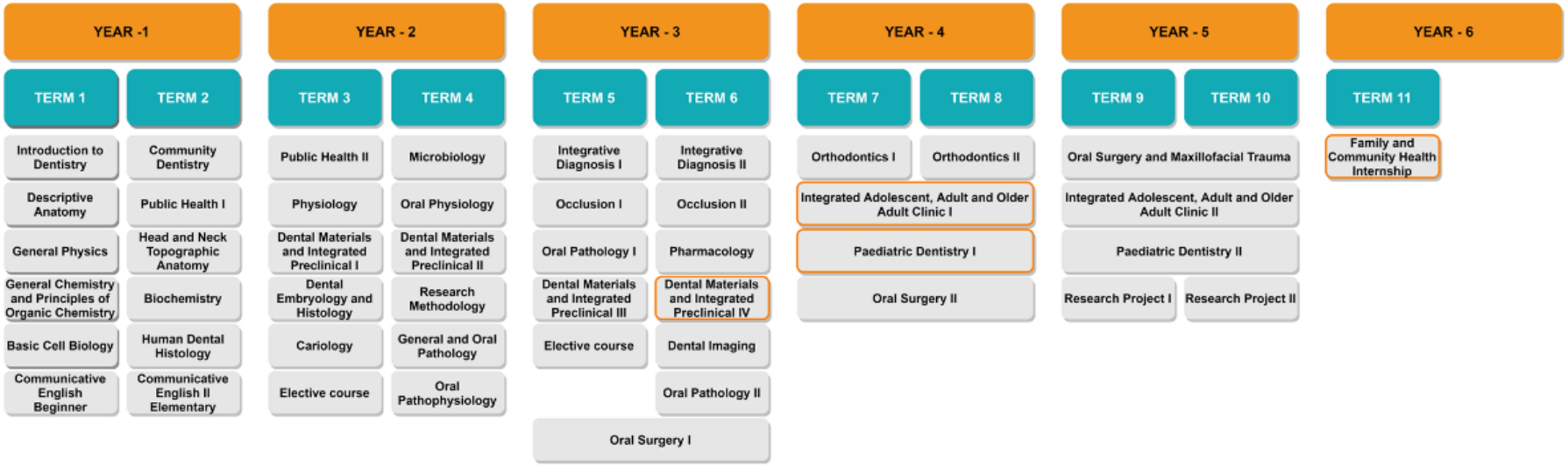
☐ I was informed that I can address the researcher and her supervisors in case I have any question or complaint related to the study.

I, _ (name), e-mail:_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _@udec.cl, consent to participate in the research.

_____

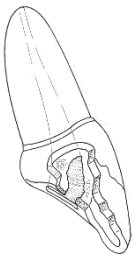
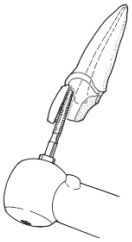
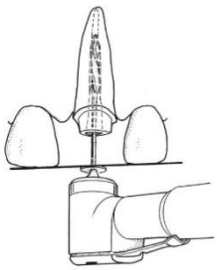
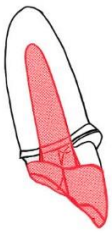
Signature Date: __/___/_____

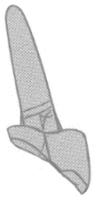
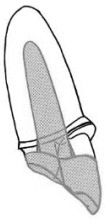
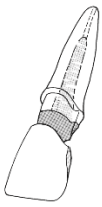
Appendix Q
Dental Programme



Note. This programme valid from 2015 to 2020. It was published in November. Each orange square represents a year of training.
Each year is constituted by two terms. The total of the programmes is 5.5 years or 11 terms.
The grey squares represent the units in each term. It was highlighted with an orange outer line the four integrative units defined in the study plan 2015-20.

Appendix R
Practical Sessions

Session		Description	Hours
1		- Group division and instrumental check-up. - Description of the case and ordering teeth on the jaw.	3
2	 	- Preparation of the crown	3
3		- Finishing crown and root preparation. - Pattern fabrication using burn out resin (i.e., Duralay),	3
4		- Finishing pattern fabrication	3
5		- Last details of pattern fabrication and send it later to the laboratory for casting.	3

Session		Description	Hours
		- 1st temporary post and core crown. Chair-side made temporary with wire extension to the root canal.	
6		- Polishing and adjusting the indirect custom-made post.	3
7	-	- 1st Temporary crown course director evaluation.	3
8		- Custom made post cementation.	3
		- 2nd Temporary crown	
9	-	- 2nd Temporary crown course director evaluation	3
		Total	27

Notes. Based in Syllabus Dental Material and Preclinical Integrated. Images adapted from Shillingburg et al. (1996), descriptions complemented using Mitchell, D., Mitchell, L., and McCaul (2018).

Appendix S
Marking scheme

UNIVERSITY OF CONCEPCION GRADUATES MARKING SCHEME AND DIFFERENTIAL LEVEL OF AWARD

Failure Marks		**Pass Marks**		**Differential level of award**
1-100 point scale	1-7 scale	1-100 point scale	1-7 scale	
1	1.0	51	4.0	
2	1.1	52	4.1	
3	1.1	53	4.1	
4	1.2	54	4.2	
5	1.2	55	4.2	
6	1.3	56	4.3	
7	1.4	57	4.4	
8	1.4	58	4.4	
9	1.5	59	4.5	Pass
10	1.5	60	4.5	
11	1.6	61	4.6	
12	1.7	62	4.6	
13	1.7	63	4.7	
14	1.8	64	4.8	
15	1.8	65	4.8	
16	1.9	66	4.9	
17	2.0	67	4.9	
18	2.0	68	5.0	
19	2.1	69	5.1	
20	2.1	70	5.2	
21	2.2	71	5.3	Merit
22	2.3	72	5.4	
23	2.3	73	5.5	
24	2.4	74	5.6	

25	2.4
26	2.5
27	2.6
28	2.6
29	2.7
30	2.7
31	2.8
32	2.9
33	2.9
34	3.0
35	3.1
36	3.1
37	3.2
38	3.2
39	3.3
40	3.4
41	3.4
42	3.5
43	3.5
44	3.6
45	3.6
46	3.7
47	3.8
48	3.8
49	3.9
50	3.9

75	5.7	Distinction
76	5.8	
77	5.9	
78	6.0	
79	6.1	
80	6.1	
81	6.2	
82	6.2	
83	6.3	
84	6.4	
85	6.4	
86	6.5	
87	6.5	
88	6.6	
89	6.6	
90	6.7	
91	6.8	
92	6.8	
93	6.9	
94	6.9	
95	7.0	
96	7.0	
97	7.0	
98	7.0	
99	7.0	
100	7.0	

Note. Translated by the author from university's regulations. (Institutional Regulation of Undergraduate Teaching, 2018)

Appendix T
Institutional project award

Universidad de Concepción

7 AÑOS UNIVERSIDAD ACREDITADA
Comisión Nacional de Acreditación CNA-Chile

Concepción, 26 de julio de 2018.
VRID Nº478/18.

Señora
Prof. Daniela Pino Valenzuela
Departamento de Odontología Restauradora
Facultad de Odontología
PRESENTE

Estimada prof. Pino,

Me es grato informar a Ud. que su proyecto **"Promoviendo la reflexión en estudiantes de preclínico de Odontología usando tecnologías móviles: Un estudio de enfoque mixto"**, ha sido aprobado a contar del día de hoy, como VRID-Iniciación por un período de dos años.

Código	218.102.031-1.0IN
Monto Total	$6.000.000.-
Año 1	$3.000.000.-
Año 2	$3.000.000.-

Agradeceré a Ud. contactar a la Sra. Teresa Tapia B., Jefa Administrativa de esta Vicerrectoría para revisar los ajustes presupuestarios, si procede.

Deseándole éxito en la ejecución del proyecto, le saluda cordialmente,

UNIVERSIDAD DE CONCEPCIÓN VICERRECTORÍA DE INVESTIGACIÓN Y DESARROLLO
DIRECCIÓN DE INVESTIGACIÓN Y CREACIÓN ARTÍSTICA

Dr. Ronald Mennickent C.
Director de Investigación y Creación Artística

/cmo
c.c.:
- Sra. Teresa Tapia B., Jefa Administrativa VRID
-archivos

Por el desarrollo libre del espíritu

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99 años

Appendix U
Topic-Related peer reviewed conference presentations

1. Pino-Valenzuela, DA., Santana Catalan, N., Grandón Villegas, F., Acuña Silva, F. Resto Training Kit (RTK) Remote training for dental undergraduate students. Short Communication. In: Annual Meeting of the Association for Medical Education in Europe (AMEE), The Virtual Conference, 2021.

2.Pino-Valenzuela, DA. Sharing experiences through images: an intervention that promotes reflection using mobile technologies in dental education. ePoster - Virtual . In: Annual Meeting of the Association for Medical Education in Europe (AMEE), The Virtual Conference, 2020.

3. Pino Valenzuela, D. Torres Hidalgo P., Pérez Cabezas P. Promoting reflection in pre-clinical dental students using Design-Based Research. ePoster Presentation In: Annual Meeting of the Association for Dental Education in Europe (ADEE), Berlin, Germany. August 2019.

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Resto Training Kit (RTK) Remote training for dental undergraduate students

Conference: AMEE 2021

Reference Number: 9244

Submitted as: Short Communication

Accepted as: Short Communication

Topic: Clinical/practical skills

Tracks: Response to COVID-19

Travel Award: Yes

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Background

The pandemic caused by SARS-CoV-2 changed the daily activities. To date, social distancing is the main public policy to control its expansion. This scenario has deeply affected traditional educational practices, online teaching as the only alternative to keep up with programmes. However, this response was mainly able to cover theoretical contents.
Dentistry is a profession which requires solid theoretical and practical background. Because of the pandemic, the latter was severely affected due to the students' impossibility to attend on-site activities. Consequently, a critical gap in their clinical competences, jeopardise their future performance with patients. Therefore, new pedagogies are needed to complement online activities.
The present approach analysed a Chilean dental school situation and identified from its curriculum those competencies where a practical training was crucial. Following Design-Based Research, an intervention was designed and implemented.

Summary of Work

The competences needed for a dentist to graduate from a dental school in Chile were analysed. Then, those not covered by online education were selected and included in an educative intervention. A specially designed restorative kit was sent to the students' homes, enabling practical work without attending campus facilities. A permanent track of their progress was achieved using photography and video recording of their work. Feedback was provided synchronous and asynchronous through an online platform.

Summary of Results

The use of remote practical training enabled the development of the student's critical competencies in the dental restorative field. The applied educative intervention was not only able to bridge the gap between theoretical concepts and their clinical application but also to lower the student's anxiety. Thus, preparing them better for clinical practice once pandemic restrictions permit it.

Discussion and Conclusions

Practical training represents a fundamental component in the education process of a dentist. Therefore, the adequate build of these clinical competencies is a milestone in the curriculum of every dental school. The innovative approach proposed here demonstrated to be a good alternative to conventional on-site practical training. Moreover, it opens a wide spectrum of alternatives for remote clinical teaching in other fields.

Take Home Messages

New pedagogical strategies are needed to accomplish graduate competences.
Remote training could be beneficial for practical skills in dental students.

Please State Presentation Preference (Face-to-Face; Remote; No Preference)

No preference

Sharing experiences through images: an intervention that promotes reflection using mobile technologies in dental education

Conference: AMEE 2020: The Virtual Experience

Reference Number: 7172

Submitted as: Poster Forum

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Topic: Other

Travel Award: No

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Background

Reflection and Critical thinking is an ability highly requested in dental students. However, programs are not finding a holistic way to measure and promote it. Besides, a gap between theory and practice is widely described in the literature, making explicit the difficulties the students face when they start treating patients after a preclinical training. Thus, following Deseing based Research (DBR) a a three phase intervention trying to cope with those issues and using moblie applications was designed and applied to third-year students at a traditional University in Chile.

Summary of Work

An intervention was designed, using OneNote (Microsoft application) as a platform to share experiences, comments and reflections, based on images took by the students while working in the preclinical sessions.

Summary of Results

From 65 students that constituted the cohort, 56 (86.15%) agreed to participate in the intervention voluntarily signing the consent form. From these participants, 37 were females (66.1%) and 19 males (35.8 %). This ratio was like the ratio of the entire cohort and did not show a tendency of females to participate in the intervention. They share in total 634 images, and a their participation where diverse in their groups of work.
There was a strong influence of extermal factors mirrored in the increment of their participation on line.
Students main use of images:
1. Record data: dimensions (e.g tooth length) needed to take some decisions; name and manipulation of different materials.
2. Self-Evaluate: See new angulation of own work;nCompare with others
3.Visualise: Step by step of the procedures, details, value the development of their work, distinguish errors, recognise the work of others.

Discussion and Conclusions

There are little actions that tutors can take to promote reflection on their students (i.e. asking them some questions to tackle deep considerations of their procedures)
The student's comments suggested that reflecting on their work help them to consider different scenarios and inform future actions they conduct.

Take Home Messages

Reflection needs to be understood as a holistic process and can be promoted through images of own work. Mobile technologies offer a high possibility to develop strategies to encourage reflection, that possible contribute to bridging the gap between theory and practice.

other hand, it is important to prepare students with coping mechanism to help reduce their anxiety before they are introduced to cadaver dissection. Virtual Reality could become an useful tool for that purpose, as a way to approach the student to the anatomical preparation.

Theme: Teaching Methods **ID:** GPP TM 04

Withdrawn by submitted

Theme: Teaching Methods **ID:** GPP TM 05

Promoting reflection in pre-clinical dental students using Design Based Research

Submitter: Ms Daniela Pino

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Abstract:

Background:
There are many practical problems in dental education, however, educators might not find the appropriate way to tackle them. One possible solution could be to employ Design-Based Research (DBR) as an attempt to value all the practical knowledge that emanates from our practices with all the theory behind.
In this sense, an intervention was incorporated into third-year students. It promoted reflection using mobile technologies. Students were asked to shared images of their work at the clinical skills lab. They used OneNote application to share the images, comments and reflections of their work.
Additionally, they completed a questionnaire to determine their level of engagement with reflection, and a rubric was used to determine the reflective level they achieved in a final task that was given to them.

Aims & Objectives:
1. Describe how DBR could be employed to design an intervention with third-year students and their tutors.
2. Consider reflection as a fundamental skill that students should acquire and develop during their training.
3. Promote reflection using mobile technologies.

Materials and Methods:
DBR was followed, using Mixed methods to achieve the aims of this study. It includes a questionnaire, observation, focus groups, interviews, rubrics.

Results:
An intervention was designed. Including elements that came from researchers practice and from the literature review. A preliminary phase (pilot study) was conducted with 12 students. After revised the framework, 57 students and their tutors (7) acceded to participate in the second part of the study.

Conclusions:
Preliminary conclusions showed the feasibility to use DBR to incorporate an intervention into dental education. Students showed high levels of engagement with reflection, however, our role as tutors is huge in promoting some activities that give them the opportunity to develop their potential, there is where technologies could help us a lot.

Theme: Teaching Methods **ID:** GPP TM 06

Typical errors with intraoral spectrophotometer - A study with preclinical students

Submitter: Dr Constanze Olms

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Abstract:

Background:
Currently there are no training methods or studies that examine the learning success rate for digital shade measuring devices.

Aims & Objectives: